HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)
CHENNAI

B. TECH. MECHANICAL ENGINEERING

(Duration: 4 Years)

CURRICULUM and SYLLABUS

(Applicable for Students admitted from Academic Year 2021-22)

DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

Motto:

To Make Every Man *a* Success *and* No Man *a* Failure

Vision:

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

Mission:

- *To create an ecosystem that promotes learning and world class research.*
- *To nurture creativity and innovation.*
- *To instill highest ethical standards and values.*
- *To pursue activities for the development of the Society.*
- *To develop national and international collaborations with institutes and industries of eminence.*
- *To enable graduates to become future leaders and innovators.*

Value Statement:

Integrity, Innovation, Internationalization.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To excel in innovation and collaborative research, promoting technical and entrepreneurial skills.

MISSION

The Mechanical Engineering program continuously strives,

M1. To provide a conducive academic environment with contemporary and innovative curricula imparting high quality education

M2. To offer state of the art laboratory infrastructure to enhance fundamental research

M3. To maintain an environment to work closely with industries to materialize collaborative and applied research

M4. To impart technical, managerial and lifelong learning skills, embedded with ethical values and social relevance.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO'S):

PEO1. Successful career and adaptability to industry: Graduates will have in-depth knowledge appropriate to the discipline of Mechanical Engineering which enables them to pursue higher studies and academic research.

PEO2. Modern design tools and multi-disciplinary project execution: Graduates will attain professionalism and shall be industry adaptive through a degree structure that is relevant to industry, and responsive to changes in technology and the needs of the society with noble attitude and social responsibility.

PEO3. Contribution to mechanical field and lifelong learning: Graduates will posses multi and inter disciplinary knowledge and excel in innovation and teamwork with entrepreneurial capabilities

PROGRAM OUTCOMES [PO's]

PO 1 : Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex Mechanical engineering problems.

PO 2 : Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first

principles of mathematics, natural sciences, and engineering sciences.

PO 3 : Design/development of solutions: Design solutions for complex Mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4 : Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, 5analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 : Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools that are relevant to Mechanical engineering, including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 : The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.

PO 7 : Environment and sustainability: Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 : Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Mechanical engineering practice.

PO 9 : Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10 : Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11 : Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12 : Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOME (PSO's)

PSO 1 : Apply their acquired knowledge in the field of thermal and manufacturing sciences to provide solutions for engineering problems using current technology.

PSO 2 : Apply the concepts of design, analysis and implementation of mechanical systems and processes to provide solutions to the real world situations.

B.TECH – MECHANICAL ENGINEERING									
(165 - CREDIT STRUCTURE)									
SEMESTER - I									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MEA4101/ ELA4101	Engineering Graphics and Computer aided Design / Professional English and soft skills	1	1	2	3	1	4
2	BS	MAA4101	Matrices and calculus	3	0	2	4	1	5
3	BS	PHA4101/ CYA4101	Engineering Physics / Engineering Materials	3	0	0	3	1	3
4	PC	CSA4101/ GEA4102	Problem Solving Using C* / Sustainable Engineering Systems	2	0	2*	3/2	1	4/3
5	PC	MEB4101	Engineering and Design	3	0	0	3	1	3
6	BS	GEA4131	Engineering Immersion Lab	0	0	2	0.5	2	2
7	BS	PHA4131/ CYA4131	Engineering Physics Lab / Materials Chemistry Lab	0	0	2	1	0	2
Total				**12**	**1**	**10**	**17.5/ 16.5**	**7**	**23/ 22**
***Project based Learning**									
SEMESTER - II									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MAA4117	Analytical Mathematics	3	0	2	4	0	5
2	BS	PHA4101/ CYA4101	Engineering Physics / Engineering Materials	3	0	0	3	1	3
3	BS	MEA4101/ ELA4101	Engineering Graphics and Computer aided Design / Professional English and soft skills	1	1	2	3	1	4
4	PC	GEA4102/ CSA4101	Sustainable Engineering Systems / Problem Solving Using C*	2	0	2*	2/3	1	3/4
5	PC	EEB4101	Introduction to Digital Systems	3	0	0	3	1	3
6	PC	MEB4116	Engineering Mechanics	3	1	0	4	1	4
7	PC	MEB4117	Manufacturing Technology – I	3	0	0	3	1	3
8	BS	PHA4131/ CYA4131	Engineering Physics Lab / Materials Chemistry Lab	0	0	2	1	0	2
9	BS	GEA4131	Engineering Immersion Lab	0	0	2	0.5	2	2
Total				**18**	**2**	**10**	**23.5/ 24.5**	**6**	**26**

SEMESTER - III									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MAA4201	Partial Differential Equations and Transforms	3	1	0	4	0	5
2	PC	MEB4201	Engineering Thermodynamics	3	1	0	4	2	4
3	PC	MEB4202	Fluid Mechanics and Machinery	3	0	0	3	2	3
4	PC	MEB4203	Manufacturing Technology – II	3	0	0	3	2	3
5	DE		Department Elective – I	3	0	0	3	0	3
6	NE		Non Department Elective – I	2	0	0	2	0	2
7	PC	MEB4231	Fluid Mechanics and Machinery Lab	0	0	2	1	1	2
8	PC	MEB4232	Manufacturing Technology Lab	0	0	2	1	1	2
9	PC	MEB4233	Design Project-I	0	0	2	1	0	2
Total				**17**	**2**	**6**	**22**	**8**	**26**

SEMESTER - IV									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MAA4216	Probability and Statistics	3	1	0	4	0	5
2	PC	MEB4216	Thermal Engineering	3	0	0	3	2	3
3	PC	MEB4217	Strength of Materials	3	0	0	3	2	3
4	PC	MEB4218	Engineering Metrology and Measurements	3	0	0	3	2	3
5	BS	GEA4216	Professional ethics and life skills	2	0	0	2	1	2
6	DE		Department Elective-II	3	0	0	3	0	3
7	NE		Non Department Elective – II	2	0	0	2	0	2
8	PC	MEB4241	Thermal Engineering Lab I	0	0	2	1	0	2
9	PC	MEB4242	Strength of Materials Lab	0	0	2	1	0	2
10	PC	MEB4243	Engineering Metrology and Measurements Lab	0	0	2	1	0	2
11	PC	MEB4244	Design Project-II	0	0	2	1	0	2
Total				**19**	**1**	**8**	**24**	**7**	**29**

SEMESTER - V									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	MAA4301	Optimization Techniques	3	1	0	4	0	4
2	PC	MEB4301	Design of Machine Elements	3	0	0	3	2	3
3	PC	MEB4302	Mechanics of Machines	3	0	0	3	1	3
4	PC	MEB4303	Gas Dynamics and Jet Propulsion	3	0	0	3	1	3
5	PC	MEB4304	Mechatronics and Pneumatics	3	0	0	3	1	3
6	DE		Department Elective-III	3	0	0	3	0	3
7	NE		Non Department Elective-III	2	0	0	2	0	2
8	PC	MEB4331	Dynamics Lab	0	0	2	1	0	2
9	PC	MEB4332	Thermal Engineering Lab –II	0	0	2	1	0	2
10	PC	MEB4333	Mechatronics and Pneumatics Lab	0	0	2	1	0	2
11	PC	MEB4334	Design Project-III	0	0	2	1	0	2
Total				**20**	**1**	**8**	**25**	**5**	**30**

SEMESTER - VI									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	MEB4316	Computer Aided Design and Manufacturing	3	0	0	3	2	3
2	PC	MEB4317	Design of Mechanical Transmission System	3	0	0	3	2	3
3	PC	MEB4318	Composites and Smart Materials	3	0	0	3	2	3
4	PC	MEB4319	Nano Technology	3	0	0	3	2	3
5	BS	GEA4304	Business Economics	2	0	0	2	1	2
6	DE		Department Elective-IV	3	0	0	3	0	3
7	NE		Non Department Elective–IV	2	0	0	2	0	2
8	PC	MEB4341	Computer Aided Design and Manufacturing Lab	0	0	2	1	0	2
9	PC	MEB4342	Composites and Smart Materials Lab	0	0	2	1	0	2
10	PC	MEB4343	Design Project-IV	0	0	2	1	0	2
11	PC	MEB4344	Comprehension	1	0	0	1	0	1
Total				**20**	**0**	**6**	**23**	**9**	**26**

SEMESTER - VII									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	MEB4401	Heat and Mass Transfer	3	0	0	3	2	3
2	PC	MEB4402	Finite Element Methods	3	0	0	3	2	3
3	PC	MEB4403	Robotics and Automation	3	0	0	3	1	3
4	PC	MEB4404	Additive Manufacturing Technology	3	0	0	3	2	3
5	NE		Non Department Elective–V	2	0	0	2	0	2
6	DE		Department Elective-V	3	0	0	3	0	3
7	PC	MEB4431	Heat Transfer Lab	0	0	2	1	1	2
8	PC	MEB4432	Computer Aided Simulation and Analysis Lab	0	0	2	1	1	2
9	PC	MEB4433	Robotics and Automation Lab	0	0	2	1	1	2
10	PC	MEB4434	Design Project-V	0	0	2	1	0	2
11	PC	MEB4435	Internship	0	0	0	1	0	0
Total				**17**	**0**	**8**	**22**	**10**	**25**

SEMESTER - VIII									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	MEB4441	Project & Viva - voce	0	0	16	8	0	16
Total				**0**	**0**	**16**	**8**	**0**	**16**
Total							**165**		

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE									
SEM	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
3	DE	MEC4251	Non Destructive Testing Methods	3	0	0	3		3
3	DE	MEC4252	Reverse Engineering	3	0	0	3		3
3	DE	MEC4253	Mechanical Metallurgy	3	0	0	3		3
3	DE	MEC4254	Unconventional Machining Process	3	0	0	3		3
3	DE	MEC4255	Computer Integrated Manufacturing	3	0	0	3		3
3	DE	MEC4256	I C Engine & Stream Turbine	3	0	0	3		3
3	DE	MEC4257	Process Planning and Cost Estimation	3	0	0	3		3
4	DE	MEC4266	Refrigeration and Air conditioning	3	0	0	3		3
4	DE	MEC4267	Power plant Engineering	3	0	0	3		3
4	DE	MEC4268	Computational Fluid Dynamics	3	0	0	3		3
4	DE	MEC4269	Heat Treatment of Metals and Alloys	3	0	0	3		3
4	DE	MEC4270	Mechanical Vibration	3	0	0	3		3
4	DE	MEC4271	Modern Concepts of Engineering Design	3	0	0	3		3
4	DE	MEC4272	Characterization of Materials	3	0	0	3		3
5	DE	MEC4351	Structure and Properties of Materials	3	0	0	3		3
5	DE	MEC4352	Engineering Economics and cost Analysis	3	0	0	3		3
5	DE	MEC4353	Tool Design	3	0	0	3		3
5	DE	MEC4354	Applied Hydraulics and Pneumatics	3	0	0	3		3
5	DE	MEC4355	Automobile Engineering	3	0	0	3		3
5	DE	MEC4356	Operations Research	3	0	0	3		3
5	DE	MEC4357	Maintenance Engineering &condition Monitoring	3	0	0	3		3
6	DE	MEC4366	Tribology in Design	3	0	0	3		3
6	DE	MEC4367	Quality and Reliability Engineering	3	0	0	3		3
6	DE	MEC4368	Productivity Management and Re-Engineering	3	0	0	3		3
6	DE	MEC4369	Polymer Science and Engineering	3	0	0	3		3
6	DE	MEC4370	Advanced IC Engine	3	0	0	3		3
6	DE	MEC4371	Creep And Fatigue Behavior of Materials	3	0	0	3		3
6	DE	MEC4372	Production Planning and Control	3	0	0	3		3
7	DE	MEC4451	Dynamics and Control	3	0	0	3		3
7	DE	MEC4452	Modal Analysis of Mechanical Systems	3	0	0	3		3
7	DE	MEC4453	New Product Design and Development	3	0	0	3		3
7	DE	MEC4454	Advanced strength of Materials	3	0	0	3		3
7	DE	MEC4455	Thermal Turbo Machines	3	0	0	3		3
7	DE	MEC4456	Power Metallurgy	3	0	0	3		3
7	DE	MEC4457	Renewable source of Energy	3	0	0	3		3
7	DE	MEC4458	Lean Manufacturing	3	0	0	3		3

LIST OF NON DEPARTMENTAL ELECTIVES OFFERED BY MECHANICAL DEPARTMENT WITH GROUPING - SEMESTER WISE									
SEM	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
3	NE	MED4281	Applied Thermodynamics for Engineers	3	0	0	3		3
3	NE	MED4282	Power developing machines for transportation sector	3	0	0	3		3
3	NE	MED4283	Modern Manufacturing Techniques	3	0	0	3		3
3	NE	MED4292	CNC Machines and Controls	3	0	0	3		3
4	NE	MED4291	Unconventional Machining Processes	3	0	0	3		3
4	NE	MED4293	Computer Workstation Ergonomics	3	0	0	3		3
4	NE	MED4294	Energy and safety aspects of mechanical system for buildings	3	0	0	3		3
5	NE	MED4381	Mechanical Measurements	3	0	0	3		3
5	NE	MED4382	Fundamentals of Computer Integrated Manufacturing	3	0	0	3		3
5	NE	MED4383	Fundamentals of Engineering Design	3	0	0	3		3
5	NE	MED4384	Basic Refrigeration and Air-conditioning	3	0	0	3		3
5	NE	MED4385	3D Printing in Modern Manufacturing	3	0	0	3		3
6	NE	MED4391	Fundamentals of Power Plant Technology	3	0	0	3		3
6	NE	MED4392	Industrial Automation	3	0	0	3		3
6	NE	MED4393	Mechatronics System Design	3	0	0	3		3
6	NE	MED4394	Virtual Instrumentation	3	0	0	3		3
6	NE	MED4395	Energy Auditing and Energy Management	3	0	0	3		3
6	NE	MED4396	Electric and Hybrid Vehicles	3	0	0	3		3
7	NE	MED4481	Design of Building Automation	3	0	0	3		3
7	NE	MED4482	Industrial Safety& Maintenance Engineering	3	0	0	3		3
7	NE	MED4483	Quality Control and Reliability Engineering	3	0	0	3		3
7	NE	MED4484	Applied hydraulics and Pneumatics	3	0	0	3		3
7	NE	MED4485	Non-destructive Testing Methods	3	0	0	3		3

SEMESTER – I

COURSE TITLE	ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN			CREDITS	3
COURSE CODE	MEA4101	COURSE CATEGORY	BS	L-T-P-S	1-1-2-1
Version	1.0	Approval Details	24 ACM 30th May 2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Practical Assessment	ESE
15%	15%	20%	50%

Course Description	This course broadly introduces the mechanical design using computer aided design tools and fundamentals of free hand sketching. It prepares the students to learn the basic concepts involved in technical drawing skills and computer graphics. It also emphasis on the principles and basic understanding of projections and visualizations aspects of component designing.
Course Objective	1. To understand the basics of Engineering graphics and plane curvatures using AutoCAD tool 2. To visualize the free hand sketch and orthographic projections and to solve simple problems 3. To comprehend the various geometrical models and its developments 4. To understand the transformation of 2D drafting to 3D models using CAD tools 5. To generate associated views of 3D models and related geometric dimensioning and tolerencing.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the AutoCAD commands to generate simple drawings and understand drafting techniques. 2. Apply the acquired knowledge to solve simple problems involving straight lines, planes and solids. 3. Visualize solid objects and apply AutoCAD commands to generate the models. 4. Recognize and use 3D model commands in AutoCAD tool to generate solid objects. 5. Generate the various views of the geometrical solid model manually and using AutoCAD as well.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	-	3	-	-	-	-	-	-	-	-	-
CO-2	2	1	2	-	3	-	-	-	-	-	-	-	-	-

CO-3	**2**	**1**	**-**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-4	**2**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO-5	**2**	**1**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
1: Weakly related, 2: Moderately related and 3: Strongly related														

MODULE 1: BASICS OF ENGINEERING GRAPHICS AND PLANE CURVES (3L+3T+6P=12)	
Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer. **Practical component:**AutoCAD – Solid modelling tool - Basics. **Suggested Readings:** Basics of drafting and dimensioning	**CO-1** **BTL-2**
MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING (3L+3T+6P=12)	
Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views. **Practical component:**2D drafting, Orthographic projections **Suggested Readings:** AutoCAD tool – Commands for sketching , Projections	**CO-2** **BTL-2**
MODULE 3: GEOMETRICAL MODELLING, ISOMETRIC AND DEVELOPMENT OF SURFACES (3L+3T+6P=12)	
Principles of isometric projection and solid modelling. Isometric drawing – IsoPlanes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modeling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces **Practical component:** 3D modelling and surface development **Suggested Readings:** Surface modelling and solid modelling	**CO-3** **BTL-3**
MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (3L+3T+6P=12)	

Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc using appropriate modelling software. 2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer. **Practical component:**2D to 3D transformation, plotting of drawings **Suggested Readings:** 3D modelling – view generations and commands	**CO-4** **BTL-2**
MODULE 5: SIMPLE DESIGN PROJECTS – COMPUTER AIDED DESIGN	**(3L+3T+6P=12)**
Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerencing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying color coding according to drawing practice. **Practical component:** 3D solid meshed topology, geometrical dimensioning, simple components **Suggested Readings:** AutoCAD dimensioning, assembly of solid components	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Jeyapoovan, T. (2016). Engineering Drawing and Graphics Using AutoCAD, Vikas Publishing House Pvt Ltd., New Delhi,7th Edition.
REFERENCE BOOKS	
1.	Warren J. Luzadder and Jon. M. Duff. (2016). Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition.
2.	Jensen, J.D. Helsel, D.R. Short. (2012). Engineering Drawing and Design, McGraw-Hill, Sixth Edition.
E BOOKS	
1.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-freeebook-pdf-download.html
2.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html
MOOC	
1.	http://nptel.ac.in/courses/112103019/
2.	http://nptel.ac.in/courses/105104148/

COURSE TITLE	**PROFESSIONAL ENGLISH AND SOFT SKILLS**			**CREDITS**	**3**
COURSE CODE	**ELA4101**	**COURSE**	**BS**	**L-T-P-S**	**1-1-2-1**

		CATEGORY			
Version	**1.0**	**Approval Details**	**24 ACM 30th May 2018**	**LEARNING LEVEL**	**BTL-5**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course has been designed to meet students' current and future language and communication needs. It attempts to develop their proficiency in the four language skills and knowledge of grammar and vocabulary. This course teaches students how to communicate accurately, appropriately and fluently in professional and social situations.				
Course Objective	1. To acquire self-confidence by which the learner can improve upon their informative listening skills by an enhanced acquisition of the English language. 2. To provide an environment to Speak in English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 3. To equip the students to Read, comprehend and answer questions based on literary, scientific and technological texts. 4. To enhance the writing skills of the students via training in instructions, recommendations, checklists, process-description, letter-writing and report writing. 5. To equip the learners in analysing and applying creative thinking skills and participate in brainstorming, mind-mapping, audiovisual activities and excel in employability skills.				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of English grammar and vocabulary, construct simple sentences and articulate ideas using simple sentences to form short paragraphs. 2. Responding to higher order English words, vocabulary, phrases, expressions, idioms, and proverbs. Derive the contextual meaning through reading and listening from general and academic situations, Identify specific details and general ideas. Learn to give instructions and make suggestions. 3. Organize and articulate ideas, concepts, and perceptions in a comprehensive manner in written business correspondence, and speaking in formal and informal situations. 4. Analyze and transcode data, construct different types of written essays, read complex passages and summarize ideas, create personal profiles in the form of a resume. 5. Induce critical and analytical thinking, participate in brainstorming on general				

	topics, and transact information with an audience. Prepare students for interview questions, presentation skills. Produce complex written documents such as reports, business/scientific documents, and project proposals.

Prerequisites: Plus Two English-Intermediate Level

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-2	-	-	-	-	-	-	-	2	2	3	-	-	-	-
CO-3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-4	-	-	-	-	-	-	2	-	-	3	2	-	-	-
CO-5	-	-	-	-	-	-	-	-	2	3	2	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNCTIONAL GRAMMAR AND VOCABULARY	**(6L+6L=12)**
Introduction to communication skills –Self Introduction - Basic grammar (tenses, subject verb agreement) - Basic vocabulary (prefixes , suffixes, roots, phrasal verbs and idioms)- Topic sentences , paragraph writing **Suggested Activities:** Short conversations-Situational Communication-Dialogue Writing - Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences. **Suggested Reading:** 1. An Introduction to Professional English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009 2. Professional Speaking Skills by Aruna Koneru, Oxford Press, 2015 3. Embark, English for Under Graduates by Steve Hart, Arvind Nair, Veena Bhambhani, Cambridge University Press 2016. 4. English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition	**CO-1** **BTL-2**
MODULE 2 – LISTENING AND SPEAKING SKILLS	**(6L+6L=12)**
Academic listening (listening to lectures different topics, audio excerpts and answering question) - General listening (conversations, speeches: formal and informal) - Giving instructions and suggestions- Active and Passive Voice **Suggested activities:** Listen and repeat, Listening to audio excerpts- Listening to native speakers - TED Talks, short prepared speeches, Table topics – Speaking in different situations- MCQ's - Cloze exercises- Complete the Dialogue **Suggested sources:** (Listening and Speaking Modules) – Language Lab Professional Speaking Skills by Aruna Koneru, Oxford Press	**CO-2** **BTL-3**

English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition	
MODULE – 3 : FUNCTIONAL READING AND WRITING	**(6L+6L=12)**
Reading comprehension (academic texts and general texts)-Reading and Interpreting visual data, charts, tables and graphs-- Report writing- accident, industrial, survey, general reports –Direct and Indirect speech **Suggested Activities:** Identify the errors in sentences, grammar exercise, reading passage for identifying the contextual meaning, interpreting charts, tables and graphs, choose the right meaning of the word given Assignment on suggested reading activity – Book review **Suggested sources:** Essential English Grammar by Raymond Murphy, Cambridge University Press, 2016 edition Embark, English for Under Graduates by Steve Hart, Arvind Nair, Veena Bhambhani, Cambridge University Press 2016.	**CO-4** **BTL-4**
MODULE – 4 : BUSINESS CORRESPONDENCE	**(6L+6L=12)**
Memo-Notice - Agenda – Minutes of the Meeting-Action Taken report- Report Writing-Connectives - Cause and effect **Suggested activities:** Drafting agenda, notice, memo, minutes of the meeting- ATR- Cause and effect exercises - Presentation in the language lab (Technical or Non-technical topic) **Suggested sources:** Cambridge Advanced English, Newspapers, library books, IELTS , IELTS Academic Writing 1, New Insights into IELTS, CUP	**CO-3** **BTL-5**
MODULE 5 – PRESENTATION SKILLS AND INTERVIEW SKILLS	**(6L+6L=12)**
Presentation Skills - Reading and Interpreting Advertisements—Job Application- Covering Letter -Curriculum Vitae –E-mail - Project proposal –Interview skills (HR questions) – Group Discussion **Suggested Activities:** Presentation in the language lab (Technical or Non-technical topic) Group Discussion (Tutorial Classes) **Suggested Sources:** English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press, 2018. Education and personality development by K. Manoharan, APH Publishing Home, 2016	**CO-5** **BTL-5**

TEXT BOOKS	
1.	Dr. Bikram K. Das etal (2009), An Introduction to Professional English and Soft Skills with audio CD. Published by Cambridge University Press.
2.	Dolly John (2014), English for Life and the Workplace Through LSRW&T skills, by, Pearson Publications.
REFERENCE BOOKS	
1.	Soft Skills & Employability Skills by Sabina Pillai and Agna Fernandez published by Cambridge

	University Press 2018.
2.	Embark, English for Undergraduates by Steve Hart et al, Cambridge University Press, 2016, edition
3.	Skills for the TOEFL IBT Test, Collins, 2012 edition
4.	Soft Skills for Everyone by Jeff Butterfield, Cengage Learning, 2010 edition
5.	Professional Speaking Skills by Aruna Koneru, Oxford Publications, 2015
E BOOKS	
1	https://www.britishcouncil.in/english/courses-business
2	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
3	http://www.bbc.co.uk/learningenglish/english/
4	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
5	Oneshopenglish.com
6	Breakingnews.com
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	**MATRICES AND CALCULUS**			**CREDITS**	**4**
COURSE CODE	**MAA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-0-2-1**
Version	**1.0**	**Approval Details**	**24 ACM 30th May 2018**	**LEARNING LEVEL**	**BTL-1-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To make the student understand the basic concepts of matrices and calculus using MATLAB				
Course Objective	1. To Know how to perform some simple operations on matrices 2. To understand effectively the basic concepts of differentiation and partial differentiation and their applications. 3. To perform integration and other operations for certain types of functions and carry out the computation fluently. 4. To classify ordinary differential equations.				

Course Outcome	Upon completion of this course, the students will be able to 1. Describe the concept of matrices and Eigen Values. 2. Apply the concept of features in Differential Calculus 3. Illustrate the concept of Integral Calculus 4. Apply the concept of ordinary differential equation

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO-8	PO -9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	1	-	-	-	-	-	-	-	-	-	-	-
CO-2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO-3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
CO-4	2	1	-	-	1	1	1	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:MATRICES	**(13L+2P=15)**
Characteristic equation – Eigen values and Eigenvectors – Properties – Cayley Hamilton theorem (Statement only) – Verification and inverse of the matrix using Cayley Hamilton theorem- Diagonalization of matrices using similarity transformation Suggested Reading: Basics of Matrices **Lab1: Eigen values and Eigenvectors, Verification and inverse using Cayley Hamilton theorem- Diagonalization**	**CO-1** **BTL-4**
MODULE 2: DIFFERENTIAL CALCULUS	**(13L+2P=15)**
Methods of differentiation of functions – Product and Quotient rules – Inverse trigonometric functions – Implicit function – parametric form. Partial differentiation – Total differentiation- Taylor's series – Maxima and minima of functions of two variables Suggested Reading: Basics of Differentiation **Lab2: Taylor's series – Maxima and minima of functions of two variables**	**CO-2** **BTL-4**
MODULE 3:INTEGRAL CALCULUS	**(13L+2P=15)**
Integration – Methods of integration – Substitution method – Integration by parts – Integration using partial fraction – Bernoulli's formula. Applications of Integral Calculus: Area, Surface and Volume. Suggested Reading: Basicsof Integrations **Lab3: Applications of Integral Calculus: Area, Surface area and Volume.**	**CO-3** **BTL-3**
MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS	**(13L+2P=15)**
Second order differential equations with constant coefficients – Particular integrals – $e^{ax}, Sinax, Cosax, x^m$, e^{ax} Cos bx, e^{ax} Sin bx. Solutions of homogeneous differential equations with variable coefficients – Variation of parameters.. Suggested Reading: Basics of Differential Equations. **Lab 4**: Solution of Second order differential equations.	**CO-4** **BTL-3**

TEXT BOOKS	
1.	Grewal B.S., (2014) "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition.
2.	Bali N. P and Manish Goyal, (2011). "A Text book of Engineering Mathematics", Laxmi Publications Pvt Ltd., Eighth Edition.
3.	Chandrasekaran A(2010) , "A Text book of Engineering Mathematics I", Dhanam Publications, Chennai.
REFERENCE BOOKS	
1.	Srimantha Pal and Bhunia, S.C, (2015) "Engineering Mathematics" Oxford University Press.
2.	Weir, M.D and Joel Hass, Thomas', (2016), Calculus, Pearson India,. 12th Edition.
3.	Advanced Engineering Mathematics With Matlab, (2011), by CRC Press, Third Edition.
E BOOKS	
1.	http://nptel.ac.in/courses/111105035/ https://www.edx.org/.../introduction-engineering-mathematics-utarlingtonx-engr3
MOOC	
1.	https://www.mooc-list.com/tags/engineering-mathematics

COURSE TITLE	ENGINEERING PHYSICS			CREDITS	3
COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course deals with fundamental principles of physics, using mathematical derivations, for first year B. Tech students; the principles and applications of elasticity, acoustics, ultrasonics, quantum physics, crystal physics, lasers and fiber optics are dealt in this course. Intended for Aeronautical, Automobile, Bio tech., Chemical, Civil and Mechanical branches.				
Course Objective	1. To explain stress, strain and elastic modulii and apply the concepts to solve basic problems 2. To apply principles of acoustics to solve basic problems and use ultrasonics as an engineering tool 3. To explain particle nature of radiation, compute Schrodinger's wave equation and				

	apply it to infinite potential well 4. To identify crystal structures and crystal planes, describe different magnetic materials and hysteresis based on concept of ferromagnetic domains. 5. To discuss the principles, working and applications of lasers and fiber optics
Course Outcome	Upon completion of this course, the students will be able to 1. Solve the basic problems in elasticity and explain the properties of matter 2. Apply the knowledge of acoustics in designing acoustical buildings and employing ultrasonic as an engineering tool. 3. Apply mathematical derivations to solve quantum problems. 4. Identify the crystal lattice planes, distinguish different magnetic materials, and explain the ferromagnetic domain. 5. Describe with the principles, working and applications of lasers and fiber optics.

Prerequisites: Knowledge in fundamentals of Physics at higher secondary level

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO -4	PO-5	PO-6	PO -7	PO-8	PO -9	PO -10	PO-11	PO -12	PSO-1	PSO-2
CO-1	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	3	2	1	1	3	1	1	1	1	1	1	1	1	1
CO-3	3	2	1	1	3	1	1	1	1	1	1	1	1	1
CO-4	3	2	1	1	2	1	1	1	1	1	1	1	1	1
CO-5	3	2	1	1	3	1	1	1	1	1	1	1	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER AND HEAT	**(9L)**
Elasticity - Hooke's law- Elastic Moduli - Young's modulus of elasticity - Rigidity modulus - Bulk modulus - Twisting couple on a wire - Torsional pendulum - determination of rigidity modulus of a wire - Depression of a cantilever - Young's modulus by cantilever - uniform and non-uniform bending. Thermal conductivity - experimental determination of thermal conductivities of good and bad conductors -Forbe's method - theory and experiment - Lee's disc method for bad conductors.	**CO-1** **BTL-3**
MODULE 2: ACOUSTICS AND ULTRASONIC	**(9L)**
Classification of sound - Characteristics of musical sound – intensity - loudness - Weber Fechner law - Decibel - Reverberation - Reverberation time, derivation of Sabine's formula for reverberation time (Jaeger's method) - absorption coefficient and its determination - factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies Ultrasonics- Production – Magnetostriction and Piezoelectric methods – properties – applications	**CO-2** **BTL-3**

MODULE 3: QUANTUM PHYSICS	(9L)
Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory - Compton effect – Theory and experimental verification Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Extension to 3 dimension (no derivation)	**CO-3** **BTL-3**
MODULE 4: CRYSTAL PHYSICS AND MAGNETISM	**(9L)**
Crystal - Lattice - Unit cell - Bravais lattice - Lattice planes - Miller indices - 'd' spacing in cubic lattice - Calculation of number of atoms per unit cell - Atomic radius - coordination number - Packing factor for SC, BCC, FCC and HCP structures. Magnetic dipole moment - atomic magnetic moments- magnetic permeability and susceptibility - Types of magnetism: diamagnetism - paramagnetism - ferromagnetism - antiferromagnetism- ferrimagnetism - domain structure - hysteresis - hard and soft magnetic materials - applications.	**CO-4** **BTL-3**
MODULE 5: PHOTONICS AND FIBER OPTICS	**(9L)**
Principle of lasers - Stimulated absorption - Spontaneous emission, stimulated emission - population inversion - pumping action - active medium - laser characteristics – Nd-YAG laser - CO_2 laser - Semiconductor laser – applications Optical fiber - principle and propagation of light in optical fibers - Numerical aperture and acceptance angle - types of optical fibers - single and multimode, step index and graded index fibers - fiber optic communication system.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P.Mani, (2011)"Engineering Physics", Vol.I & II, Dhanam Publications, Chennai.
REFERENCE BOOKS	
1.	Gaur R.K. and Gupta S.L.,(2010) "Engineering Physics", DhanpatRai publications (P) Ltd., New Delhi. 8th Edition.
2.	P.Charles, Poople and Frank J. Owens, (2007) "Introduction to Nanotechnology", Wiley India.
3.	Arthur Beiser, (2007)"Concepts of Modern Physics", Tata McGraw – Hill Publications.
4.	Rajendran V. Marikani A., (2003) "Applied Physics for engineers", Tata McGraw –Hill publishing company Ltd., New Delhi. 3rd edition.
E BOOKS	
1.	Dr. P. S. Aithal and Dr. H. J. Ravindra, "Textbook of Engineering Physics", 1st edition, ACME Learning Pvt. Ltd., New Delhi (2011).
2.	John R. Gordon, Ralph V. McGrew and Raymond A. Serway, "Physics for Scientists and Engineers" 8th edition, Brooks/Cole Cengage learning, USA (2010).
MOOC	
1.	https://www.coursera.org/learn/how-things-work
2.	https://www.coursera.org/learn/quantum-physics
3.	https://onlinecourses.nptel.ac.in/noc21_ph21
4.	https://onlinecourses.swayam2.ac.in/aic20_sp64

COURSE TITLE	ENGINEERING MATERIALS (Common to ALL Branches of Engineering)			CREDITS	3
COURSE CODE	CYA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the students understand the basic concepts of Engineering Materials and their applications.
Course Objective	1. To make the students understand the basics of crystal structure and phase rule. 2. To provide an exposure on the fundamentals of powder metallurgy and applications of inorganic materials and composites. 3. To give a strong foundation on the basic concepts of nanomaterials, the general synthetic methods with emphasis on their applications. 4. To illustrate the applications of conducting polymers and liquid- crystals, with a good exposure on their basic terminologies. 5. To provide a knowledge on the theoretical basis of the chemical composition, properties and applications of lubricants, adhesives and explosives.
Course Outcome	Upon completion of this course, the students will be able to 1. Propose and justify suitable metals/materials for alloying. 2. State and select a suitable high-temperature material for industrial applications. 3. Identify an appropriate technique for nanomaterial synthesis and also select a property-guided molecular material for a given application. 4. Identify the materials which can be employed as organic conductors and liquid- crystals in electronic devices. 5. Distinguish and select a suitable organic / inorganic material as lubricant / adhesive / explosive based on its applications.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	1	-	-	-	-	1	-	-

CO2	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO3	**3**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO4	**3**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO5	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CRYSTAL STRUCTURE AND PHASE RULE (9)	
Basic crystal systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure. Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.	**CO-1 BTL-3**
MODULE 2: POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES (9)	
Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses. Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites – Types and Applications. Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.	**CO-2 BTL-2**
MODULE 3: NANOMATERIALS AND MOLECULAR SIEVES (9)	
Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only). Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.	**CO-3 BTL-3**
MODULE 4: MATERIALS FOR ELECTRONIC APPLICATONS (9)	
Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermotropic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications. Conducting and Super conducting Organic electronic materials - Applications. Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.	**CO-3 BTL-2**
MODULE 5: LUBRICANTS, ADHESIVES AND EXPLOSIVES (9)	
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	**CO-4 BTL-2**
TEXT BOOKS	

1.	P.C. Jain and Monicka Jain,(2012), Engineering Chemistry, Dhanpat Raj Publishing Company (P) Ltd, New Delhi.
2.	Puri, Sharma and Pathania,(2004), Principles of Physical Chemistry, Vishal Publishing Co. Jalandar.
REFERENCE BOOKS	
1.	K.K. Chawala (2012), Composite materials, Springer-Verlag, New York. 3rd edition.
2.	P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Nanocomposite Science and Technology, Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
3.	V.V. Vasiliev and E.V. Morozov, (2001), Mechanics and Analysis of Composite Materials, Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2.	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf`
MOOC	
1.	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2.	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	**PROBLEM SOLVING USING C**			**CREDITS**	**3**
COURSE CODE	**CSA4101**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Practical Component**		**ESE**	
15%	**15%**	**20%**		**50%**	
Course Description	To introduce computers and programming in C and also explore the power of computational techniques those are currently used by engineers and scientists and to develop programming skills with reasonable complexity.				
Course Objective	1. To acquire the basic knowledge in computer hardware, programming languages and Problem-solving techniques. 2. To Learn the fundamentals of C programming. 3. To Gain knowledge in Functions, arrays and strings in C programming. 4. To Understand the pointers, Structures and Union in C programming 5. To Gain Knowledge on Embedded Programming				

Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of digital computer and programming languages. 2. Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem. 3. Design and Implement C program using Control Statements and Functions. 4. Design and Implement C program using Pointers and File operations. 5. Identify the need for embedded C in real-time applications.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO - 1	PO-2	PO-3	PO-4	PO -5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	-	-	2	-	2	-	-	1	2	2	-
CO-2	3	3	3	2	2	1	-	2	2	1	-	1	2	3
CO-3	3	3	3	2	2	2	-	1	3	3	2	1	2	3
CO-4	3	3	3	2	-	-	-	-	-	-	1	-	1	2
CO-5	1	1	1	-	1	2	-	1	-	-	-	2	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO CYBER SECURITY	**(6L+6L=12)**
Introduction – Fundamentals of digital computers - Programming languages -Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code. **Practical Component:** Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems (i) Greatest of three numbers, (ii) Sum of N numbers (iii) Computation of nCr	**CO-1** **BTL-1**
MODULE 2: SECURITY ATTACKS, PRINCIPLES AND MANAGEMENT	**(6L+6L=12)**
Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements. **Practical Component:** (i) Program to illustrate arithmetic and logical operators (ii) Program to read and print data of different types (iii) Program to calculate area and volume of various geometrical shapes (iv) Program to compute biggest of three numbers (v) Program to print multiplication table (vi) Program to convert days to years, months and days (vii) Program to find sum of the digits of an integer	**CO-2** **BTL-3**
MODULE 3: SECURITY PLANS, POLICIES AND PROCEDURES	**(6L+6L=12)**
Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements. **Practical Component:** (i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion (ii) Program to compute sum and average of N Numbers stored in an array	**CO-3** **BTL-4**

(iii) Program to sort the given n numbers stored in an array (iv) Program to search for the given element in an array (v) Program to do word count (vi) Program to insert a substring in a string (vii) Program to concatenate and compare two strings (viii) Program using pre-processor statements	
MODULE 4: OVERVIEW OF SECURITY COUNTERMEASURE TOOLS	**(6L+6L=12)**
Pointers – Dynamic Memory allocation – Structure and Union – Files. **Practical Component:** (i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation (ii) Program to read and print records of a student/payroll database using structures (iii) Program to simulate file copy (iv) Program to illustrate sequential access file (v) Program to illustrate random access file	**CO-4** **BTL-3**
MODULE 5: TESTING, DIGITAL FORENSICS AND NEXT GENERATION SECURITY	**(6L+6L=12)**
Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler. **Practical component:** Simple programs using embedded C	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Jeyapoovan T, (2015), “Fundamentals of Computing and Programming in C”, Vikas Publishing house.
2.	Mark Siegesmund, (2014), "Embedded C Programming", Elsevier publications, first edition.
REFERENCE BOOKS	
1.	Ashok Kamthane, (2017), “Computer Programming”, Pearson Education, 7th Edition.
2.	Yashavant Kanetkar, (2016), “Let us C”, BPP publication, 15th edition.
3.	S.Sathyalakshmi, S.Dinakar,(2013), “Computer Programming Practicals – Computer Lab Manual”, Dhanam Publication, First Edition.
E BOOKS	
1.	https://en.wikibooks.org/wiki/C_Programming
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	**SUSTAINABLE ENGINEERING SYSTEMS (Common to ALL Branches of Engineering)**			**CREDITS**	**2**
COURSE CODE	**GEA4102**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course introduces concepts and method for determining the net environmental, economic, and social impacts of an engineering technology or process
Course Objective	1. To Understand the complex environmental, economic, and social issues related to sustainable engineering 2. To Become aware of concepts, analytical methods/models, and resources for evaluating and comparing sustainability implications of engineering activities 3. To Critically evaluate existing and new methods 4. To Develop sustainable engineering solutions by applying methods and tools to research a specific system design 5. To Clearly communicate results related to their research on sustainable engineering
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the principles of sustainability with case studies. 2. Describe assessing technologies and their impact on environment. 3. Apply the concept of green energy in their projects at higher semesters. 4. Manage natural resources and waste from various types of industries. 5. Illustrate learn water technology and behavioral aspects of humans.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	-	1	1	-	-	1	3	1	3	1	-	1	-	-
CO-2	-	3	1	-	-	1	2	1	1	1	-	2	-	-
CO-3	-	3	2	-	-	3	1	2	2	1	-	1	-	-
CO-4	-	1	2	-	-	1	2	1	2	3	-	2	-	-
CO-5	-	1	1	-	-	1	2	2	2	1	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 : PRINCIPLES OF SUSTAINABLE SYSTEMS	(5L)
Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering - Frameworks for Applying Sustainability Principles - Summary & Activities.	CO-1 BTL-2

MODULE 2 : TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT	(5L)
Technology as a part of anthropogenic environment - Technology readiness levels	CO-2

(TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities.	**BTL-3**
MODULE 3 : GREEN ENGINEERING	**(5L)**
Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities.	**CO-3** **BTL-3**
MODULE 4 : RESOURCE MANAGEMENT TECHNOLOGIES	**(5L)**
Waste management purpose and strategies - Recycling: open-loop versus closed-loop thinking - Recycling efficiency - Management of food waste and composting technologies - E-waste stream management - Reuse and redistribution programs - LCA approach to waste management systems - Summary and Activities.	**CO-4** **BTL-3**
MODULE 5 : SUSTAINABLE WATER AND WASTEWATER SYSTEMS	**(5L)**
Water cycle - Water conservation and protection technologies - Water treatment systems Metrics for assessment of water management technologies-Summary & Activities.	**CO-4** **BTL-3**
MODULE 6 : BEHAVIORAL ASPECTS AND FEEDBACKS	**(5L)**
Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	C.U. Becker, (2012), Sustainability Ethics and Sustainability Research, Springer.
2.	J.B. Guinee et al., (2011), Life Cycle Assessment: Past, Present, and Future, Environ. Sci. Technol., 45, 90-96.
3.	Anastas, P.T., Zimmerman, J.B.,(2013), Innovations in Green Chemistry and Green Engineering, Springer.
E BOOKS	
1.	David T. Allen, David R. Shonnard, Sustainable Engineering Concepts, Design and Case Studies, Pearson Education, December 2011. (ISBN: 9780132756587)
2.	*Gerald Jonker Jan Harmsen, Engineering for Sustainability 1st Edition, A Practical Guide for Sustainable Design, Elsvier 2012. (*ISBN: 9780444538475).
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.academiccourses.com/Certificate/Sustainability-Studies/India/
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview
4.	https://www.coursera.org/learn/ecosystem-services

COURSE TITLE	**ENGINEERING AND DESIGN**			**CREDITS**	**3**
COURSE CODE	**MEB4101**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**

Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course is specifically designed to give the students a clear understanding of the mechanical engineering design and its process.
Course Objective	1. To excite the students on creative design and its significance 2. To make the students aware of the process involved in design 3. To make the student understand the interesting interaction of various segments of humanities, sciences and engineering in the evaluation of the design. 4. To get an exposure to engineer a design 5. To make the student aware of the IPR and trade aspects.
Course Outcome	Upon completion of this course, the students will be able to 1. Differentiate the elements involved in good designs and to apply them in practice when called for. 2. Apply the product oriented and user oriented aspects that make the design a success. 3. Apply the product oriented and user oriented aspects that make the design a success 4. Illustrate broader perspective of design covering function, cost, environmental sensitivity, safety and other factors other than engineering analysis. 5. Describe economic and environmental Issues, trade aspects and IPR

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	3	2	-	-	-	-	-	-	-	-	2	1
CO-2	-	-	2	2	-	-	-	-	-	-	-	-	2	1
CO-3	-	-	2	-	2	-	-	-	-	-	-	-	2	1
CO-4	1	2	3	-	-	-	-	-	-	-	-	-	2	1
CO-5	-	-	-	3	2	-	-	-	-	-	-	-	2	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1- INTRODUCTION TO MECHANICAL ENGINEERING DESIGN (9)

Design and its objectives; Design constraints, Design functions, Design means and Design from; Role of Science, Engineering and Technology in design; Engineering as a business proposition; Functional and Strength Designs. Design form, function and strength; How to initiate creative designs Initiating the thinking process for designing a product of daily use. Need identification; Problem Statement; Market survey-customer requirements; Design attributes and objectives; Ideation; Brain storming approaches; arriving at solutions; Closing on to the Design needs. Project: An Exercise in the process of design initiation. A simple problem is to be taken up to examine different solutions- Ceiling fan Group Presentation and discussion	**CO-1** **BTL-2**
MODULE 2-PROCESSES IN DESIGN IN MECHANICAL SYSTEMS	**(9)**
Design process- Different stages in design and their significance; Defining the design space; Analbgies and "thinking outside of the box"; Quality function deployment-meeting what the customer wants; Evaluation and choosing of a design. Design Communication; Realization of the concept into a configuration, drawing and model. Concept of "Complex is Simple". Design for function and strength. Design detailing- Material selection, Design visualization- Solid modelling; Detailed 2D drawings; Tolerance; Use of standard items in design; Research needs in design; Energy needs of the design, both in its realization and in the applications. Project: An exercise in the detailed design of any two products	**CO-2** **BTL-2**
MODULE 3 – PROTOTYPE OF MECHANICAL PARTS	**(9)**
Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis. Engineering the design - From prototype to product. Planning; Scheduling; Supply chains; inventory; handling; manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design Project: List out the standards organizations. Prepare a list of standard items used in any engineering specialization. Develop any design with over 50% standard items as parts	**CO-3** **BTL-3**
MODULE 4- QUALITY ASPECTS IN MECHANICAL ENGINEERING DESIGN	**(9)**
Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering etc. Project: Example: List out the design requirements(x) for designing a rocket shell of 3-meter diameter and 8-meter length. Design mineral water bottles that could be packed compactly for transportation.	**CO-4** **BTL-2**
MODULE 5 – USER CENTRED DESIGNS IN MECHANICAL ENGINEERING	**(9)**
Product centered and user centered design. Product centered attributes and user centered attributes. Bringing the two closer. Example: Smart phone. Aesthetics and ergonomics. Value engineering, Concurrent engineering, Reverse engineering in design; Culture based design; Architectural designs; Motifs and cultural background; Tradition and design; Study the evolution of Wet grinders; Printed motifs; Role of	**CO-5** **BTL-2**

colours in design. Make sharp corners and change them to smooth curves-check the acceptance. Design as a marketing tool; Intellectual Property rights - Trade secret; patent; copy-right; trademarks; product liability. Group presentation of any such products covering all aspects that could make or mar it. Project: Examine the possibility of value addition for an existing product.	
TEXT BOOKS	
1	Philip Kosky, Robert Balmer, William Keat – George Wise,(2010), Explore Engineering, Academic Press, Elsevier, 4th Edition.
REFERENCE BOOKS	
1	Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P., Exploring Engineering,: An Introduction to Engineering and Design - [Part 3 - Chapters 17 to 27], ISBN13: 978-0124158917 ISBN-10: 0124158919, Third Edition.
2	Dym, C. L., Little, P. and Orwin, E. J., Engineering Design - A Project based introduction - Wiley, ISBN-978-1-118-32458-5
3	Eastman, C. M. (Ed.), Design for X Concurrent engineering imperatives, (1996), ISBN 978-94-011-3985-4 Springer, XI, 489 p.
E BOOKS	
1	http://opim.wharton.upenn.edu/~ulrich/designbook.html
2	http://www2.warwick.ac.uk/fac/sci/wmg/ftmsc/modules/modulelist/peuss/designforx design_for_x_notes_s

COURSE TITLE	**ENGINEERING IMMERSION LAB**			**CREDIT**	**0.5**
COURSE CODE	**GEA4131**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**0-0-2-2**
VERSION	**1.0**	**APPROVAL DETAILS**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
CIA				**ESE**	
80%				**20%**	
Course Description	To provide the students with hands on experience on various basic engineering practices				
Course Objective	1. To Relate theory and practice of basic Civil and Mechanical Engineering 2. To Learn basic concepts in Aeronautical and Automobile Engineering 3. To Learn basic concepts in Electrical, Electronics, mechatronics and Computer Science				
Course Outcome	Upon completion of this course, the students will be able to 1. Identify and use of tools, Types of joints used in welding, carpentry and plumbing operations. 2. Explore the parts of various IC engines used in various automobiles. 3. Demonstrate the basic concepts related to flow pattern and aircraft model.				

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	-	2	-	1	-	-	-	-	-	-	-	-
CO-2	3	2	-	2	-	1	-	-	-	-	-	-	-	-
CO-3	3	2	-	2	-	1	-	-	-	-	-	-	-	-

SLOT X - LIST OF EXPERIMENTS

I. MECHANICAL ENGINEERING WORKSHOP

1. Welding: Arc welding: Butt joints
2. Lap joints.
3. Machining: Facing
4. Turning

II. AUTOMOBILE ENGINEERING

1. Dismantling and Studying of two stroke gasoline engine.
2. Assembling of two stroke gasoline engine.
3. Dismantling and Studying of four stroke gasoline engine
4. Assembling of four stroke gasoline engine.

III. AERONAUTICAL ENGINEERING

1. Study of Flow Pattern around Various Objects.
2. Force measurement on Aircraft Model
3. Determination of Young's Modulus for Aluminum Cantilever Beam
4. Binary Addition & Subtraction using Microprocessor

IV. CIVIL ENGINEERING

1. Plumbing- Basic Pipe Connection using valves, couplings and elbows.
2. Carpentry – Sowing, Planning and making common Joints.
3. Bar Bending
4. Construction of a 50 cm height brick wall without mortar using English Bond.

SLOT Y - LIST OF EXPERIMENTS

V.ELECTRICAL ENGINEERING

1. Study of tools and accessories.
2. Study of cables.
3. Staircase wiring, Tube light and Fan connection.
4. Measurement of energy using single phase energy meter.

VI. ELECTRONICS ENGINEERING

1. Study of Active and Passive Components.
2. Study of Logic Circuits.
3. Making simple circuit using Electronic Components.
4. Measuring of parameters for signal using CRO.

VII. COMPUTER SCIENCE

1. Troubleshooting different parts of the computer peripherals, Monitor, Keyboard & CPU.
2. Installation of various operating systems, their capabilities, Windows, Unix, Linux.
3. Installation of commonly used software like MS Office

4. Assembling digital computer.

VIII. MECHATRONICS ENGINEERING

1. Study of Key Elements of Mechatronics Systems
2. Sensors – Load Cell, Thermocouple
3. Actuators – Linear & Rotary Actuators
4. Interfacing & Measurements – Virtual Instrumentation

REFERENCE

1	Jeyapoovan T and Saravanapandian M., (2015),Engineering practices lab manual, Vikas publishing House, New Delhi, 4th Edition.
2	Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K.,(2008), "Elements of Workshop Technology", Vol.I ,Media promoters and publishers private limited, Mumbai.
3	Ibrahim Zeid,(2011) CAD/CAM Theory and Practice, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

METHOD OF ALLOCATION FOR ENGINEERING IMMERSION LAB

SLOT X : MECH, AERO, AUTO, CIVIL EXPERIMENTS

SLOT Y : EEE, ELECTRONICS, CSE, MECHATRONICS EXPERIMENTS

- EVERY CLASS OF
  - GROUP A (AERO, AUTO, MECH, MCT, CHEM, BIO, CIVIL
  - GROUP B (CSE, IT, ECE, EEE, AEROSPACE)

GETS DIVIDED INTO 4 SUB - GROUPS NAMELY a, b, c, d -- EACH CONSISTING OF 15 TO 20 STUDENTS MAX.

- FOR EXAMPLE: **GROUP A STUDENTS WILL OCCUPY SLOT X**
  - WEEK 1 : SLOT X ---
    - ✓ a – MECH; b – AUTO; c – AERO ; d – CIVIL
  - WEEK 2 : SLOT X ---
    - ✓ b – MECH; c – AUTO; d – AERO ; a – CIVIL
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)
- **GROUP B STUDENTS WILL OCCUPY SLOT Y**
  - WEEK 1 : SLOT Y ---
    - ✓ a – EEE; b – ECE; c – CSE ; d – MCT
  - WEEK 2 : SLOT Y ---
    - ✓ b – EEE; c – ECE; d – CSE ; a – MCT
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)

COURSE TITLE	ENGINEERING PHYSICS LAB (Common to ALL branches of Engineering)			CREDITS	1
COURSE CODE	PHA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0

Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
EXPERIMENT	**CALCULATION**	**RESULT**	**VIVA**	**RECORD**	**ESE**
30	**10**	**10**	**20**	**10**	**20%**
Course Description	Learn experimental methods to determine engineering properties of materials and demonstrate the use of modern tools in engineering				
Course Objective	1. To train students to analyze elastic properties of materials 2. To determine thermal conductivity of a bad conductor. 3. To train students to measure viscosity of liquids. 4. To study the V-I characteristics of diode 5. To train students to apply light phenomena to analyse materials.				
Course Outcome	Upon completion of this course, the students will be able to 1. Determine elastic properties of materials 2. Determine thermal conductivity of bad conductor 3. Measure the viscosity of liquids 4. Plot V-I characteristics of a diode. 5. Measure thickness of thin wire and refractive index of a material				
Prerequisites: Physics practical at higher secondary level					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	0	0	0	0	0	0	3	0	0	3	0	0
CO-2	3	3	0	0	0	0	0	0	3	0	0	3	0	0
CO-3	3	3	0	0	0	0	0	0	3	0	0	3	0	0
CO-4	3	3	0	0	3	0	0	0	3	0	0	3	0	0
CO-5	3	3	0	0	0	0	0	0	3	0	0	3	0	0

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER- SOLID	**(9 L)**
1. Torsional Pendulum – Determination of rigidity modulus of the material of a wire. 2. Non Uniform Bending – Determination of Young's Modulus. 3. Uniform Bending – Determination of Young's Modulus.	**CO-1** **BTL-3**
MODULE 2: PROPERTIES OF MATTER- LIQUID	**(3L)**

4. Viscosity – Determination of co-efficient of viscosity of a liquid by Poiseuille's flow.	**CO-2 BTL-3**
MODULE 3: THERMAL CONDUCTIVITY	**(3 L)**
5. Lee's Disc – Determination of thermal conductivity of a bad conductor. Preparation of urea-formaldehyde resin.	**CO-3 BTL-3**
MODULE 4: OPTICS	**(6 L)**
6. Air – Wedge – Determination of thickness of a thin wire 7. Spectrometer – refractive index of a prism	**CO-4 BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE	**(6 L)**
8. Semiconductor laser – Determination of wavelength of laser using grating 9. Semiconductor diode – VI characteristics	**CO-5 BTL-3**

TEXT BOOKS	
1.	P. Mani,(2005), engineering Physics Practicals, Dhanam Publications, Chennai.
REFERENCE BOOKS	
1.	Glenn V. Lo, Jesus Urrechaga - Aituna,(2005) Introductory Physics Laboratory Manual, Part-I, Fall edition.
2.	P. Kulkarni,(2015), Experiments in Engineering Physics Bachelor of Engineering and Technology.
E BOOKS	
1.	http://www.aurora.ac.in/images/pdf/departments/humanities-and-sciences/engg-phy-lab-manual.pdf
MOOC	
1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

COURSE TITLE	**MATERIALS CHEMISTRY LAB (Common to ALL branches of Engineering)**			**CREDITS**	**1**
COURSE CODE	**CYA4131**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**0-0-2-0**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
Experimental	**Calculation**	**Result**	**Viva**	**Record**	**ESE**
30%	**10%**	**10%**	**20%**	**10%**	**20%**
Course Description	This course imparts practical exposure on basic techniques employed for the analyses of lubricants, refractories & other engineering materials and spectrophotometric analyses for metal ions.				

Course Objective	1. To train the students in characterization of lubricants by viscosity measurement. 2. To give a practical exposure for the construction of phase diagram, for partially-miscible liquids (phenol-water system) 3. To provide the students practical knowledge in preparation of polymers (urea-formaldehyde resin) 4. To impart hands-on training in characterization of refractories. 5. To equip the students with practical skill in estimation of metal ions by spectrophotometry.
Course Outcome	Upon completion of this course, the students will be able to 1. Grade the lubricants based on viscosity 2. Analyze the phase diagram and interpret the critical solution temperature. 3. Apply the practical knowledge gained on the preparation of polymers, for the preparation of other similar macromolecules. 4. Analyze the strength of refractories. 5. Apply the spectrophotometric method for the determination of metal ions in different environment.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-2	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-3	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-4	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-5	3	2	1	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF LUBRICANTS	**(6)**
1. Determination of viscosity of polymer using Ostwald Viscometer. 2. Determination of Viscosity Index of lubricants. 3. Determination of viscosity of oil using Red-Wood Viscometer.	**CO-1** **BTL-3**
MODULE 2: PHASE DIAGRAM IN LIQUID SYSTEM	**(6)**
4. Construction of phenol-water phase diagram. 5. Determination of adsorption isotherm for acetic acid on activated charcoal.	**CO-2** **BTL-3**
MODULE 3: PREPARATION POLYMER RESIN	**(6)**
6. Preparation of urea-formaldehyde resin.	**CO-3** **BTL-3**
MODULE 4: BASIC PROPERTIES OF REFRACTORIES	**(6)**

7. Determination of porosity of a refractory. 8. Determination of apparent density of porous solids.	**CO-4** **BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE	**(6)**
9. Estimation of dye content in the effluent by UV-Visible spectrophotometry. 10. Determination of copper / iron content in the alloy by colorimetry. 11. Estimation of sodium and potassium ions by flame photometry. 12. Verification of Beer-Lambert's law using gold nanoparticles.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P.S. Raghavan, (2018), Materials Chemicals Laboratory Manual, Dhanam Publications.
REFERENCE BOOKS	
1.	J. Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, Vogel's (2009), Textbook of Quantitative Chemical Analysis, Pearson Education, 6th Edition.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
MOOC	
1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

SEMESTER II

COURSE TITLE	ANALYTICAL MATHEMATICS			CREDITS	4
COURSE CODE	MAA 4117	COURSE CATEGORY	BS	L-T-P-S	3-0-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic analytical mathematical skills that is imperative for effective understanding of engineering subject using MATLAB.
Course Objective	1. To demonstrate the fundamental understanding and history of AI 2. To apply problem solving skills using the problem solving methods of AI 3. To Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models 4. To understand the applications of AI
Course Outcome	Upon completion of this course, the students will be able to 1. Competent to evaluate surface and volume integrals. 2. Describe vector operations and interpret the results geometrically 3. Solve the system of ordinary differential equations using Laplace Transform 4. Identify the periodic function satisfying Dirichlet's conditions can be expressed as a Fourier series 5. Illustrate complex variable theory, applications of analytic function and harmonic conjugate.

Prerequisites:

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-2	2	1	1	2	-	-	-	-	-	-	-	-	-	-
CO-3	2	1	1	2	-	-	-	-	-	-	-	-	-	-
CO-4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	2	1	-	-	-	-	2	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1:MULTIPLE INTEGRALS	**(10L+2P)**
Double integration – Cartesian and polar co-ordinates – Change of order of integration. Area as a double integral – Triple integration in Cartesian coordinates – Volume as a triple integral – Change of variables between Cartesian and polar coordinates. Suggested Reading: Line Integrals **Lab: Area and Volume using double and triple integration.**	**CO-1** **BTL-3**
MODULE 2:VECTOR CALCULUS	**(10L+2P)**
Gradient, Divergence and Curl – Unit normal vector, Directional derivative – angle between surfaces–Solenoidal and Irrotationalvector fields, Green's theorem - Gauss divergence theorem and Stoke's theorem (without proof) – Verification and evaluation of the above theorems - Simple applications to regions such as square, rectangle, triangle, cuboids and rectangular parallelopipeds. Suggested Reading: Basics of Vectors **Lab: Area using Green's theorem and Volume using Gauss divergence theorem.**	**CO-2** **BTL-3**
MODULE 3:LAPLACE TRANSFORMS	**(10L+2P)**
Laplace transform – Conditions of existence – Transform of elementary functions – properties– Transforms of derivatives– Initial and final value theorems – Transform of periodic functions. Inverse Laplace transforms using partial fraction and convolution theorem. Solution of linear ODE of second order with constant coefficients. Suggested Reading: Basics of Transform **Lab: Finding Laplace and Inverse Laplace Transform of Elementary Functions, Solutions of Ordinary differential equations using Laplace transform**	**CO-3** **BTL-3**
MODULE 4: FOURIER SERIES	**(10L+2P)**
Dirichlet's Conditions – General Fourier Series – Odd and even functions – Half range sine and cosine series –Harmonic Analysis. Suggested Reading: Basics of series **Lab: Fourier series Expansion of simple functions, Harmonic Analysis**	**CO-3** **BTL-3**
MODULE 5: COMPLEX VARIABLES	**(10L+2P)**
Functions of a complex variable – Analytic function – Cauchy - Riemann equations (Statement only) – Properties of analytic function (Statement only) – Construction of Analytic functions by Milne – Thomson method. Suggested Reading: Complex Numbers **Lab: Complex Numbers**	**CO-4** **BTL-3**
TEXT BOOKS	

1.	Kreyszig Erwin, (2016), "Advanced Engineering Mathematics ", John Wiley and Sons, New Delhi, 10th Edition.
2.	A.P.Santhakumaran, P.Titus, (2012), Engineering Mathematics - II, NiMeric Publications, Nagercoil.
3.	Chandrasekaran A, (2014), Engineering Mathematics- II, Dhanam Publications.
4.	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, (2016), "MATLAB and its Applications in Engineering", Pearson Publication, Second Edition.
REFERENCE BOOKS	
1.	Sastry, S.S, (2014),—Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd,New Delhi, 4th Edition.
2.	Wylie, R.C. and Barrett, L.C., (2012), —Advanced Engineering Mathematics —Tata McGraw Hill Education Pvt. Ltd, New Delhi, 6th Edition.
3.	Dean G. Duffy.,(2013), "Advanced Engineering Mathematics with MATLAB", CRC Press, Third Edition.
E BOOKS	
1.	http.// nptel.ac.in/courses/122104017/28 https://www.khanacademy.org/.../double-integrals.../double-integral. nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-1.pdf nptel.ac.in/syllabus/122104017/ nptel.ac.in/courses/111105035/22 nptel.ac.in/syllabus/111103070/
MOOC	
1.	https://www.edx.org/course/introduction-engineering-mathematics-utarlingtonx-engr3-0x

COURSE TITLE	**ENGINEERING MATERIALS (Common to ALL Branches of Engineering)**			**CREDITS**	**3**
COURSE CODE	**CYA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To make the students understand the basic concepts of Engineering Materials and their applications.				

Course Objective	1. To make the students understand the basics of crystal structure and phase rule. 2. To provide an exposure on the fundamentals of powder metallurgy and applications of inorganic materials and composites. 3. To give a strong foundation on the basic concepts of nanomaterials, the general synthetic methods with emphasis on their applications. 4. To illustrate the applications of conducting polymers and liquid- crystals, with a good exposure on their basic terminologies. 5. To provide a knowledge on the theoretical basis of the chemical composition, properties and applications of lubricants, adhesives and explosives.
Course Outcome	Upon completion of this course, the students will be able to 1. Propose and justify suitable metals/materials for alloying. 2. State and select a suitable high-temperature material for industrial applications. 3. Identify an appropriate technique for nanomaterial synthesis and also select a property-guided molecular material for a given application. 4. Identify the materials which can be employed as organic conductors and liquid-crystals in electronic devices. 5. Distinguish and select a suitable organic / inorganic material as lubricant / adhesive / explosive based on its applications.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	2	1	-	-	-	1	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO3	3	2	1	1	-	-	2	-	-	-	-	2	-	-
CO4	3	2	1	1	-	-	2	-	-	-	-	2	-	-
CO5	3	2	1	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CRYSTAL STRUCTURE AND PHASE RULE	**(9)**
Basic crystal systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure. Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.	**CO-1 BTL-1, 2,3**

MODULE 2: POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES (9)

Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses. Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites –Types and Applications. Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.	**CO-2** **BTL-2**
MODULE 3: NANOMATERIALS AND MOLECULAR SIEVES	**(9)**
Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only). Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.	**CO-3** **BTL- 3**
MODULE 4: MATERIALS FOR ELECTRONIC APPLICATONS	**(9)**
Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermotropic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications. Conducting and Super conducting Organic electronic materials - Applications. Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.	**CO-3** **BTL-2**
MODULE 5: LUBRICANTS, ADHESIVES AND EXPLOSIVES	**(9)**
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	**CO-4** **BTL-2**

TEXT BOOKS	
1.	P.C. Jain and Monicka Jain, (2012), Engineering Chemistry, Dhanpat Raj Publishing Company (P) Ltd, New Delhi.
2.	Puri, Sharma and Pathania, (2004), Principles of Physical Chemistry, Vishal Publishing Co. Jalandar.
REFERENCE BOOKS	
1.	K.K. Chawala, (2012), Composite materials, Springer-Verlag, New York, 3rd edition.
2.	P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Nanocomposite Science and Technology, Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
3.	V.V. Vasiliev and E.V. Morozov, (2001), `Mechanics and Analysis of Composite Materials, Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2.	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf`
MOOC	

1.	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2.	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	ENGINEERING PHYSICS			CREDITS	3
COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course deals with fundamental principles of physics, using mathematical derivations, for first year B. Tech students; the principles and applications of elasticity, acoustics, ultrasonics, quantum physics, crystal physics, lasers and fiber optics are dealt in this course. Intended for Aeronautical, Automobile, Bio tech., Chemical, Civil and Mechanical branches.				
Course Objective	1. To explain stress, strain and elastic modulii and apply the concepts to solve basic problems 2. To apply principles of acoustics to solve basic problems and use ultrasonics as an engineering tool 3. To explain particle nature of radiation, compute Schrodinger's wave equation and apply it to infinite potential well 4. To identify crystal structures and crystal planes, describe different magnetic materials and hysteresis based on concept of ferromagnetic domains. 5. To discuss the principles, working and applications of lasers and fiber optics				
Course Outcome	Upon completion of this course, the students will be able to 1. Solve the basic problems in elasticity and explain the properties of matter 2. Apply the knowledge of acoustics in designing acoustical buildings and employing ultrasonic as an engineering tool. 3. Apply mathematical derivations to solve quantum problems. 4. Identify the crystal lattice planes, distinguish different magnetic materials, and explain the ferromagnetic domain. 5. Describe with the principles, working and applications of lasers and fiber optics.				
Prerequisites: Knowledge in fundamentals of Physics at higher secondary level					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO -4	PO-5	PO-6	PO -7	PO-8	PO -9	PO-10	PO -11	PO -12	PSO-1	PSO-2

CO-1	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO-2	**3**	**2**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO-3	**3**	**2**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO-4	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO-5	**3**	**2**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER AND HEAT	**(9L)**
Elasticity - Hooke's law- Elastic Moduli - Young's modulus of elasticity - Rigidity modulus - Bulk modulus - Twisting couple on a wire - Torsional pendulum - determination of rigidity modulus of a wire - Depression of a cantilever - Young's modulus by cantilever - uniform and non-uniform bending. Thermal conductivity - experimental determination of thermal conductivities of good and bad conductors -Forbe's method - theory and experiment - Lee's disc method for bad conductors.	**CO-1** **BTL-3**
MODULE 2: ACOUSTICS AND ULTRASONIC	**(9L)**
Classification of sound - Characteristics of musical sound – intensity - loudness - Weber Fechner law - Decibel - Reverberation - Reverberation time, derivation of Sabine's formula for reverberation time (Jaeger's method) - absorption coefficient and its determination - factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies Ultrasonics- Production – Magnetostriction and Piezoelectric methods – properties – applications	**CO-2** **BTL-3**
MODULE 3: QUANTUM PHYSICS	**(9L)**
Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory - Compton effect – Theory and experimental verification Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Extension to 3 dimension (no derivation)	**CO-3** **BTL-3**
MODULE 4: CRYSTAL PHYSICS AND MAGNETISM	**(9L)**
Crystal - Lattice - Unit cell - Bravais lattice - Lattice planes - Miller indices - 'd' spacing in cubic lattice - Calculation of number of atoms per unit cell - Atomic radius - coordination number - Packing factor for SC, BCC, FCC and HCP structures. Magnetic dipole moment - atomic magnetic moments- magnetic permeability and susceptibility - Types of magnetism: diamagnetism - paramagnetism - ferromagnetism - antiferromagnetism- ferrimagnetism - domain structure - hysteresis - hard and soft magnetic materials - applications.	**CO-4** **BTL-3**
MODULE 5: PHOTONICS AND FIBER OPTICS	**(9L)**
Principle of lasers - Stimulated absorption - Spontaneous emission, stimulated emission - population inversion - pumping action - active medium - laser characteristics – Nd-YAG	**CO-5** **BTL-3**

laser - CO_2 laser - Semiconductor laser – applications Optical fiber - principle and propagation of light in optical fibers - Numerical aperture and acceptance angle - types of optical fibers - single and multimode, step index and graded index fibers - fiber optic communication system.	
TEXT BOOKS	
1.	P.Mani, (2011), “Engineering Physics”, Vol.I & II, Dhanam Publications, Chennai.
REFERENCE BOOKS	
1.	Gaur R.K. and Gupta S.L.,(2010), “Engineering Physics”, , DhanpatRai publications (P) Ltd., New Delhi, 8th edition.
2.	P.Charles, Poople and Frank J. Owens, (2007), "Introduction to Nanotechnology", Wiley India.
3.	Arthur Beiser, (2007), "Concepts of Modern Physics", Tata McGraw – Hill Publications.
4.	Rajendran V. Marikani A., (2003), “Applied Physics for engineers”, , Tata McGraw –Hill publishing company Ltd., New Delhi,3rd edition.
E BOOKS	
1.	Dr. P. S. Aithal and Dr. H. J. Ravindra, “Textbook of Engineering Physics”, 1st edition, ACME Learning Pvt. Ltd., New Delhi (2011).
2.	John R. Gordon, Ralph V. McGrew and Raymond A. Serway, “Physics for Scientists and Engineers” 8th edition, Brooks/Cole Cengage learning, USA (2010).
MOOC	
1.	https://www.coursera.org/learn/how-things-work
2.	https://www.coursera.org/learn/quantum-physics
3.	https://onlinecourses.nptel.ac.in/noc21_ph21
4.	https://onlinecourses.swayam2.ac.in/aic20_sp64

COURSE TITLE	**PROFESSIONAL ENGLISH AND SOFT SKILLS**			**CREDITS**	**3**
COURSE CODE	**ELA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**1-1-2-1**
Version	**1.0**	**Approval Details**	**24 ACM 30th May 2018**	**LEARNING LEVEL**	**BTL-5**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course has been designed to meet students' current and future language and communication needs. It attempts to develop their proficiency in the four language skills and knowledge of grammar and vocabulary. This course teaches students how to communicate accurately, appropriately and fluently in professional and social situations.				

Course Objective	1. To acquire self-confidence by which the learner can improve upon their informative listening skills by an enhanced acquisition of the English language. 2. To provide an environment to Speak in English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 3. To equip the students to Read, comprehend and answer questions based on literary, scientific and technological texts. 4. To enhance the writing skills of the students via training in instructions, recommendations, checklists, process-description, letter-writing and report writing. 5. To equip the learners in analysing and applying creative thinking skills and participate in brainstorming, mind-mapping, audiovisual activities and excel in employability skills.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of English grammar and vocabulary, construct simple sentences and articulate ideas using simple sentences to form short paragraphs. 2. Responding to higher order English words, vocabulary, phrases, expressions, idioms, and proverbs. Derive the contextual meaning through reading and listening from general and academic situations, Identify specific details and general ideas. Learn to give instructions and make suggestions. 3. Organize and articulate ideas, concepts, and perceptions in a comprehensive manner in written business correspondence, and speaking in formal and informal situations. 4. Analyze and transcode data, construct different types of written essays, read complex passages and summarize ideas, create personal profiles in the form of a resume. 5. Induce critical and analytical thinking, participate in brainstorming on general topics, and transact information with an audience. Prepare students for interview questions, presentation skills. Produce complex written documents such as reports, business/scientific documents, and project proposals.

Prerequisites: Plus Two English-Intermediate Level

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-2	-	-	-	-	-	-	-	2	2	3	-	-	-	-
CO-3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-4	-	-	-	-	-	-	2	-	-	3	2	-	-	-
CO-5	-	-	-	-	-	-	-	-	2	3	2	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: FUNCTIONAL GRAMMAR AND VOCABULARY	**(6L+6L=12)**
Introduction to communication skills –Self Introduction - Basic grammar (tenses, subject verb agreement) - Basic vocabulary (prefixes , suffixes, roots, phrasal verbs and idioms)- Topic sentences , paragraph writing **Suggested Activities:** Short conversations-Situational Communication-Dialogue Writing - Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences. **Suggested Reading:** 1. An Introduction to Professional English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009 2. Professional Speaking Skills by Aruna Koneru, Oxford Press, 2015 3. Embark, English for Under Graduates by Steve Hart, Arvind Nair, Veena Bhambhani, Cambridge University Press 2016. 4. English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition	**CO-1** **BTL-2**
MODULE 2 – LISTENING AND SPEAKING SKILLS	**(6L+6L=12)**
Academic listening (listening to lectures different topics, audio excerpts and answering question) - General listening (conversations, speeches: formal and informal) - Giving instructions and suggestions- Active and Passive Voice **Suggested activities:** Listen and repeat, Listening to audio excerpts- Listening to native speakers - TED Talks, short prepared speeches, Table topics – Speaking in different situations- MCQ's - Cloze exercises- Complete the Dialogue **Suggested sources:** (Listening and Speaking Modules) – Language Lab Professional Speaking Skills by Aruna Koneru, Oxford Press English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition	**CO-2** **BTL-3**
MODULE – 3 : FUNCTIONAL READING AND WRITING	**(6L+6L=12)**
Reading comprehension (academic texts and general texts)-Reading and Interpreting visual data, charts, tables and graphs-- Report writing- accident, industrial, survey, general reports –Direct and Indirect speech **Suggested Activities:** Identify the errors in sentences, grammar exercise, reading passage for identifying the contextual meaning, interpreting charts, tables and graphs, choose the right meaning of the word given Assignment on suggested reading activity – Book review **Suggested sources:** Essential English Grammar by Raymond Murphy, Cambridge University Press, 2016 edition Embark, English for Under Graduates by Steve Hart, Arvind Nair, Veena Bhambhani, Cambridge University Press 2016.	**CO-4** **BTL-4**

MODULE – 4 : BUSINESS CORRESPONDENCE	(6L+6L=12)
Memo-Notice - Agenda – Minutes of the Meeting-Action Taken report- Report Writing-Connectives - Cause and effect **Suggested activities:** Drafting agenda, notice, memo, minutes of the meeting- ATR- Cause and effect exercises - Presentation in the language lab (Technical or Non-technical topic) **Suggested sources:** Cambridge Advanced English, Newspapers, library books, IELTS , IELTS Academic Writing 1, New Insights into IELTS, CUP	**CO-3** **BTL-5**
MODULE 5 – PRESENTATION SKILLS AND INTERVIEW SKILLS	**(6L+6L=12)**
Presentation Skills - Reading and Interpreting Advertisements—Job Application-Covering Letter -Curriculum Vitae –E-mail - Project proposal –Interview skills (HR questions) – Group Discussion **Suggested Activities:** Presentation in the language lab (Technical or Non-technical topic) Group Discussion (Tutorial Classes) **Suggested Sources:** English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press, 2018. Education and personality development by K. Manoharan, APH Publishing Home, 2016	**CO-5** **BTL-5**

TEXT BOOKS	
1.	Dr. Bikram K. Das etal (2009), An Introduction to Professional English and Soft Skills with audio CD. Published by Cambridge University Press.
2.	Dolly John (2014), English for Life and the Workplace Through LSRW&T skills, by, Pearson Publications.
REFERENCE BOOKS	
1.	Soft Skills & Employability Skills by Sabina Pillai and Agna Fernandez published by Cambridge University Press 2018.
2.	Embark, English for Undergraduates by Steve Hart et al, Cambridge University Press, 2016, edition
3.	Skills for the TOEFL IBT Test, Collins, 2012 edition
4.	Soft Skills for Everyone by Jeff Butterfield, Cengage Learning, 2010 edition
5.	Professional Speaking Skills by Aruna Koneru, Oxford Publications, 2015
E BOOKS	

1	https://www.britishcouncil.in/english/courses-business
2	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
3	http://www.bbc.co.uk/learningenglish/english/
4	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
5	Oneshopenglish.com
6	Breakingnews.com
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	**ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN**			**CREDITS**	**3**
COURSE CODE	**MEA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**1-1-2-1**
Version	**1.0**	**Approval Details**	**24 ACM 30th May 2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment		**Second Periodical Assessment**	**Practical Assessment**		**ESE**
15%		**15%**	**20%**		**50%**
Course Description	This course broadly introduces the mechanical design using computer aided design tools and fundamentals of free hand sketching. It prepares the students to learn the basic concepts involved in technical drawing skills and computer graphics. It also emphasis on the principles and basic understanding of projections and visualizations aspects of component designing.				
Course Objective	1. To understand the basics of Engineering graphics and plane curvatures using AutoCAD tool 2. To visualize the free hand sketch and orthographic projections and to solve simple problems 3. To comprehend the various geometrical models and its developments 4. To understand the transformation of 2D drafting to 3D models using CAD tools 5. To generate associated views of 3D models and related geometric dimensioning and tolerencing.				

Course Outcome	Upon completion of this course, the students will be able to 1. Apply the AutoCAD commands to generate simple drawings and understand drafting techniques. 2. Apply the acquired knowledge to solve simple problems involving straight lines, planes and solids. 3. Visualize solid objects and apply AutoCAD commands to generate the models. 4. Recognize and use 3D model commands in AutoCAD tool to generate solid objects. 5. Generate the various views of the geometrical solid model manually and using AutoCAD as well.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	-	3	-	-	-	-	-	-	-	-	-
CO-2	2	1	2	-	3	-	-	-	-	-	-	-	-	-
CO-3	2	1	-	-	3	1	-	-	-	-	-	-	-	-
CO-4	2	1	-	-	3	-	-	-	-	-	1	-	-	-
CO-5	2	1	3	-	3	-	-	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF ENGINEERING GRAPHICS AND PLANE CURVES (3L+3T+6P=12)	
Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer. **Practical component:** AutoCAD – Solid modelling tool - Basics. **Suggested Readings:** Basics of drafting and dimensioning	**CO-1** **BTL-2**
MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING (3L+3T+6P=12)	
Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views. **Practical component:** 2D drafting, Orthographic projections	**CO-2** **BTL-2**

Suggested Readings: AutoCAD tool – Commands for sketching , Projections	
MODULE 3: GEOMETRICAL MODELLING, ISOMETRIC AND DEVELOPMENT OF SURFACES (3L+3T+6P=12)	
Principles of isometric projection and solid modelling. Isometric drawing – IsoPlanes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modeling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces **Practical component:** 3D modelling and surface development **Suggested Readings:** Surface modelling and solid modelling	**CO-3** **BTL-3**
MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (3L+3T+6P=12)	
Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc using appropriate modelling software. 2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer. **Practical component:** 2D to 3D transformation, plotting of drawings **Suggested Readings:** 3D modelling – view generations and commands	**CO-4** **BTL-2**
MODULE 5: SIMPLE DESIGN PROJECTS – COMPUTER AIDED DESIGN (3L+3T+6P=12)	
Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerencing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying color coding according to drawing practice. **Practical component:**3D solid meshed topology, geometrical dimensioning, simple components **Suggested Readings:** AutoCAD dimensioning, assembly of solid components	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Jeyapoovan, T. (2016). Engineering Drawing and Graphics Using AutoCAD, Vikas Publishing House Pvt Ltd., New Delhi, 7th Edition.
REFERENCE BOOKS	
1.	Warren J. Luzadder and Jon. M. Duff. (2016), Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition.
2.	Jensen, J.D. Helsel, D.R. Short. (2012), Engineering Drawing and Design, McGraw-Hill, Sixth Edition.
E BOOKS	

1.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-freeebook-pdf-download.html
2.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html
MOOC	
1.	http://nptel.ac.in/courses/112103019/
2.	http://nptel.ac.in/courses/105104148/

COURSE TITLE	**SUSTAINABLE ENGINEERING SYSTEMS (Common to ALL Branches of Engineering)**			**CREDITS**	**2**
COURSE CODE	**GEA4102**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	The course introduces concepts and method for determining the net environmental, economic, and social impacts of an engineering technology or process
Course Objective	1. To Understand the complex environmental, economic, and social issues related to sustainable engineering 2. To Become aware of concepts, analytical methods/models, and resources for evaluating and comparing sustainability implications of engineering activities 3. To Critically evaluate existing and new methods 4. To Develop sustainable engineering solutions by applying methods and tools to research a specific system design 5. To Clearly communicate results related to their research on sustainable engineering
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the principles of sustainability with case studies. 2. Describe assessing technologies and their impact on environment. 3. Apply the concept of green energy in their projects at higher semesters. 4. Manage natural resources and waste from various types of industries. 5. Illustrate learn water technology and behavioral aspects of humans.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	-	1	1	-	-	1	3	1	3	1	-	1	-	-
CO-2	-	3	1	-	-	1	2	1	1	1	-	2	-	-
CO-3	-	3	2	-	-	3	1	2	2	1	-	1	-	-
CO-4	-	1	2	-	-	1	2	1	2	3	-	2	-	-
CO-5	-	1	1	-	-	1	2	2	2	1	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 : PRINCIPLES OF SUSTAINABLE SYSTEMS	**(5L)**
Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering - Frameworks for Applying Sustainability Principles - Summary & Activities.	**CO-1** **BTL-2**
MODULE 2 : TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT	**(5L)**
Technology as a part of anthropogenic environment - Technology readiness levels (TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities.	**CO-2** **BTL-3**
MODULE 3 : GREEN ENGINEERING	**(5L)**
Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities.	**CO-3** **BTL-3**
MODULE 4 : RESOURCE MANAGEMENT TECHNOLOGIES	**(5L)**
Waste management purpose and strategies - Recycling: open-loop versus closed-loop thinking - Recycling efficiency - Management of food waste and composting technologies - E-waste stream management - Reuse and redistribution programs - LCA approach to waste management systems - Summary and Activities.	**CO-4** **BTL-3**
MODULE 5 : SUSTAINABLE WATER AND WASTEWATER SYSTEMS	**(5L)**
Water cycle - Water conservation and protection technologies - Water treatment systems Metrics for assessment of water management technologies-Summary & Activities.	**CO-4** **BTL-3**
MODULE 6 : BEHAVIORAL ASPECTS AND FEEDBACKS	**(5L)**
Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.	**CO-5** **BTL-3**

TEXT BOOKS

1. C.U. Becker, (2012), Sustainability Ethics and Sustainability Research, Springer.
2. J.B. Guinee et al., (2011), Life Cycle Assessment: Past, Present, and Future, Environ. Sci. Technol., 45, 90-96.
3. Anastas, P.T., Zimmerman, J.B.,(2013), Innovations in Green Chemistry and Green Engineering, Springer.

E BOOKS

1.	David T. Allen, David R. Shonnard, Sustainable Engineering Concepts, Design and Case Studies, Pearson Education, December 2011. (ISBN: 9780132756587)
2.	*Gerald Jonker Jan Harmsen, Engineering for Sustainability 1st Edition, A Practical Guide for Sustainable Design, Elsvier 2012. (*ISBN: 9780444538475).
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.academiccourses.com/Certificate/Sustainability-Studies/India/
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview
4.	https://www.coursera.org/learn/ecosystem-services

COURSE TITLE	**PROBLEM SOLVING USING C**			**CREDITS**	**3**
COURSE CODE	**CSA4101**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Practical Component**		**ESE**	
15%	**15%**	**20%**		**50%**	
Course Description	To introduce computers and programming in C and also explore the power of computational techniques that is currently used by engineers and scientists and to develop programming skills with reasonable complexity.				
Course Objective	1. To acquire the basic knowledge in computer hardware, programming languages and Problem-solving techniques. 2. To learn the fundamentals of C programming. 3. To gain knowledge in Functions, arrays and strings in C programming. 4. To understand the pointers, Structures and Union in C programming 5. To gain Knowledge on Embedded Programming				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of digital computer and programming languages. 2. Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem. 3. Design and Implement C program using Control Statements and Functions. 4. Design and Implement C program using Pointers and File operations. 5. Identify the need for embedded C in real-time applications.				
Prerequisites: Nil					
CO, PO AND PSO MAPPING					

CO	PO - 1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO - 10	PO-11	PO -12	PSO -1	PSO -2
CO-1	2	2	2	-	-	2	-	2	-	-	1	2	2	-
CO-2	3	3	3	2	2	1	-	2	2	1	-	1	2	3
CO-3	3	3	3	2	2	2	-	1	3	3	2	1	2	3
CO-4	3	3	3	2	-	-	-	-	-	-	1	-	1	2
CO-5	1	1	1	-	1	2	-	1	-	-	-	2	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO CYBER SECURITY	**(6L+6L=12)**
Introduction – Fundamentals of digital computers - Programming languages - Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code. **Practical Component:** Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems (i) Greatest of three numbers (ii) Sum of N numbers (iii) Computation of nCr	**CO-1** **BTL-1**
MODULE 2: SECURITY ATTACKS, PRINCIPLES AND MANAGEMENT (6L+6L=12)	
Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements. **Practical Component:** (i) Program to illustrate arithmetic and logical operators (ii) Program to read and print data of different types (iii) Program to calculate area and volume of various geometrical shapes (iv) Program to compute biggest of three numbers (v) Program to print multiplication table (vi) Program to convert days to years, months and days (vii) Program to find sum of the digits of an integer	**CO-2** **BTL-3**
MODULE 3: SECURITY PLANS, POLICIES AND PROCEDURES	**(6L+6L=12)**
Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements. **Practical Component:** (i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion (ii) Program to compute sum and average of N Numbers stored in an array (iii) Program to sort the given n numbers stored in an array (iv) Program to search for the given element in an array (v) Program to do word count	**CO-3** **BTL-4**

(vi) Program to insert a substring in a string (vii) Program to concatenate and compare two strings (viii) Program using pre-processor statements	
MODULE 4: OVERVIEW OF SECURITY COUNTERMEASURE TOOLS	**(6L+6L=12)**
Pointers – Dynamic Memory allocation – Structure and Union – Files. **Practical Component:** (i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation (ii) Program to read and print records of a student/payroll database using structures (iii) Program to simulate file copy (iv) Program to illustrate sequential access file (v) Program to illustrate random access file	**CO-4** **BTL-3**
MODULE 5: TESTING, DIGITAL FORENSICS AND NEXT GENERATION SECURITY	**(6L+6L=12)**
Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler. **Practical component:** Simple programs using embedded C	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Jeyapoovan T, (2015), “Fundamentals of Computing and Programming in C”, Vikas Publishing house.
2.	Mark Siegesmund, (2014), "Embedded C Programming", Elsevier publications, first edition.
REFERENCE BOOKS	
1.	Ashok Kamthane, (2017), “Computer Programming”, Pearson Education, 7th Edition.
2.	Yashavant Kanetkar, (2016), “Let us C”, BPP publication, 15th edition.
3.	S.Sathyalakshmi, S.Dinakar,(2013), “Computer Programming Practicals – Computer Lab Manual”, Dhanam Publication, First Edition.
E BOOKS	
1.	https://en.wikibooks.org/wiki/C_Programming
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	**INTRODUCTION TO DIGITAL SYSTEMS**			**CREDITS**	**3**
COURSE CODE	**EEB4101**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**

Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	An introduction to digital system design, with an emphasis on practical design techniques and circuit implementation.
Course Objective	1. To Utilize binary and hexadecimal numbers. 2. To Solve problems involving digital codes, operations, and number systems 3. To analyze and design combinational logic circuits
Course Outcome	Upon completion of this course, the students will be able to 1. Assess basic operation in digital systems and instruments. 2. Choose appropriate sensors and display units. 3. Apply the concepts of signal processing and converting elements. 4. Describe and apply concepts of microcontrollers, programmable logic controller and PID controller 5. Examine the concepts of consumer electronics and communication devices.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	-	-	-	-	-	-	-	-	-
CO-2	3	3	2	2	3	-	-	-	-	-	-	-	-	1
CO-3	3	3	2	2	3	-	-	-	-	-	-	-	-	1
CO-4	3	3	2	2	3	-	-	-	-	-	-	-	-	1
CO-5	3	3	3	2	3	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 – Introduction to Digital Systems (9)

Analog& Digital signals - Need for digital instruments – Elements of digital instruments – Number systems: - Binary, Hexadecimal - Logic gates - Boolean algebra (Identities and Properties) - Digital controllers (ON-OFF). **Practical Component:** Lab: - (*To be done in Simulation environment*) 1. Logic gates simulation 2. Boolean Identities and Property verification 3. Digital controller design **Suggested Reading:** Basics of number systems, All digital systems in consumer and industrial electronics.	**CO-1** **BTL-3**
MODULE 2 –Sensors and Displays	**(12)**
Sensors and Transducers –Classification, Potentiometer, Strain Gauge, Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers - Displays: - Light Emitting Diode (including OLED) displays. **Practical Component**: - (To be done in Simulation environment) 1. Simulation of Sensor characteristics- potentiometer 2. Simulation of Sensor Characteristics-Strain Gauge 3. Simulation of Sensor characteristics-LVDT 4. Simulation of Sensor characteristics-RTD 5. Simulation of Sensor Characteristics-Thermocouple **Suggested Reading**: Primary sensing elements, introduction to displays.	**CO-2** **BTL-4**
MODULE – 3 : Signal Conditioning Circuits	**(9)**
D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass - Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor. **Practical Component:** - (*To be done in Simulation environment*) 1. Simulation of DC bridges 2. Operational amplifier applications 3. Active filter simulation 4. ADC- DAC simulation. **Suggested Reading:** Basic network theorems.	**CO-3** **BTL-4**
MODULE – 4 :Introduction to Micro controllers	**(9)**
Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics Processing Unit (GPU) - Applications: -Interfacing of Digital Input/Output, Analogue Input/Output, Display. Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller. **Practical Component:** - (*To be done in Simulation environment*) 1. PLC Ladder logic simulation. 2. Proportional controller simulation. 3. Proportional + Integral controller simulation. 4. Proportional + Derivative controller simulation. 5. Proportional +Integral + Derivative controller simulation. **Suggested Reading:** Hobby electronics with Microcontroller interface.	**CO-4** **BTL-3**

MODULE 5 – Consumer Electronics and Communication System	(6)
Consumer Electronics: Television, Mobile Phones, Air conditioners, Refrigerators, Washing Machine. (Block diagram approach only.) Communication System: Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only.) **Suggested Reading:** Consumer Electronics User Manuals**.**	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Thomas l. Floyd (2018),*Digital Fundamentals*, Pearson, 11th edition .
2.	Ramakant A. Gayakwad (2017),*Op-amps and Linear Integrated Circuits*, Prentice Hall,4th edition.
REFERENCE BOOKS	
1.	David A. Bell(2018) ,*Electronic Instrumentation and Measurements*, Oxford University Press.
2.	SepehrNaimi, SarmadNaimi, Muhammad Ali Mazidi (2017), *The 8051 Microcontroller And Embedded Systems Using Assembly And C*, Pearson, Second edition.
3.	Frank D. Petruzella (2016), *Programmable Logic Controllers*, McGraw-Hill Education.
E BOOKS	
1.	http://www.ee.iitm.ac.in/~giri/pdfs/EE4140/textbook.pdf
2.	https://electronics.howstuffworks.com/home-audio-video-channel.htm
MOOC	
1.	http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
2.	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
3.	http://www.nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Microprocessors%20and%20Microcontrollers/pdf/Teacher_Slides/mod3/M3L6.pdf
4.	http://nptel.ac.in/courses/108105063/pdf/L-09(SS)(IA&C)%20((EE)NPTEL).pdf
5.	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro/ui/Course_home2_5.html

COURSE TITLE	**ENGINEERING MECHANICS**			**CREDITS**	**4**
COURSE CODE	**MEB4116**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-1-0-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. The course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving.				

Course Objective	1. To know the basics of statics 2. To understand the concepts of friction and its applications 3. To acquire the knowledge on properties of solids and surfaces 4. To understand the concepts of dynamics 5. To understand momentum and impulse
Course Outcome	Upon completion of this course, the students will be able to 1. Recall all the basic laws and principles of mechanics. 2. Analyze the problems related to machine structures and friction. 3. Apply concepts of geometrical properties such as centroid, center of gravity and moment of inertia. 4. Solve engineering problems on Statics in case of equilibrium conditions. 5. Solve problems on dynamics, momentum and impulse.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO - 10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	3	2	-	-	-	-	1	-	-	1	-	-
CO-2	3	-	-	-	-	-	-	-	2	-	-	1	-	-
CO-3	3	2	3	3	-	-	-	-	1	-	-	-	-	-
CO-4	3	-	3	-	-	-	-	-	2	-	-	-	-	-
CO-5	3	2	3	3	-	-	-	-	1	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO MECHANICS AND FORCE SYSTEM	**12**
Statics: Fundamental concepts, Units & dimensions, Laws of mechanics, System of forces – parallelogram, triangle and polygon law of forces – resultant of a force system - - resultant of a concurrent, coplanar and parallel force system – resolution and composition of forces - Lami's theorem – transmissibility of forces - moment of a force – physical significance of moment - Varignon's theorem – resolution of a force into force and couple – equivalent system of forces – Equilibrium of rigid body in two dimensions - Problems. ***Suggested Reading:*** *Forces in space – addition of concurrent forces in space – equilibrium of a particle in space*	**CO1 BTL2**
MODULE 2: FRICTION	**12**

Frictional resistance – classification of friction – limiting friction - laws of friction – coefficient of friction - angle of friction – angle of repose - cone of friction – properties, advantages and disadvantages of friction - free body diagram - equilibrium of a body on an inclined plane - ladder friction – wedge friction – belt friction. Simple machines - concept of lifting machines - law of lifting machine – efficiency - Problems. ***Suggested Reading:*** *Mechanical advantages – velocity ratio and their relationship.*	**CO2** **BTL3**
MODULE 3: PROPERTIES OF SURFACES AND SOLIDS	**12**
Properties of planar surfaces – Centroid and second moment of area - Parallel and perpendicular axis theorem – Centroid and Moment of Inertia of composite plane figure - Polar Moment of Inertia – Radius of gyration - Mass moment of inertia of cylinder and thin disc (No derivations required) - Product of inertia – principal axes and Principal Moment of Inertia - Theorems of Pappus and Guldinus – Problems. ***Suggested Reading***: Determination of Centroids of Volumes by Integration (derivations).	**CO3** **BTL3**
MODULE 4: BASICS OF DYNAMICS	**12**
Definition – kinematics and kinetics – displacements, velocity and acceleration- Equations of motion - Types of motion – Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of a particle – projectiles – angle of projection – range – time of flight and maximum height. Newton's second law of motion – linear momentum – D Alembert's principle, Dynamics equilibrium - Problems. ***Suggested Reading:*** *Work energy equation of particles– law of conservation of energy – principle of work and energy.*	**CO4** **BTL3**
MODULE 5: IMPULSE MOMENTUM AND IMPACT OF ELASTIC BODIES	**12**
Impulsive force – Impulse – linear impulse and momentum – Equations of momentum – principle impulse and momentum – impulsive motion – conservation of momentum. Definition – Time of compression, restitution, collision – law of conservation of momentum – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – Problems – MATLAB©, basics, Application in collision problems, simple programming. ***Suggested Reading:*** *Collision of small body with a massive body – loss of kinetic energy.*	**CO5** **BTL3**

TEXT BOOKS	
1	Beer, F. P and Johnston Jr. E.R., (2017), Vector Mechanics for Engineers (In SI Units): Statics and Dynamics‖, Tata McGraw-Hill Publishing company, New Delhi, 11thEdition.
2	Timoshenko S. & Young D. H., (2015), Engineering Mechanics, Mc-GrawHill.
REFERENCE BOOKS	
1	Bhavikatti, S. S and Rajashekarappa, K.G.,(2016), Engineering Mechanics, New Age International (P) Limited Publishers.
2	Hibbeller, R.C and Ashok Gupta, (2017), Engineering Mechanics: Statics and Dynamics, Pearson Education, 14th Edition.
3	Benjamin J., (2015), Mechanics, Pentex Book Publishers and Distributors.

E BOOKS	
1	https://sites.google.com/.../popularebookfreetop659/-pdf-engineering-mechanics-statics
2	www.springer.com › Home › Engineering › Mechanics
3	https://www.amazon.in/Text-Book-Engineering-Mechanics/dp/9381069123
4	https://www.topfreebooks.org/free-engineering-ebooks-online-mechanical-engineering/`
5	https://www.studynama.com/.../453-Engineering-mechanics-pdf-lecture-notes-ebook-
6	https://themech.in/mechanical/mechanical-engineering-complete-ebooks-free-download/
7	www.faadooengineers.com/threads/17024-Engineering-mechanics-Pdf-Free-Download
8	https://www.pdfdrive.net/engineering-mechanics-books.html
MOOC	
1	https://swayam.gov.in/courses/public
2	https://www.iitm.ac.in/content/nptel-open-online-course-noc-0 https://sites.google.com/view/nptelmits/departments/mechanical-engineering
3	nptel.ac.in/courses/122104015/
4	nptel.ac.in/courses/112103108/
5	nptel.ac.in/courses/112103109/
6	freevideolectures.com › Mechanical › IIT Guwahati
7	freevideolectures.com › Mechanical › IIT Kanpur
8	https://swayam.gov.in/courses/public

COURSE TITLE	MANUFACTURING TECHNOLOGY-I			CREDITS	3
COURSE CODE	MEB4117	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course introduces the basics on the various manufacturing processes that are used to manufacture any engineering parts(for both metals and plastics).It also gives the pros and cons of using the manufacturing processes and the basic criteria for choosing the same.				
Course Objective	1. To perceive the various casting processes that are prevalent in the engineering industry. 2. To understand the joining processes and the significance of the same. 3. To comprehend the forming processes performed on the metals and the working principle of the same. 4. To understand the sheet-metal working processes on metals and the basic working				

	mechanism 5. To learn about the forming and shaping processes for plastics.
Course Outcome	Upon completion of this course, the students will be able to 1. Differentiate the type of metal casting process and should able to demonstrate casting process 2. Apply the knowledge of required fabrication process for their own design project 3. Demonstrate the bulk deformation process like rolling, forging and extrusion 4. Apply the knowledge of sheet metal forming for their own design project 5. Demonstrate the forming and shaping of the plastic

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO-3	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: METAL CASTING PROCESSES	**(10)**
Sand casting - Sand moulds - Type of patterns - Pattern materials - Pattern allowances- Types of Moulding sand - Properties - Core making - Methods of Sand testing - Moulding machines - Types of moulding machines - Melting furnaces - Working principle of Special casting processes - Shell, investment casting - Ceramic mould - Lost Wax process - Pressure die casting - Centrifugal casting - CO2 process - Sand Casting defects - Inspection methods. ***Suggested Reading:*** *Taxonomy of the manufacturing processes, Contemporary trends and practices in metal casting process*	**CO-1** **BTL-4**
MODULE 2: FABRICATION PROCESS	**(10)**
Fusion welding processes - Types of Gas welding - Equipments used - Flame characteristics - Filler and Flux materials - Arc welding equipments - Electrodes - Coating and specifications - Principles of Resistance welding - Spot/butt, seam welding - Percussion welding - Gas metal arc welding - Flux cored - Submerged arc welding - Electroslag welding - TIG welding - Principle and application of special welding processes - Plasma arc welding - Thermit welding - Electron beam welding - Friction welding - Diffusion welding - Flame cutting - Weld defects - Brazing and soldering process - Methods and process capabilities - Filler materials and fluxes - Types of Adhesive bonding ***Suggested Reading:*** *Promising advanced welding processes that have the potential to*	**CO-2** **BTL-4**

develop further and support the green manufacturing trend	
MODULE 3: BULK DEFORMATION PROCESSES	**(10)**
Hot working and cold working of metals - Forging processes - Open and close die forging - Characteristics of the process - Types of Forging Machines - Typical forging operations - Rolling of metals - Flat strip rolling - Types of Rolling mills - Shape rolling operations - Tube piercing - Defects in rolled parts - Principles of Extrusion - Types of Extrusion - Hot and Cold extrusion -Principle of rod and wire drawing - Equipments used ***Suggested Reading:*** *Advanced techniques in bulk deformation process, Significant Variables in a Deformation Process*	**CO-3** **BTL-4**
MODULE 4: SHEET METAL FORMING PROCESSES	**(8)**
Sheet metal characteristics - Typical shearing operations, bending and drawing operations - Stretch forming operations - Formability of sheet metal - Test methods - Working principle and application of special forming processes - Hydro forming - Rubber pad forming - Metal spinning - Explosive forming - Magnetic pulse forming - Peen forming - Super plastic forming - Process characteristics ***Suggested Reading:*** *Forming of fan for vacuum cleaners, An Approach for Modeling Sheet Metal Forming for Process Controller Design*	**CO-4** **BTL-4**
MODULE 5: FORMING AND SHAPING OF PLASTICS	**(7)**
Types of plastics - Characteristics of forming and shaping processes - Moulding of Thermoplastics Working principles and typical applications of - Injection moulding - Plunger and screw machines Blow moulding - Rotational moulding - Film blowing - Extrusion - Typical industrial applications Thermoforming - Processing of Thermosets - Working principles and typical applications Compression moulding - Transfer moulding - Bonding of Thermoplastics - Fusion and solvent methods - Induction and Ultrasonic methods. ***Suggested Reading:*** *Agile new plastics change shape with heat, Research on eco-friendly plastics for manufacturing process*	**CO-5** **BTL-4**

TEXT BOOKS	
1	Hajra Choudhury, (2010), Elements of Workshop Technology, Vol. I and II, Media Promotors Pvt Ltd., Mumbai.
2	Serope Kalpak jain, Steven R.Schmid, (2013), Manufacturing Engineering and Technology, Pearson Education, Inc. 7th Edition.
REFERENCE BOOKS	
1	P.N. Rao, (2010), Manufacturing Technology, Tata McGraw-Hill Publishing Limited.
2	B.S. Magendran Parashar & R.K. Mittal, (2011), Elements of Manufacturing Processes, Prentice Hall of India.
3	P.C. Sharma, (2010), A Text book of production technology, S. Chand and Company.
4	R.K. Rajput, (2016), A Textbook of Manufacturing Technology, Laxmi Publications, Second edition.

E BOOKS	
1	https://books.google.co.in/books/about/Manufacturing_Technology.html?id=fSHZAgAAQBAJ&redir_esc=y
2	https://books.google.co.in/books?id=6wFuw6wufTMC&printsec=frontcover &redir_esc=y#v=onepage&q&f=false- R.K.Rajput
3	https://books.google.co.in/books?id=COpTAAAAMAAJ&q=manufacturing+technology &dq=manufacturing+technology&hl=en&sa=X&ved=0ahUKEwiqqa6SltDZAhVLvrwKH fikBFwQ6AEILDAB- David L. Goetsch
MOOC	
1	https://www.coursera.org/learn/advanced-manufacturing-process-analysis?siteID=.GqSdLGGurk-ihvgV6WlX0vV4OvPhJzUQ&utm_content=10&utm_ medium=partner s&utm_source=linkshare&utm_campaign=*GqSdLGGurk
2	https://www.coursera.org/learn/manufacturing-process-fusion-360?siteID=. GqSdLGGurk-raM8i73q9gPGjzghYEJbgQ &utm_content=10&utm_medium= partners&utm_ source=linkshare&utm_campaign=*GqSdLGGurk
3	https://www.fun-mooc.fr/courses/course v1:ENSCachan+20014+session02/about
4	https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2008 x-?source=aw&awc=6798_1520081220_4c266c011b90221d93f594ab6136cb0 a&utm_source=aw&utm_medium=affiliate_partner&utm_content=text-link&utm_term=425997_CoToNet,%20Unip.%20Lda

COURSE TITLE	ENGINEERING PHYSICS LAB (Common to ALL branches of Engineering)			CREDITS	1
COURSE CODE	PHA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
EXPERIMENT	CALCULATION	RESULT	VIVA	RECORD	ESE
30	10	10	20	10	20%
Course Description	Learn experimental methods to determine engineering properties of materials and demonstrate the use of modern tools in engineering				
Course Objective	1. To train students to analyze elastic properties of materials 2. To determine thermal conductivity of a bad conductor. 3. To train students to measure viscosity of liquids. 4. To study the V-I characteristics of diode 5. To train students to apply light phenomena to analyse materials.				

Course Outcome	Upon completion of this course, the students will be able to 1. Determine elastic properties of materials 2. Determine thermal conductivity of bad conductor 3. Measure the viscosity of liquids 4. Plot V-I characteristics of a diode. 5. Measure thickness of thin wire and refractive index of a material

Prerequisites: Physics practical at higher secondary level

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO-8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	0	0	0	0	0	0	3	0	0	3	0	0
CO-2	3	3	0	0	0	0	0	0	3	0	0	3	0	0
CO-3	3	3	0	0	0	0	0	0	3	0	0	3	0	0
CO-4	3	3	0	0	3	0	0	0	3	0	0	3	0	0
CO-5	3	3	0	0	0	0	0	0	3	0	0	3	0	0

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER- SOLID	**(9 L)**
1. Torsional Pendulum – Determination of rigidity modulus of the material of a wire. 2. Non Uniform Bending – Determination of Young's Modulus. 3. Uniform Bending – Determination of Young's Modulus.	**CO-1** **BTL-3**
MODULE 2: PROPERTIES OF MATTER- LIQUID	**(3L)**
4. Viscosity – Determination of co-efficient of viscosity of a liquid by Poiseuille's flow.	**CO-2** **BTL-3**
MODULE 3: THERMAL CONDUCTIVITY	**(3 L)**
5. Lee's Disc – Determination of thermal conductivity of a bad conductor. Preparation of urea-formaldehyde resin.	**CO-3** **BTL-3**
MODULE 4: OPTICS	**(6 L)**
6. Air – Wedge – Determination of thickness of a thin wire 7. Spectrometer – refractive index of a prism	**CO-4** **BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE	**(6 L)**
8. Semiconductor laser – Determination of wavelength of laser using grating 9. Semiconductor diode – VI characteristics	**CO-5** **BTL-3**

TEXT BOOKS

1. P. Mani, (2005), Engineering Physics Practicals, Dhanam Publications, Chennai.

REFERENCE BOOKS

1.	Glenn V. Lo, Jesus Urrechaga, (2005), - Aituna, Introductory Physics Laboratory Manual, Part-I, Fall Edition.
2.	P. Kulkarni, (2015), Experiments in Engineering Physics Bachelor of Engineering and Technology.
E BOOKS	
1.	http://www.aurora.ac.in/images/pdf/departments/humanities-and-sciences/engg-phy-lab-manual.pdf
MOOC	
1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

COURSE TITLE	**MATERIALS CHEMISTRY LAB (Common to ALL branches of Engineering)**			**CREDITS**	**1**
COURSE CODE	**CYA4131**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**0-0-2-0**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
EXPERIMENTAL	**CALCULATION**	**RESULT**	**VIVA**	**RECORD**	**ESE**
30%	**10%**	**10%**	**20%**	**10%**	**20%**
Course Description	This course imparts practical exposure on basic techniques employed for the analyses of lubricants, refractories & other engineering materials and spectrophotometric analyses for metal ions.				
Course Objective	1. To train the students in characterization of lubricants by viscosity measurement. 2. To give a practical exposure for the construction of phase diagram, for partially-miscible liquids (phenol-water system) 3. To provide the students practical knowledge in preparation of polymers (urea-formaldehyde resin) 4. To impart hands-on training in characterization of refractories. 5. To equip the students with practical skill in estimation of metal ions by spectrophotometry.				
Course Outcome	Upon completion of this course, the students will be able to 1. Grade the lubricants based on viscosity 2. Analyze the phase diagram and interpret the critical solution temperature. 3. Apply the practical knowledge gained on the preparation of polymers, for the preparation of other similar macromolecules. 4. Analyze the strength of refractories. 5. Apply the spectrophotometric method for the determination of metal ions in different environment.				
Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.					

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-2	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-3	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-4	3	2	1	-	-	-	2	-	-	-	-	2	-	-
CO-5	3	2	1	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF LUBRICANTS	**(6)**
1. Determination of viscosity of polymer using Ostwald Viscometer. 2. Determination of Viscosity Index of lubricants. 3. Determination of viscosity of oil using Red-Wood Viscometer.	**CO-1** **BTL-3**
MODULE 2: PHASE DIAGRAM IN LIQUID SYSTEM	**(6)**
4. Construction of phenol-water phase diagram. 5. Determination of adsorption isotherm for acetic acid on activated charcoal.	**CO-2** **BTL-3**
MODULE 3: PREPARATION POLYMER RESIN	**(6)**
6. Preparation of urea-formaldehyde resin.	**CO-3** **BTL-3**
MODULE 4: BASIC PROPERTIES OF REFRACTORIES	**(6)**
7. Determination of porosity of a refractory. 8. Determination of apparent density of porous solids.	**CO-4** **BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE	**(6)**
9. Estimation of dye content in the effluent by UV-Visible spectrophotometry. 10. Determination of copper / iron content in the alloy by colorimetry. 11. Estimation of sodium and potassium ions by flame photometry. 12. Verification of Beer-Lambert's law using gold nanoparticles.	**CO-5** **BTL-3**

TEXT BOOKS

1.	P.S. Raghavan,(2018), Materials Chemicals Laboratory Manual, Dhanam Publications.

REFERENCE BOOKS

1.	J. Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, (2009), Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education. 6th Edition.

E BOOKS

1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html

MOOC

1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

COURSE TITLE	ENGINEERING IMMERSION LAB			CREDIT	0.5
COURSE CODE	GEA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-2
VERSION	1.0	APPROVAL DETAILS	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	To provide the students with hands on experience on various basic engineering practices
Course Objective	The course should enable the students to 1. To Relate theory and practice of basic Civil and Mechanical Engineering 2. To Learn basic concepts in Aeronautical and Automobile Engineering 3. To Learn basic concepts in Electrical, Electronics, mechatronics and Computer Science
Course Outcome	Upon completion of this course, the students will be able to 1. Identify and use of tools, Types of joints used in welding, carpentry and plumbing operations. 2. Explore the parts of various IC engines used in various automobiles. 3. Demonstrate the basic concepts related to flow pattern and aircraft model.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	-	2	-	1	-	-	-	-	-	-	-	-
CO-2	3	2	-	2	-	1	-	-	-	-	-	-	-	-
CO-3	3	2	-	2	-	1	-	-	-	-	-	-	-	-

SLOT X - LIST OF EXPERIMENTS

I. MECHANICAL ENGINEERING WORKSHOP

1. Welding: Arc welding: Butt joints
2. Lap joints.
3. Machining: Facing
4. Turning

II. AUTOMOBILE ENGINEERING

1. Dismantling and Studying of two stroke gasoline engine.
2. Assembling of two stroke gasoline engine.
3. Dismantling and Studying of four stroke gasoline engine
4. Assembling of four stroke gasoline engine.

III. AERONAUTICAL ENGINEERING

1. Study of Flow Pattern around Various Objects.

2. Force measurement on Aircraft Model
3. Determination of Young's Modulus for Aluminum Cantilever Beam
4. Binary Addition & Subtraction using Microprocessor

IV. CIVIL ENGINEERING

1. Plumbing- Basic Pipe Connection using valves, couplings and elbows.
2. Carpentry – Sowing, Planning and making common Joints.
3. Bar Bending
4. Construction of a 50 cm height brick wall without mortar using English Bond.

SLOT Y - LIST OF EXPERIMENTS

V.ELECTRICAL ENGINEERING

1. Study of tools and accessories.
2. Study of cables.
3. Staircase wiring, Tube light and Fan connection.
4. Measurement of energy using single phase energy meter.

VI. ELECTRONICS ENGINEERING

1. Study of Active and Passive Components.
2. Study of Logic Circuits.
3. Making simple circuit using Electronic Components.
4. Measuring of parameters for signal using CRO.

VII. COMPUTER SCIENCE

1. Troubleshooting different parts of the computer peripherals, Monitor, Keyboard & CPU.
2. Installation of various operating systems, their capabilities, Windows, Unix, Linux.
3. Installation of commonly used software like MS Office
4. Assembling digital computer.

VIII. MECHATRONICS ENGINEERING

1. Study of Key Elements of Mechatronics Systems
2. Sensors – Load Cell, Thermocouple
3. Actuators – Linear & Rotary Actuators
4. Interfacing & Measurements – Virtual Instrumentation

REFERENCE

1	Jeyapoovan T and Saravanapandian M.,(2015), Engineering practices lab manual, Vikas publishing House, New Delhi, 4th Edition.
2	Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., (2008), "Elements of Workshop Technology", Vol. I, Media promoters and publishers private limited, Mumbai.
3	Ibrahim Zeid, (2011), CAD/CAM Theory and Practice, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

METHOD OF ALLOCATION FOR ENGINEERING IMMERSION LAB

SLOT X : MECH, AERO, AUTO, CIVIL EXPERIMENTS

SLOT Y : EEE, ELECTRONICS, CSE, MECHATRONICS EXPERIMENTS

- EVERY CLASS OF
  - GROUP A (AERO, AUTO, MECH, MCT, CHEM, BIO, CIVIL
  - GROUP B (CSE, IT, ECE, EEE, AEROSPACE)

GETS DIVIDED INTO 4 SUB - GROUPS NAMELY a, b, c, d -- EACH CONSISTING OF 15 TO 20 STUDENTS

MAX.

- FOR EXAMPLE: **GROUP A STUDENTS WILL OCCUPY SLOT X**
  - WEEK 1 : SLOT X ---
    - ✓ a – MECH; b – AUTO; c – AERO ; d – CIVIL
  - WEEK 2 : SLOT X ---
    - ✓ b – MECH; c – AUTO; d – AERO ; a – CIVIL
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)
- **GROUP B STUDENTS WILL OCCUPY SLOT Y**
  - WEEK 1 : SLOT Y ---
    - ✓ a – EEE; b – ECE; c – CSE ; d – MCT
  - WEEK 2 : SLOT Y ---
    - ✓ b – EEE; c – ECE; d – CSE ; a – MCT
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)

SEMESTER III

COURSE TITLE	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS			CREDITS	4
COURSE CODE	MAA4201	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of partial differential equations and transforms and its applications
Course Objective	1. To present the main results in the context of partial differential equations and to study numerical methods for the approximation of their solution 2. To introduce the wave equation including time and position dependence 3. to mathematically model the way thermal energy moves through the plate 4. To understand the concept of Fourier transform 5. To understand the concept of Z-transform and its properties
Course Outcome	Upon completion of this course, the students will be able to 1. formulate and solve some of the physical problems involving partial differential equations 2. classify and solve the Wave and Heat equations 3. classify and solve two dimensional heat equations 4. solve problems related to engineering applications by using Fourier Transform techniques 5. Illustrate the discrete transform applied to engineering problems

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	1	1	1	-	-	-	-	-	-	1	-	-
CO-2	2	1	1	1	1	-	-	-	-	-	-	1	-	-
CO-3	2	1	1	1	1	-	-	-	-	-	-	1	-	-
CO-4	2	1	1	1	1	-	-	-	-	-	-	1	-	-
CO-5	2	1	1	1	1	-	-	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: PARTIAL DIFFERENTIALEQUATIONS	**(9L+3T=12)**
Formation of partial differential equations by elimination of arbitrary constants, arbitrary functions - Solution of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second order with constant coefficients. Suggested Reading: Partial Differentiation	**CO-1** **BTL-4**
MODULE 2: ONE DIMENSIONAL WAVE AND HEAT FLOW EQUATION	**(9L+3T=12)**
Classification of second order linear partial differential equations - Solutions of one dimensional wave equation (without proof) - One dimensional heat flow equation (without proof) and application in string and rod problems. Suggested Reading: Partial Differential Equations, Half range sine series.	**CO-2** **BTL-4**
MODULE 3: TWO DIMENSIONAL HEAT FLOW EQUATION	**(9L+3T=12)**
Steady state solution of two dimensional heat equations and applications in finite plates and infinite plates problems. Suggested Reading: Partial Differential Equations, Half range sine series.	**CO-3** **BTL-4**
MODULE 4: FOURIERTRANSFORM	**(9L+3T=12)**
Fourier Integral Theorem (without proof) - Fourier transform pair - Sine and Cosine transforms - Properties - Transforms of Simple functions - Convolution theorem - Parseval's identity. Suggested Reading: Basic integration .	**CO-3** **BTL-3**
MODULE 5: Z-TRANSFORM AND DIFFERENCE EQUATIONS	**(9L+3T=12)**
Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution theorem - Formation of Difference equations - Solution of difference equations using Z-Transform Suggested Reading: Basic calculus	**CO-4** **BTL-4**

TEXT BOOKS	
1.	Grewal. B.S., (2012), "Higher Engineering Mathematics", Khanna Publishers, Delhi. 42nd Edition.
2.	Chandrasekaran A, (2015), "A Text Book of Transforms and Partial Differential Equations", Dhanam Publication.
REFERENCE BOOKS	
1.	BaILN.P and Manish Goyal,(2007), "A Textbook of Engineering Mathematics", Laxmi Publications Pvt Ltd, 7th Edition.
2.	Datta.K.B., (2013), "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi.
3.	Veerarajan. T., (2012), "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint.
E BOOKS	

1.	nptel.ac.in/courses/122107037/
2.	nptel.ac.in/courses/122107037/22
MOOC	
1.	https:f/www.mooc-list.com/tags/laplace-transforms
2.	https://www.edx.org/course/introduction-differential-equations-bux-math226-1x-1

COURSE TITLE	**ENGINEERING THERMODYNAMICS**			**CREDITS**	**4**
COURSE CODE	**MEB4201**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-1-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To provide an appreciation of energy conversion processes in the context of engineering applications and to introduce the laws of thermodynamics.				
Course Objective	1. To relate the concepts of Energy (Heat & Work) in real life situations and Apply energy transformation in flow & non flow processes. 2. To Demonstrate the concepts of sensible heat, Latent heat and use steam tables for solving problems 3. To Differentiate ideal and real gases and to demonstrate its properties 4. To Do basic analysis of the properties of gas mixtures 5. To Demonstrate the various psychrometric processes				
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze and solve first law problems in a methodical fashion with respect to closed and open systems 2. Validate the concepts of degradation of energy and its effect in practical applications 3. Analyze and evaluate the performance of vapour power cycles and to describe binary vapour cycles. 4. Evaluate the thermodynamic relations and properties of gas mixtures. 5. Evaluate the properties of air and water vapour mixtures using psychrometric chart				
Prerequisites: NIL					
CO, PO AND PSO MAPPING					

CO	PO -1	PO -2	PO-3	PO-4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	1	-	2	-	-	-	1	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	1	-	2	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC CONCEPTS & FIRST LAW OF THERMODYNAMICS	**(9L+3T=12)**
Thermodynamic systems, concepts of continuum, basic definitions, heat and work, zeroth law, First law, SFEE, First Law for closed and open systems. ***Suggested Reading***: IC engine Indicator diagram and problems associated MEP, IP, BP. Solving SFEE applications using Matlab©	**CO-1** **BTL-3**
MODULE 2: SECOND LAW OF THERMODYNAMICS	**(9L+3T=12)**
Second law of thermodynamics Statements, reversibility, causes of irreversibility, Carnot cycle, reversed Carnot cycles. Thermodynamic Temperature Scale, entropy, Clausius inequality, Entropy change in isothermal and adiabatic processes. Isentropic processes. ***Suggested Reading***: Concepts of Exergy, Solving combined heat engines and refrigerator problems using Matlab ©	**CO-2** **BTL-4**
MODULE 3: PROPERTIES OF PURE SUBSTANCE	**(9L+3T=12)**
Properties of pure substances, PVT surface, Steam tables, calculation of properties, Carnot cycle for steam and ideal efficiency. Rankine cycle with dry, saturated and superheated steam. Reheat and Regenerative cycles. Binary vapour power cycles (descriptive treatment only) ***Suggested Reading***: Binary vapour cycles and combined cycles. Simulation of Rankine cycle with reheat and regeneration using Matlab©	**CO-3** **BTL-4**
MODULE 4: GAS MIXTURES AND THERMODYNAMIC RELATIONS	**(9L+3T=12)**
Ideal and real gases, Avagadro's law, compressibility. Dalton's and Amagat's law, properties of gas mixtures, Maxwell relations, Clausius Clapeyron equations, Joule Thomson Coefficient. ***Suggested Reading***: Ideal and real gases, Plotting compressibility chart using Matlab©	**CO-4** **BTL-4**
MODULE 5: PSYCHROMETRY	**(9L+3T=12)**
Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric processes - Adiabatic mixing, evaporative cooling. ***Suggested Reading***: Air water vapour mixture property calculation and plotting using Matlab©.	**CO-5** **BTL-3**
TEXT BOOKS	

1	Cengel & Boles. (2017), Thermodynamics: an Engineering Approach, McGraw Hill, 8th Edition.
2	Nag, P.K., (2017), Engineering Thermodynamics Tata McGraw-Hill Publishing Company Limited New Delhi, 6th Edition,
REFERENCE BOOKS	
1	Moran and Shapairo,(2015), Principles of Engineering Thermodynamics, Wiley, 8th Edition.
2	Rajput R K (2016), "A text book of Engineering Thermodynamics", S. Chand publishers.
3	Stephen J Chapman, (2012), Matlab programing for Engineers, Cengage publishers, 4th edition.
E BOOKS	
1	http://engineeringstudymaterial.net/ebook/schaum-outline-of-thermodynamics-for-engineers/
2	http://engineeringstudymaterial.net/ebook/basics-and-applied-thermodynamics/
3	http://www.freebookcentre.net/physics-books-download/Thermodynamics-Fundamentals-and-Its-Application-in-Science.html
MOOC	
1	http://nptel.ac.in/courses/112103016/
2	http://nptel.ac.in/courses/112106133/
3	http://nptel.ac.in/courses/112104113/
4	http://nptel.ac.in/courses/112105123/

COURSE TITLE	**FLUID MECHANICS AND MACHINERY**			**CREDITS**	**3**
COURSE CODE	**MEB4202**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course offers basic knowledge on fluid statics, dynamics and hydraulic machines. It contains laws and principles of fluid mechanics and their application for various fluid flows and hydraulic machinery.				
Course Objective	1. To understand the basic principles of fluid mechanics 2. To identify various types of flows 3. To understand boundary layer concepts and flow through pipes 4. To evaluate the performance of hydraulic turbines 5. To understand the functioning and characteristic curves of pumps				

Course Outcome	Upon completion of this course, the students will be able to 1. Identify the effect of fluid properties on a flow system. 2. Identify type of fluid flow patterns, boundary layer and describe continuity equation. 3. Analyze a variety of practical fluid flow and measuring devices and utilize Fluid Mechanics principles in design. 4. Select and analyze an appropriate turbine with reference to given situation in power plants. 5. Estimate performance parameters of a given Centrifugal and Reciprocating pump.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	1	-	2	-	-	2	-	-	-	2	1	-
CO-2	3	3	-	1	2	-	-	-	1	-	-	2	1	-
CO-3	3	3	-	2	2	-	-	1	-	2	-	2	1	-
CO-4	3	3	1	-	2	-	-	-	-	1	-	2	1	-
CO-5	3	3	-	-	2	-	-	1	-	1	-	2	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC CONCEPTSAND PROPERTIES	**(9)**
Fluid–Definition, distinction between solid and fluid-Units and dimensions-Properties of fluids- density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges. ***Suggested Reading****: Hydrostatic forces on a submerged plane and curved surfaces – centre of pressure –stability of floating and submerged bodies*.	**CO-1** **BTL-3**
MODULE 2: FLUID KINEMATICSAND FLUID DYNAMICS	**(9)**
Fluid Kinematics-Flow visualization-lines of flow-types of flow-velocity field and acceleration-continuity equation (one and three dimensional differential forms)-Equation of streamline-stream function-velocity potential function-circulation-flow net–fluid dynamics-equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube- dimensional analysis-Buckingham's π theorem-applications- similarity laws and models. ***Suggested Reading:*** Ideal fluid flow- Uniform flow, source flow- sink flow and free vortex flow	**CO-2** **BTL-2**
MODULE 3: INCOMPRESSIBLE FLUID FLOW	**(9)**

Viscous flow - Navier-Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - flow through pipes - Darcy -weisback's equation - piperoughness-frictionfactor-Moody'sdiagram-minorlosses-flowthroughpipesinseriesand in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients. ***Suggested Reading**: derive continuity and momentum equation for incompressible fluid flow*	**CO-3** **BTL-3**
MODULE 4: HYDRAULIC TURBINES	**(9)**
Hydro turbine: Definition and classification - exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagrams - Head and specific work - components of energy transfer - degree of reaction. Pelton turbine- Francis turbine- Propeller turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies -performance curve for turbines. ***Suggested Reading**: draft tube for reaction turbine*	**CO-4** **BTL-2**
MODULE 5: HYDRAULIC PUMPS	**(9)**
Pumps: definition and classifications - Centrifugal pump: classifications, working principle, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: classification, working principle, indicator diagram, work saved by air vessels and performance curves - cavitation in pumps - rotary pumps: working principles of gear and vane pumps ***Suggested Reading**: diffusers for centrifugal pump and cavitation in diffusers, Plot H-Q Characteristics curve for the centrifugal for different RPM using MATLAB©*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Streeter, V.L., and Wylie, E.B., (2010) "Fluid Mechanics", McGraw-Hill, New Delhi.
2	Kumar, K.L., (2015) "Engineering Fluid Mechanics", S Chand & Company (P)Ltd.
3	Modi, P.N., and Seth, S.M., (2013) "Hydraulics and Fluid Mechanics including Hydraulic Machine", Standard Book House, New Delhi, 20th edition.
REFERENCE BOOKS	
1	Anderson, John D.(2016), Fundamentals of Aerodynamics. . New York, NY: McGraw-Hill, 6th edition.
2	White, F.M., (2010), "Fluid Mechanics", Tata McGraw-Hill, 5th Edition, New Delhi.
3	Ramamirtham,S., (2014), "Fluid Mechanics and Hydraulics and Fluid Machines", Dhanpat Rai and Sons, 9th edition.
4	Som,S.K., and Biswas,G. (2011), "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw- Hill, New Delhi, 3rd edition.
E BOOKS	

1	https://books.google.co.in/books/about/Fluid_Mechanics.html?id=K5-rK6HUoo8C - Streeter, V.L.
2	https://books.google.co.in/books/about/Engineering_Fluid_Mechanics.html?id=qZaf8XVAPGQC - K L Kumar
3	https://books.google.co.in/books?id=FzQz6A6SnyoC - R K Bansal
4	https://books.google.co.in/books/about/Fluid_Mechanics.html?id=egk8SQAACAAJ-White F M
5	https://books.google.co.in/books/about/INTRO_TO_FLUID_MECH_FLUID_ MACHINES.html?
MOOC	
1	https://www.mooc-list.com/course/introduction-%C3%A0-la-m%C3%A9canique-des-fluides-
2	http://nptel.ac.in/courses/112105182/
3	http://nptel.ac.in/courses/112105183/
4	http://nptel.ac.in/courses/112105171/1
5	http://nptel.ac.in/courses/112104117/
6	https://swayam.gov.in/

COURSE TITLE	**MANUFACTURING TECHNOLOGY-II**			**CREDITS**	**3**
COURSE CODE	**MEB4203**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Manufacturing technology deals with the applications of Metal removal science in manufacturing processes. It provides a means of assessing the suitable machining process in lath machines, their application, and the designing of manufactured components.				
Course Objective	1. To acquire knowledge on concepts of metal cutting. 2. To acquire knowledge manufacturing sciences to provide solutions for engineering problems using current technology. 3. To acquire knowledge on the concepts of design. 4. To acquire knowledge on analysis and implementation of mechanical systems. 5. To acquire knowledge on techniques for CNC part program.				

Course Outcome	Upon completion of this course, the students will be able to 1. Select the metal cutting processes involved in the manufacture of parts and estimates the cutting forces, tool life in orthogonal metal cutting. 2. Utilize the operational features of different lathes for various applications. 3. Devise the turning operations using conventional and special purpose Lathes, 4. Utilize the operational features of shaping, planning, milling and boring machines and devise the plain surface machining using reciprocating & milling machines. 5. Fix the sequence of grinding and gear cutting operations for different jobs. 6. Control of Machine tools using Numerical control machine and part-programming and process plan of components.

Prerequisites: MANUFACTURING TECHNOLOGY –I

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	1	-	1	2	2	2	-	-	-	-	-	-
CO-2	2	2	-	1	2	-	1	-	1	-	-	-	-	-
CO-3	2	2	-	2	2	-	-	1	-	2	-	2	-	-
CO-4	2	2	1	-	2	-	1	-	-	1	-	2	-	-
CO-5	2	2	-	-	2	-	-	1	-	1	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: THEORY OF METAL CUTTING	**08**
Introduction to material removal processes - theory of metal cutting: chip formation, orthogonal-metal cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids - Types of machine tools Suggested Reading: Coolants and its influence on metal cutting, type of coolants and their properties	**CO-1** **BTL-3**
MODULE 2: CENTRE LATHE AND SPECIAL PURPOSE LATHES	**10**
Centre lathe, constructional features, cutting tools, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes - automatic lathes: semi-automatic, automats - single spindle: cutting off, Swiss type, automatic screw type - multi spindle; cutting off, bar type. Suggested Reading: Tool layout and cam design for automats	**CO-2** **BTL-3**
MODULE 3: MILLING, RECIPROCATING & HOLE MAKING MACHINES	**10**
Milling: types, milling cutters, operations - Reciprocating machine tools: shaper, planer, slotter - Hole making machine tools: drilling, reaming, boring, tapping. Suggested Reading: Jig boring machine, Deep hole drilling machine	**CO-3** **BTL-3**
MODULE 4: ABRASIVE GRINDING, BROACHING AND GEAR CUTTING	**10**

Abrasive processes: grinding wheel - specifications and selection, types of grinding process-cylindrical grinding, surface grinding, center less grinding - honing, lapping, super finishing, polishing and buffing, abrasive jet grinding Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction push, pull, surface and continuous broaching machines, gear cutting: forming, generation, shaping, hobbing. Suggested Reading: Thread grinding, thread milling and thread rolling – process-wise merits and limitations	**CO-4** **BTL-3**
MODULE 5: CNC MACHINE TOOLS AND PART PROGRAMMING	**07**
Numerical control (NC) machine tools - CNC: types, constructional details, special features. Part programming fundamentals - manual programming - computer assisted part programming- APT language. Suggested Reading: Drives, Feedback devices, Interpolator systems, Control loop circuit elements in point to point and contouring system,	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Rao, P. N. (2013), Manufacturing Technology: Metal Cutting and Machine Tools, Tata McGraw-Hill, New Delhi.
REFERENCE BOOKS	
1.	Hajra Choudhary, S. K, (2010), Elements of Work Shop Technology - Vol. II, Media Promoters & Publishers Pvt. Ltd., Mumbai.
2.	Rajput R.K, (2016), A Text Book of Manufacturing Technology, Lakshmi Publications, II Edition.
3.	Sharma P.C, (2010), A Text Book of Production Engineering, S. Chand and Co. Ltd.
E BOOKS	
1.	https://www.mooc-list.com/tags/manufacturing
MOOC	
1.	https://www.openlearning.com/courses/manufacturing-technology-course-mooc
2.	https://www.mooc-list.com/course/fundamentals-manufacturing-processes-edx

COURSE TITLE	**FLUID MECHANICS AND MACHINERY LAB**			**CREDITS**	**1**
COURSE CODE	**MEB4231**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
CIA			**ESE**		
80%			**20%**		
Course Description	The Fluid Mechanics laboratory is designed to examine the properties of fluids and to conduct experiments to investigating the fundamentals of fluid statics as well as kinematics and kinetics of fluid flow to enhance the hands-on experience of our students. The laboratory is also equipped to conduct experiments on pumps and				

	turbines.
Course Objective	1. To calibrate venturimeter, orifice meter and pitot tube. 2. To calculate the head loss due to friction in the pipe for pumping power requirement. 3. To Conduct experiment to measure the friction factor of the given pipe to calculate the hydraulic resistance 4. To identify the type of turbine with known specific speed 5. To conduct experiment to measure the performance of the various centrifugal pump and positive displacement pump
Course Outcome	Upon completion of this course, the students will be able to 1. Calibrate venture-meter, orifice meter and pitot tube. 2. Calculate the head loss due to friction in the pipe for pumping power requirement. 3. Measure the friction factor of the given pipe to calculate the hydraulic resistance 4. Identify the type of turbine with known specific speed and parameters. 5. Measure the performance of the various centrifugal pump and positive displacement pumps.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO-4	PO -5	PO -6	PO -7	PO-8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	-	3	3	-	-	-	1	-	-	3	3	3
CO-2	2	2	-	3	3	-	-	-	1	-	-	3	3	3
CO-3	2	2	-	3	3	-	-	-	1	-	-	3	3	3
CO-4	2	2	-	3	3	-	-	-	1	-	-	3	3	3
CO-5	2	2	-	3	3	-	-	-	1	-	-	3	3	3

1: Weakly related, 2: Moderately related and 3: Strongly related

List of Experiments (Any 10 Experiments)

1	D etermination of the Coefficient of discharge of given Orifice meter
2	Determination of the Coefficient of discharge of given Venturi meter.
3	Calculation of the rate of flow using Rota meter.
4	Determination of friction factor for a given set of pipes.
5	Conducting experiments to find the laminar to turbulent transition for a flow in a pipe.

6	Performing an experiment and drawing the characteristic curves of submergible pump
7	Conducting an experiment and drawing the characteristic curves of centrifugal pump
8	Conducting an experiment and drawing the characteristic curves of reciprocating pump.
9	Conducting an experiment and drawing the characteristic curves of Gear Oil pump.
10	Performing an experiment and drawing the characteristic curves of Jet pump
11	Conducting an experiment and drawing the characteristic curves of Francis turbine.
12	Conducting anexperiment and drawing the characteristic curves of Kaplan turbine.
13	Performing an experiment and drawing the characteristic curves of Turgo Impulse Wheel
14	Plot system curve and H-Q Characteristic curve for given piping system with pump for different speed using Matlab®

LIST OF EQUIPMENTS (For a batch of 30 students)			
1.	Orifice meter setup	8	Reciprocating pump setup
2.	Venturi meter setup	9	Gear oil pump setup
3.	Rotameter setup	10	Jet pump
4.	Reynolds Apparatus	11	Pelton wheel setup
5.	Pipe Flow analysis setup	12	Francis turbine setup
6.	submergible pump setup	13	Kaplan turbine setup
7.	Centrifugal pump	14	Turbo Impulse Wheel

COURSE TITLE	MANUFACTURING TECHNOLOGY LAB			CREDITS	1
COURSE CODE	MEB4232	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80 %	20%

Course Description	The main purpose of this laboratory is to make the students aware of the manufacturing process. The lathe machining has been widely used in the manufacturing industry. So engineering students must get exposure to manufacturing process.
Course Objective	1. To get Knowledge on concepts of metal cutting. 2. To get Knowledge manufacturing sciences to provide solutions for engineering problems using current technology. 3. To get Knowledge on the concepts of design. 4. To get Knowledge on analysis and implementation of mechanical systems. 5. To get Knowledge on the CNC hardware and CNC Programming.

Course Outcome	Upon completion of this course, the students will be able to 1. Select the right tool, machining condition and relevant measurement 2. Describe the Applications of mechanics of metal cutting 3. Machining in milling and drilling and grinding operations 4. Describe the methods and applications of various machining operations 5. Illustrate the CNC hardware and develop CNC Program.

Prerequisites: MANUFACTURING TECHNOLOGY

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO-8	PO-9	PO - 10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO-2	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO-3	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO-4	3	2	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	3	2	-	-	2	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1. Two or More Metal Cutting Experiments (Example: Shear Angle Measurement, Cutting Force
2. Measurement, Cutting Temperature Measurement, Tool Wear Measurement, Life Measurement
3. Measurement of tool life using Matlab©
4. One or More Exercises in Milling Machines (Example: Milling Polygon Surfaces, Gear milling,
5. Keyway milling, Helical Groove milling etc.)
6. Two or More Exercises in Grinding / Abrasive machining (Example: Surface Grinding,
7. Cylindrical Grinding, Centreless Grinding, Lapping, Honing etc.)
8. Two or More Exercises in Machining Components for Assembly of different fits. (Example:

MATLAB ASSIGNMENTS

1. Glass Tube Manufacturing Process
2. Compensator Design for a Set of Plant Models
3. Fault Diagnosis of Centrifugal Pumps using Steady State Experiments
4. Robust Tuning of Mass-Spring-Damper System
5. Modeling a Kanban Production System
6. Generalized Extreme Value Distribution
7. Test Real-Time Application

LIST OF EQUIPMENTS (For a batch of 30 students)

1. Centre Lathes 5 Surface Grinding Machine
2. Turret and Capstan Lathe 6 Tool Dynamometer
3. Horizontal Milling Machine 7 Gear Hobbing Machine

4. Vertical Milling Machine 8 CNC Lathe (Trainer or Industrial Type)
5.Centre Lathes 5 Surface Grinding Machine
6.Turret and Capstan Lathe 6 Tool Dynamometer
7. Horizontal Milling Machine 7 Gear Hobbing Machine

COURSE TITLE	DESIGN PROJECT I			CREDITS	1
COURSE CODE	MEB4233	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-6

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	Strategies and methods of designing, manufacturing, and testing of mechanical products. Engineering drawing and CAD, design methods, material properties, failure modes, selection methodology, fundamental GD&T, and selected manufacturing processes.
Course Objective	1. To provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To understand the engineering aspects of design with reference to simple products 3. To foster innovation in design of products, processes or systems 4. To develop design that add value to products and solve technical problems 5. To develop skills in doing literature survey, technical presentation and report preparation.
Course Outcome	Upon completion of this course, the students will be able to 1. Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters. 2. Describe making a product is achieved for solving practical problem. 3. Prepare a technical drawing, technical report and technical presentation skill.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	-	-	-	-	-	-	2	1	2
CO-3	1	2	2	-	3	1	2	2	1	2	2	3	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE	
• The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution. • The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc. • The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.	**CO-1,2,3** **BTL-6**

ASSESSMENT (%)	
Continuous Assessment	**80**
Viva-voce	**20**
Total	**100**

SEMESTER IV

COURSE TITLE	PROBABILITY AND STATISTICS			CREDITS	4
COURSE CODE	MAA 4216	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-1-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science
Course Objective	1. To understand the concept of probability and random variable 2. To identify the standard distribution variables. 3. To understand the discrete and continuous random variables 4. To understand the types of hypothesis testing 5. To establish optimal process performance
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the concept of Probability and one dimensional random variable 2. improve the ability to understand the importance of discrete and continuous distributions 3. explore the random experiments specified by two dimensional random variables 4. perform test of hypothesis as well as calculate confidence interval for the population parameter 5. proficient to obtain knowledge on design of experiments

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	2	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROBABILITY AND RANDOM VARIABLES	(9L+3T=12)
Axioms of Probability- Bayes' Theorem -Random variables – Moments – Moment generating functions. Suggested Reading: Basic Probability	CO-1 BTL-1,2,3
MODULE 2: STANDARD DISTRIBUTIONS	**(9L+3T=12)**
Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions Suggested Reading: Discrete and Continuous Functions	CO-2 BTL-1,2,3
MODULE 3: TWO-DIMENSIONAL RANDOM VARIABLES	**(9L+3T=12)**
Joint distribution – Marginal and conditional distribution – Co-variance – Correlation and Regression Suggested Reading: Random Variables	CO-3 BTL-1,2,3
MODULE 4: TESTING OF HYPOTHESIS	**(9L+3T=12)**
Sampling distributions – Testing of Hypothesis –Small samples– t Test, F Test and Chi-square Test – Large samples– Single mean– Difference in means– single proportion and difference in proportions. Suggested Reading: Sampling Problems	CO-4 BTL-1,2,3,4
MODULE 5:DESIGN OF EXPERIMENTS	**(9L+3T=12)**
Analysis of variance– One Way Classification–Completely Randomized block design– Two Way Classification – Randomized block design – Latin Square design Suggested Reading: Analysis of variance	CO-5 BTL-1,2,3,4

TEXT BOOKS	
1.	A. Chandrasekaran, G.Kavitha, (2014), "Probability,Statistics,RandomProcesses and QueuingTheory", Dhanam Publications.
2.	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, (2016), "MATLAB and its Applications in Engineering", Pearson Publication, Second Edition.
REFERENCE BOOKS	
1.	Devore. J.L.,(2012), "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition.
2.	Dean G. Duffy., (2013), "Advanced Engineering Mathematics with MATLAB", CRC Press, Third Edition.
E BOOKS	
1.	http.//nptel.ac.in/courses/IIT-MADRAS/Principles_of_Communication1/Pdfs/1_5.pdf https://www.khanacademy.org
MOOC	
1.	https://www.edx.org/course/introduction-probability-science-mitx-6-041x-2

COURSE TITLE	THERMAL ENGINEERING			CREDITS	3
COURSE CODE	MEB4216	COURSE CATEGORY	PC	L-T-P-S	3-0-0-2
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Thermal Engineering deals with the applications of the laws of Thermodynamics to various advanced energy system in engineering applications. The course will provide an insight to various thermal cycles applied for petrol, diesel and aircraft engines. The machineries such as IC engines, hybrid vehicles, steam nozzles & turbines, air compressors and refrigeration systems are analyzed in detail and enable the student to solve more advanced problems.
Course Objective	1. To understand the working of conventional and hybrid vehicles components. 2. To understand the features of Gas power cycles and efficiency enhancement methods. 3. To understand the working principles of steam nozzles and turbine and to analyze the performance. 4. To understand the working principles of air compressors, selection, design for given application. 5. To understand the principles of air conditioning and refrigeration, usage of property table and charts and to design a system for the given application and specification.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the understanding of various components of IC engines and Hybrid vehicles 2. Identify, Relate, Analyze and Evaluate the performance of the gas power cycles 3. Analyze different types of steam nozzles and to assess the performance of steam turbines 4. Analyze the performance of single and multistage reciprocating compressors and to Demonstrate various types of rotary compressors 5. Evaluate the performance of refrigeration systems (using different refrigerants), to do basic calculations of air conditioning using psychrometric chart and to describe absorption systems.

Prerequisites: Engineering Thermodynamics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1	2	-	-	1	1	1	-	-	3	-
CO-2	3	3	-	1	2	2	2	-	-	-	-	-	-	-
CO-3	-	3	2	1	-	-	2	-	-	-	-	-	-	-
CO-4	3	-	-	1	2	2	2	-	1	-	-	-	3	-

CO-5	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**3**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CONVENTIONAL AND HYBRID VEHICLES	**9**
Conventional vehicles: Classification - Components. Actual and theoretical p-V diagram. Ignition Systems, Diesel pump and injector system, MPFI, CRDI. - Knocking in SI and CI Engines. Lubrication and Cooling systems: Hybrid Vehicles: Components, hybrid traction, hybrid drive-train topologies, Energy Storage: Battery storage, Fuel Cell, Super Capacitor and Flywheel based energy, Hybridization of different energy storage devices. Matching the electric machine and the internal combustion engine. ***Suggested Reading*:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). Generation of Heat balance sheet for 4 stroke engines using Matlab©.	**CO-1** **BTL-3**
MODULE 2: GAS POWER CYCLES	**9**
Carnot, Otto, Diesel, Dual cycles, difference between ideal and real cycles; Gas turbine cycles, methods of improving performance - inter-cooling, reheat and regenerative cycles. ***Suggested Reading*:** Simulation of Otto, Diesel and Dual cycles using Matlab©.	**CO-2** **BTL-4**
MODULE 3: STEAM NOZZLES AND STEAM TURBINES	**9**
Convergent and convergent-divergent nozzles - Isentropic flow - Effect of Friction. General flow analysis. Critical pressure ratio and maximum mass flow. General principle of Impulse and Reaction Turbines, Compounding of steam turbines - Stage efficiency, Overall efficiency and re-heat factor. Multi-Stage Turbines (descriptive treatment only) **Suggested Reading:** visit to steam power station,	**CO-3** **BTL-4**
MODULE 4: AIR COMPRESSOR	**9**
Classification and working principle. Work of compression with and without clearance. Volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressors, Rotary compressors (Descriptive treatment only). ***Suggested Reading*:** Simulation of Air compressor using Matlab©.	**CO-4** **BTL-4**
MODULE 5: REFRIGERATION AND AIR-CONDITIONING	**9**
Vapour Compression Refrigeration cycle – ideal and actual cycles, performance calculations. Working principle of vapour absorption system. (Description only). Summer and winter air conditioning systems – for dry and humid weather. Concept of RSHF, GSHF, ESHF using psychrometric chart. Cooling Load calculations. **Suggested Reading**: visit to mall or cold storage air conditioning, Simulation of VCR Cycle and cooling load calculations using Matlab©.	**CO-5** **BTL-4**
TEXT BOOKS	

1.	Rajput. R. K., (2010), “Thermal Engineering” S.Chand Publishers.
2.	Domkundwar. And Kothandaraman.C.P., (2016), “A course in thermal Engineering ”Dhanpat Rai & Co , Fifth Edition.
REFERENCE BOOKS	
1.	Domkundwar and Arora,(2014), ”Refrigeration and Air Conditioning ,” Dhanpat Rai & Co.
2.	Ganesan V. (2017),“Internal Combustion Engines”, Tata Mcgraw-Hill, Third Edition.
3.	Sarkar, B.K, (2017),”Thermal Engineering” Tata McGraw-Hill Publishers.
4.	Rudramoorthy, R, (2017), “Thermal Engineering “, Tata McGraw-Hill, New Delhi.
E BOOKS	
1.	https://books.google.co.in/books?id=YLNGv0bVay0C&dq=thermal+engineering
2.	https://books.google.co.in/books/about/Thermal_Engineering.html?id=65gxCX2dC84C
MOOC	
1.	http://www.nptelvideos.in/2012/12/refrigeration-and-airconditioning.html
2.	http://nptel.ac.in/courses/112105128/
3.	http://www.nptelvideos.com/mechanical/
4.	http://nptel.ac.in/courses/112106133/

COURSE TITLE	**STRENGTH OF MATERIALS**			**CREDITS**	**3**
COURSE CODE	**MEB4217**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Understand the basic concepts and techniques, both theoretical and experimental, with emphasis on the application of these to the solution of suitable problems in engineering. Provide a firm foundation for more advanced study.				
Course Objective	1. To Gain knowledge of simple stresses, strains and deformations components due to external loads. 2. To Assess stresses and deformations through mathematical models of beams, twisting bars or combination of both. 3. To Provide the Basic knowledge for use in the design courses				

Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic principles of structural elasticity, including statically determinate and indeterminate systems, and the factors which affect their strength and stiffness. 2. Illustrate an understanding of the relationships between loads, member forces and deformations and material stresses and strains. 3. Identify the contemporary analytical, experimental and computational tools needed to solve the engineering problems. 4. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials. 5. Independent judgment required to interpret the results of the engineering problems.

Prerequisites: Applied Mathematics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	1	-	2	-	-	-	1	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	1	-	2	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: STRESS, STRAIN AND DEFORMATION OF SOLIDS	**9**
Rigid and Deformable bodies - Strength, Stiffness and Stability - Stresses; Tensile, Compressive and Shear - Deformation of simple and compound bars under axial load - Thermal stress - Elastic constants - Strain energy and unit strain energy - Strain energy in uniaxial load. ***Suggested Reading:*** *Statically determinate – indeterminate, Stress on inclined planes under axial loading.*	**CO-1** **BTL-3**
MODULE 2: BEAMS - LOADS AND STRESSES	**9**
Types of beams: Supports and Loads - Shear force and Bending Moment in beams - Cantilever, simply supported and Overhanging beams - Stresses in beams - Theory of simple bending - Stress variation along the length and in the beam section - Effect of shape of beam section on stress induced - Shear stresses in beams. ***Suggested Reading:*** *Shear force – bending moment – continuous beam, bending of unsymmetrical beams - composite.*	**CO-2** **BTL-3**
MODULE 3: TORSION	**9**

Analysis of torsion of circular bars - Shear stress distribution - Bars of Solid and hollow circular section - Stepped shaft - Twist and torsion stiffness - Compound shafts - Fixed and simply supported shafts - Application to close-coiled helical springs - Maximum shear stress in spring section including Wahl Factor - Deflection of Close-coil helical springs under axial loads - Design of helical coil springs - stresses in helical coil springs under torsion loads ***Suggested Reading:*** *Torsion – rectangular shaft – thin walled shaft, strain energy due to torsion.*	**CO-3** **BTL-3**
MODULE 4: BEAM DEFLECTION	**9**
Elastic curve of Neutral axis of the beam under normal loads - Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area Method -Columns - End conditions - Equivalent length of a column - Euler equation - Slenderness ratio - Rankine formula for columns ***Suggested Reading****: Instability – failure mode - Necking – tensile member – plastic buckling – Study of a beam under loads in MATLAB©.*	**CO-4** **BTL-3**
MODULE 5: ANALYSIS OF STRESSES IN TWO DIMENSIONS	**9**
Biaxial state of stresses - Thin cylindrical and spherical shells - Deformation in thin cylindrical and spherical shells - Biaxial stresses at a point - Stresses on inclined plane - Principal planes and stresses - Mohr's circle for biaxial stresses - Maximum shear stress - Strain energy in bending and torsion. ***Suggested Reading:*** *Mohr's circle – plane stress – plane strain - Fracture – ductile specimen – brittle specimen.*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Popov E.P,(2015), " *Mechanics of Materials* ", Pearson Education India; Second edition.
2	Beer F. P. and Johnston R, (2015),"*Mechanics of Materials*", McGraw-Hill Book Co, Seventh Edition.
3	Stephen Timoshenko, (2017),"*Theory of Elasticity*", McGraw Hill Education, Third edition.
REFERENCE BOOKS	
1	Nash W.A, (2013), "*Theory and problems in Strength of Materials*", Schaum Outline Series, McGrawHill Book Co, New York.
2	Bansal RK,(2017), "*A textbook of Strength of* materials" Laxmi Publications; Sixth edition.
3	Rattan SS, (2017),"*Strength of Materials*", McGraw Hill Education., Third Edition.
4	U. C. Jindal,(2017), "*Strength of Materials*", Pearson Education, Second edition.
5	Hibbeler,R.C,(2016), "*Mechanics of materials*" Pearson Education, 10th edition.
E BOOKS	

1	https://goo.gl/ArHdiY - Popov E.P
2	https://goo.gl/EgypX3 - Beer F. P. and Johnston R
3	https://goo.gl/VroJEj - R K Bansal
4	https://goo.gl/bqvlA8 - Rattan S S
MOOC	
1	https://goo.gl/lCHuKR
2	http://nptel.ac.in/courses/112107147/
3	http://nptel.ac.in/courses/112107146/
4	http://nptel.ac.in/courses/112101095/
5	http://nptel.ac.in/courses/112106141/
6	http://nptel.ac.in/courses/105105108/

COURSE TITLE	**ENGINEERING METROLOGY AND MEASUREMENTS**			**CREDITS**	**3**
COURSE CODE	**MEB4218**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Engineering metrology deals with the applications of measurement science in manufacturing processes. It provides a means of assessing the suitability of measuring instruments, their calibration, and the quality control of manufactured components.				
Course Objective	1. To get knowledge on concepts of measurements 2. To get knowledge on linear and angular measurements techniques 3. To get knowledge on form measurements techniques 4. To get knowledge on uses of laser assisted metrology techniques 5. To get knowledge on techniques for measurements of physical quantities				
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the basic concepts of metrology in various measurements. 2. Demonstrate with linear and angular measurements techniques. 3. Formulate and define the form measurements techniques. 4. Use laser assisted metrology techniques. 5. Recognize the techniques for measurements of physical quantities.				
Prerequisites: Engineering Physics					

CO, PO AND PSO MAPPING														
CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	-	-	-	2	2	2	-	-	-	-	-	-
CO-2	2	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3	2	-	-	2	2	-	-	-	-	2	-	2	-	-
CO-4	2	2	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	2	2	-	-	2	-	-	-	-	-	-	2	-	-
1: Weakly related, 2: Moderately related and 3: Strongly related														

MODULE 1: CONCEPT OF MEASUREMENT	9
General concept–Generalized measurement system-Units and standards-measuring instruments- sensitivity, readability, range of accuracy, precision-static and dynamic response- repeatability-systematic and random errors-correction, calibration, interchangeability. **Practical component:** Calibration **Suggested Readings:** *limits, fits, tolerances, Manufacturing cost and tolerances*	**CO-1** **BTL-3**
MODULE 2: LINEAR AND ANGULAR MEASUREMENT	**9**
Definition of Metrology - Linear measuring instruments: Vernier, Micrometer, internal measurement, Slip gauges and classification, Interferometery, optical flats, limit gauges- Comparators: Mechanical, pneumatic and electrical types, applications. Angular measurements: Sine bar, optical bevel protractor, angle Deckkor – Taper measurements **Practical component:** Linear and angular measurements. **Suggested Readings:** *Statistical analysis of experimental data, Regression analysis*	**CO-2** **BTL-3**
MODULE 3: FORM MEASUREMENT	**9**
Measurement of screw threads-Thread gauges, floating carriage micrometer-measurement of gear-tooth thickness-constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish, straightness, flatness and roundness measurements. **Practical component:** Form measurement **Suggested Readings:** *Quality standard principle, Design of experiments*	**CO-3** **BTL-3**
MODULE 4: LASER AND ADVANCES IN METROLOGY	**9**

Precision instruments based on laser-Principles- Laser Interferometer-application in linear, angular measurements and machine tool metrology Coordinate measuring machine (CMM)- Constructional features – types, applications – digital devices-computer aided inspection. **Practical component:** Coordinate measurement **Suggested Readings:** *Importance of nano dimension, Importance of nano metrology*	**CO-4** **BTL-3**
MODULE 5: MEASUREMENT OF POWER,FLOW ANDTEMPERATURE RELATED PROPERTIES	**9**
Force, Torque, Power - Mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement:-Venturi, Orifice, Rotometer, Pitottube. Temperature: Bimetallic strip, Thermometers, Thermocouples, Electrical resistance Thermister. **Practical component:** Physical quantity measurement **Suggested Readings:** *Errors in temperature measurement, testing quality assurance sciences using Matlab©*	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Richard S Figliola, Donald E Beasley, (2014), Theory and Design for Mechanical Measurements, Wiley India, 6th Edition.
REFERENCE BOOKS	
1.	Graham T. Smith, (2016), Machine Tool Metrology: An Industrial Handbook, Kindle First Edition.
2.	N V Raghavendra and Krishnamurthy, (2013), Engineering Metrology and Measurement, Oxford University Press.
E BOOKS	
1.	https://www.bbau.ac.in/dept/UIET/Study%20MAterials%20for%20EME-403.pdf
MOOC	
1.	https://www.mooc-list.com/course/internet-measurements-hands-introduction-fun
2.	https://www.classcentral.com/course/swayam-engineering-metrology-14037

COURSE TITLE	**PROFESSIONAL ETHICS AND LIFE SKILLS**			**CREDITS**	**2**
COURSE CODE	**GEA4216**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**2-0-0-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Practical Assessment**	**ESE**
15%	**15%**	**20%**	**50%**

Course Description	Students will understand the Ethical theory and its roles and its responsibilities of individual, employee, Corporate responsibilities towards stack holders with friendly approach.

Course Objective	1. To understand business ethics, levels, myths, use and train oneself to be ethical. 2. To improve the Knowledge on Ethical principles, reasoning, roles & responsibilities. 3. To understand stake holder theory, Individual and corporate responsibilities towards stake holders. 4. To understand corporate responsibilities towards Product Safety & Reliability and environment friendly approach. 5. To understand the Employee & Corporate on responsibilities on aspects of contracts, equal opportunity , Affirmative action, sexual harassment etc.,.
Course Outcome	Upon completion of this course, the students will be able to 1. An understanding of business ethics, levels, myths, use and train oneself to be ethical. 2. Knowledge on Ethical principles, reasoning, roles & responsibilities. 3. An understanding of stake holder theory, Individual and corporate responsibilities towards stake holders. 4. Understanding on Corporate responsibilities towards Product Safety & Reliability and environment friendly approach. 5. Understanding between the Employee & Corporate on responsibilities on aspects of contracts, equal opportunity , Affirmative action, sexual harassment etc.,

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	-	-	2	-	3	-	-	-	-	-	-	-	-	-
CO-3	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	3	-	-	-	-	-	1	-	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 - HUMAN VALUES	**(6)**
Definition of ethics-Morals values and ethics – integrity-Work ethics- Service learning-Civic virtue-Respect for others-Caring-Sharing-Honesty-Courage-Valuing time-Cooperation-Commitment-Empathy-Self-confidence-Character-Spirituality-Introduction to Yoga and meditation for professional excellence and stress management. **Suggested Reading**: Case study of Discovery failure	**CO1,BTL2**

MODULE 2 - ENGINEERING ETHICS (6)

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories. **Suggested Reading**: Study the Bhopal gas tragedy	**CO2,BTL2**
MODULE 3- SAFETY, RESPONSIBILITIES AND RIGHTS	**(6)**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination. **Suggested Reading**: Chernobyl explosion, Nuclear and thermal power plant issues	**CO3,BTL3**
MODULE 4 - LIFE SKILLS	**(6)**
Definition, Relevance, Types of values, changing concepts of values-aims and values of value education- basic etiquette-morals and values in life-dealing with people. Personal values – Self – Strengths (self-confidence, self-assessment, self-reliance, self-discipline, determination, self-restraint, contentment, humility, sympathy and compassion, gratitude, forgiveness) Weaknesses **Suggested Reading:** Influences - Peer pressure, familial and societal expectations, media	**CO4,BTL2**
MODULE 5 - SOCIETIES IN PROGRESS	**(6)**
Definition of society; Units of society; Communities – ancient and modern – Agents of change – Sense of survival, security, desire for comfort and ease sense of belonging, social consciousness and responsibility **Suggested Reading**: Personal value and professional value of Engineers on societies perception	**CO5,BTL2**

TEXT BOOKS	
1	Subramanian R., Professional ethics, Oxford University press
REFERENCE BOOKS	
1	Megan J. Murphy (Editor), Lorna Hecker (Editor), Ethics and Professional Issues in Couple and Family Therapy
2	Andrew Belsey (Editor), Ruth Chadwick (Editor), Ethical Issues in Journalism and the Media (Professional Ethics)
3	Warwick Fox (Editor), Ethics and the Built Environment (Professional Ethics)
4	RuchikaNath, (2012) Value Education, APH Publishing Corporation, New Delhi.
5	Manoharan P.K.,(2012) Education and Personality Development, APH Publishing Corporation, New Delhi.
E BOOKS	
1	https://www.bkconnection.com/static/Business_Ethics_EXCERPT.pdf
2	https://bookboon.com/en/business-ethics-ebook
MOOC	

1	https://www.mooc-list.com/course/global-impact-business-ethics-coursera

COURSE TITLE	THERMAL ENGINEERING LAB -I			CREDITS	1
COURSE CODE	MEB4241	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	To gain experimental knowledge on the performance and operations of apparatus like blowers, compressors, refrigeration and air conditioning plants.
Course Objective	1. To understand the basic concepts and utilization of heat for accomplishing specific work 2. To understand the operational details of refrigeration units and its performance features 3. To learn the basic principle of air conditioning.
Course Outcome	Upon completion of this course, the students will be able to 1. Evaluate the performance and efficiency of air blower 2. Calculate the cop of the refrigeration and A/C plant 3. Conduct experiment on reciprocating air compressor and refrigeration system 4. Demonstrate the performance of walk in cooler and cooling tower and LPG refrigerator 5. Conduct experimental analysis on solar flat plate collector

Prerequisites: Thermodynamics

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-2	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-3	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-4	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-5	3	3	1	1	3	2	2	1	2	1	-	3	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

	1	Performance characteristics of a constant speed air blower.		
	2	Verification of fan laws and static efficiency of air blower.		
	3	C.O.P. of a Refrigeration plant.		
	4	Performance test on A/C plant.		
	5	Performance test on single/two stage reciprocating air compressor with Matlab© coding.		BTL-4
	6	Capillary optimization for a Refrigeration System using Matlab© and Simulink©.		
	7	Performance analysis of Walk-in cooler		
	8	Performance test on a Cooling Tower		
	9	Performance analysis of a Solar Flat Plate Collector		
	10	Performance test on a LPG Refrigerator		
	11	Performance test on Vertical Axis wind turbine		

LIST OF EQUIPMENTS (For a batch of 30 students)

1.	Air Blower	7	Single/two stage reciprocating air compressor
2.	Cooling Tower	8	Vapour Compression Refrigeration test rig
3.	Solar Flat Plate Collector	9	Vapour compression Air Conditioning test rig
4.	Refrigeration unit with Capillary optimization	10	Axial-fan with vertical axis wind turbine
5	LPG Refrigerator		
6	Walk-in cooler		

COURSE TITLE	STRENGTH OF MATERIALS LABORATORY			CREDITS	1
COURSE CODE	MEB4242	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	To understand the properties of materials and metals and how to measure the same
Course Objective	1. To gain knowledge on different metals used in mechanical applications. 2. To understand the importance of strength of different components like springs, beams etc 3. To understand the heat treatment process which alters the properties of materials.

Course Outcome	Upon completion of this course, the students will be able to 1. Conduct experiments to find out different properties of metals and alloys 2. Compare the properties of metals before and after the heat treatment. 3. Conduct experiment to measure the deflection of a beam 4. Measure the strain using rosette strain gauge 5. Conduct experiments to calculate the strength of different components like springs beams etc.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	-	2	-	2	-	-	-	2	-	-	2	-	-
CO-2	-	-	-	-	2	-	-	-	-	-	2	2	-	-
CO-3	2	-	-	-	2	-	-	-	-	-	2	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1	Tension test on a mild steel rod
2	Double shear test on Mild steel and Aluminium rods
3	Torsion test on mild steel rod
4	Impact test on metal specimen
5	Hardness test on metals - Brinell and Rockwell Hardness Number
6	Deflection test on beams
7	Compression test on helical springs
8	Strain Measurement using Rosette strain gauge
9	Effect of hardening- Improvement in hardness and impact resistance of steels.
10	Tempering- Improvement Mechanical Properties Comparison a. Unhardened specimen b. Quenched Specimen and c. Quenched and tempered specimen
11	Microscopic Examination of a. Hardened samples and b. Hardened and tempered samples. c. Deflection test on Beams in MATLAB©

MATLAB ASSIGNMENTS

1. Solving a Heat Transfer Problem With Temperature-Dependent Properties
2. Inhomogeneous Heat Equation on a Square Domain
3. Heat Conduction in a Spherical Multidomain Geometry with Nonuniform Heat Flux
4. Heat Distribution in a Circular Cylindrical Rod
5. Gain-Scheduled Control of a Chemical Reactor
6. Nonlinear State Estimation of a Degrading Battery System

7. Single Hydraulic Cylinder Simulation 8. Two Cylinder Model with Load Constraints

LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Universal Tensile Testing machine with double shear attachment-40Ton Capacity-1 No
2	Torsion Testing Machine (60 NM Capacity) - 1 No
3	Impact Testing Machine (300 J Capacity) - 1 No
4	Brinell Hardness Testing Machine - 1 No
5	Rockwell Hardness Testing Machine - 1 No
6	Spring Testing Machine for tensile and compressive loads (2500 N) - 1 No
7	Metallurgical Microscopes - 3 Nos
8	Muffle Furnace (800^0C) - 1 No
9	MATLAB© – 30 No

COURSE TITLE	ENGINEERING METROLOGY AND MEASUREMENTS LAB			CREDITS	1
COURSE CODE	MEB4243	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	Engineering metrology and measurements laboratory deals with the practical exposure on measurement science. It provides a means of assessing the suitability of measuring instruments, their calibration, and the quality control of various components.
Course Objective	1. To acquire knowledge on calibration of Vernier / Micrometer / Dial Gauge 2. To acquire knowledge on calculation of the taper angle 3. To acquire knowledge on calculation of pitch, thread angle using profile projector 4. To acquire knowledge on calculation of force and torque 5. To acquire knowledge on measurement of Displacement (Strain Gauge / LVDT/ Wheatstone Bridge)
Course Outcome	Upon completion of this course, the students will be able to 1. Calibrate Vernier / Micrometer / Dial Gauge. 2. Calculate taper angle. 3. Calculate pitch, thread angle using profile projector. 4. Calculate force and torque. 5. Measure Displacement (Strain Gauge / LVDT/ Wheatstone Bridge).

Prerequisites: Engineering Physics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO-7	PO -8	PO -9	PO-10	PO -11	PO-12	PSO -1	PSO-2
CO-1	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**
CO-2	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**
CO-3	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**
CO-4	**2**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**
CO-5	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

	LIST OF EXPERIMENTS
1	Calibration of Vernier / Micrometer / Dial Gauge
2	Checking Dimensions of part using slip gauges
3	Measurement of Gear Tooth Dimensions
4	Measurement of Taper Angle using sine bar /Tool Makers microscope
5	Measurement of Straightness and flatness
6	Measurement of Thread parameters
7	Checking the limits of dimensional tolerances using comparators (Mechanical / Pneumatic / Electrical)
8	Measurement of Temperature using Thermocouple / Pyrometer
9	Measurement of Displacement (Strain Gauge / LVDT/ Wheatstone Bridge)
10	Measurement of Force
11	Measurement of Torque
12	Measurement of Vibration / Shock
13	Measurement of Coordinates for the given component using coordinate measuring machine

	LIST OF EQUIPMENTS (For a batch of 30 students)
1.	Micrometer - 5
2	Vernier Height Gauge - 2
3	Vernier Depth Gauge - 2
4	Slip Gauge Set - 1
5	Gear Tooth Vernier - 1
6	Sine Bar - 2
7	Bevel Protractor - 1
8	Floating Carriage Micrometer - 1
9	Profile Projector - 1
10	Mechanical / Electrical / Pneumatic
11	Comparator
12	Temperature Measuring Setup
13	Displacement Measuring Setup
14	Force Measuring Setup

15	Torque Measuring Setup
16	Vibration / Shock Measuring
17	Coordinate Measuring Machine
18	Autocollimator
19	Coordinate Measuring Machine
20	Tool makers Microscope
21	Dial gauge Calibration

COURSE TITLE	DESIGN PROJECT II			CREDITS	1
COURSE CODE	MEB4244	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-6
ASSESSMENT SCHEME					
CIA			ESE		
80%			20%		
Course Description	Strategies and methods of designing, manufacturing, and testing of mechanical products. Engineering drawing and CAD, design methods, material properties, failure modes, selection methodology, fundamental GD&T, and selected manufacturing processes.				
Course Objective	1. To Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To understand the engineering aspects of design with reference to simple products 3. To foster innovation in design of products, processes or systems 4. To develop a design that add value to products and solve technical problems 5. To develop skills in doing literature survey, technical presentation and report preparation.				
Course Outcome	Upon completion of this course, the students will be able to 1. Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters. 2. Describe the making a product is achieved for solving practical problem. 3. prepare a technical drawing, technical report and technical presentation skill.				
Prerequisites: Nil					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO - 10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	-	-	-	-	-	-	2	1	2
CO-3	1	2	2	-	3	1	2	2	1	2	2	3	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE

- The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
- The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.
- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.

BTL-6

ASSESSMENT (%)	
Continuous Assessment	**80**
Viva-voce	**20**
Total	**100**

SEMESTER V

COURSE TITLE	OPTIMIZATION TECHNIQUES			CREDITS	4
COURSE CODE	MAA 4301	COURSE CATEGORY	PC	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student develop a knowledge in the field of optimization techniques their basic concepts, principles of linear and integer programming, assignment and transportation problems
Course Objective	1. To understand the concept of optimization 2. To formulate linear programming model 3. To understand the concept of integer programming 4. To understand the assignment and transportation problem 5. To understand the concept of network analysis
Course Outcome	Upon completion of this course, the students will be able to 1. Formulate mathematical model 2. Cast engineering maxima/minima problems into optimization framework. 3. Solve the integer programming problems 4. Solve the assignment and transportation problems 5. Analyze the designs of networks

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	-	1	-	1	1	-	-	-	-	-	-	-	-
CO-2	2	-	1	-	-	1	-	-	-	-	-	-	-	-
CO-3	-	-	-	-	1	1	-	-	-	-	-	-	-	-
CO-4	2	-	1	-	1	1	-	-	-	-	-	-	-	-
CO-5	2	-	3	-	-	1	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO OPTIMIZATION (9L+3T=12)

Introduction to operations research – objective – scope of OR – Limitations of OR – Introduction and formulation of linear programming – Solving LPP using Graphical method. Suggested Reading: Basics of inequalities	**CO-1** **BTL-2**
MODULE 2: LINEAR PROGRAMMMING PROBLEM	**(9L+3T=12)**
Solving LPP using simple method – Big-M method – Two phase method – conversion of primal to dual. Suggested Reading: System of equations	**CO-2** **BTL-3**
MODULE 3: INTEGER PROGRAMMING	**(9L+3T=12)**
Integer programming – Cutting plane method – Gomory's Mixed integer method – Branch and Bound method Suggested Reading: System of equations	**CO-3** **BTL-4**
MODULE 4: ASSIGNMENT AND TRANSPORTATION PROBLEM	**(9L+3T=12)**
Hungarian Method – Maximization and unbalanced assignment problem – Basic feasible solution of transportation problem – Modi method – Degeneracy – Unbalanced Transportation problem. Suggested Reading: Arithmetic Calculation	**CO-4** **BTL-4**
MODULE 5: PERT AND CPM	**(9L+3T=12)**
Network diagram – Representation – Labeling – CPM – PERT probabilities of CPM – PERT probabilities of project duration. Suggested Reading: Basics of graphs	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Chandrasekaran A,(2017), "A Text book of Operation Research", Dhanam Publications, Chennai.
REFERENCE BOOKS	
1.	Hamdy A. Taha,(2010), "Operations Research: An Introduction", Prentice Hall.
2.	D S Hira & Prem Kumar Gupta,(2012) "Introduction to Operations Research", S. Chand Publishing, (9th Edition).
E BOOKS	
1.	http://nptel.ac.in/courses/112106134/1
2.	https://onlinecourses.nptel.ac.in/noc17_mg10/preview
MOOC	
1.	https://www.edx.org/course/operations-management-iimbx-om101-1x

COURSE TITLE	**DESIGN OF MACHINE ELEMENTS**			**CREDITS**	**3**
COURSE CODE	**MEB4301**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical**	**Seminar/ Assignments/**	**Surprise Test / Quiz**	**Attendance**	**ESE**

	Assessment	Project			
15%	15%	10%	5%	5%	50%

Course Description	The course focuses on the fundamentals and principles of basic mechanical elements, failure theories and design criteria, and structures of basic mechanical systems. The goal of the course is to learn how to design simple mechanical elements and systems.
Course Objective	1. To understand procedure of machine design and develop an ability to apply it for simple component design by using design data hand book. 2. To understand the different theories of failure and develop an ability to apply its knowledge for design of mechanical component and determine the resisting areas against failure 3. To determine forces on transmission shaft and design of transmission shaft 4. To determine the endurance strength and design of components subjected to fluctuating loads 5. To determine the forces in welds and riveted joints and formulate design solution for size of weld and size of rivet 6. To determine forces on power screw and bolted joints and formulate design solution for size of power screw and size of bolt
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze and design power screws with respect to torque requirements, overhauling, and column buckling. 2. Design bolted connections with respect to static and dynamic axial loads. 3. Analyze and design bolted riveted, pinned, welded, brazed, soldered, and glued joints with respect to static and dynamic shear and bending loads. 4. Analyze and design full cylindrical hydrodynamic bearings using design charts and custom software. 5. Select appropriate flywheel and springs for the application using printed and electronic catalogue data.

Prerequisites: Engineering Physics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	1	2	-	2	-	-	-	-	-	1	-	-
CO-2	2	2	-	-	-	2	-	-	1	1	-	2	-	-
CO-3	3	1	-	-	-	-	-	-	1	1	-	2	-	-
CO-4	2	3	1	1	-	2	-	-	-	-	-	3	-	-
CO-5	3	1	1	1	-	3	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: INTRODUCTION TO THE DESIGN PROCESS	**(9)**
Factor influencing machine design, selection of materials based on mechanical properties - Direct, Bending and torsion stress equations - Impact and shock loading - calculation of principle stresses for various load combinations, eccentric loading - Design of curved beams - crane hook and 'C' frame Factor of safety - theories of failure - stress concentration - fatigue strength and the S-N diagram - Soderberg, Goodman and Gerber relations. **Suggested Readings:** International standards for fits and tolerances	**CO-1** **BTL-4**
MODULE 2: DESIGN OF SHAFTS AND COUPLINGS	**(9)**
Design of solid and hollow shafts based on strength, rigidity and critical speed - Design of keys and key ways - Design of rigid and flexible couplings - Introduction to gear and shock absorbing couplings - design of knuckle joints. **Suggested Readings:** Study on cotter joints	**CO-2** **BTL-4**
MODULE 3: DESIGN OF FASTENERS AND WELDED JOINTS	**(9)**
Threaded fasteners - Design of bolted joints including eccentric loading - Design of welded joints for pressure vessels and structures - theory of bonded joints. **Suggested Readings:** Study of welding on dissimilar materials	**CO-3** **BTL-4**
MODULE 4: DESIGN OF SPRINGS AND LEVERS	**(9)**
Design of helical, leaf, disc and torsion springs under constant loads and varying loads - Concentric torsion springs - Belleville springs - Design of Levers **Suggested Readings:** Study of composite leaf spring	**CO-4** **BTL-4**
MODULE 5: DESIGN OF BEARINGS AND FLYWHEELS	**(9)**
Design of bearings - sliding contact and rolling contact types. - Cubic mean load - Design of journal bearings - McKee's equation - Lubrication in journal bearings - calculation of bearing dimensions Design of flywheels involving stresses in rim and arm. **Suggested Readings:** Study on hydrodynamic gas bearing and its applications	**CO-5** **BTL-4**

TEXT BOOKS	
1	Juvinall R. C., Marshek K.M., (2012), Fundamentals of Machine component Design - John Wiley & Sons, Fifth Edition,.
2	Bhandari, V.B., (2010) Design of Machine Elements, Tata McGraw-Hill Publishing Company Ltd.
REFERENCE BOOKS	

1	Norton R.L, (2004), Design of Machinery, McGraw-Hill Book co,
2	Orthwein W, (2013),Machine Component Design, Jaico Publishing Co.
E BOOKS	
1	https://books.google.co.in/books?isbn=1118987683
2	https://www.google.co.in/search?tbo=p&tbm=bks&q=isbn:1259083519
3	https://books.google.co.in/books?isbn=007742171X
4	https://books.google.co.in/books?isbn=8172247737
MOOC	
1	http://nptel.ac.in/courses/112106137/
2	http://nptel.ac.in/courses/112105125/
3	http://www.nptelvideos.in/2012/12/design-of-machine-elements.html
4	http://nptel.ac.in/courses/112106137/

COURSE TITLE	**MECHANICS OF MACHINES**			**CREDITS**	**3**
COURSE CODE	**MEB4302**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Kinematics of mechanisms, vector method of analysis of plane mechanisms. Static and dynamic analysis of machines, inertia forces, gyroscopic forces, Static and dynamic balancing, balancing machines. Dynamics and balancing of reciprocating engines. Flywheels. Kinematics and dynamics of cam mechanisms. Elements of mechanical vibrations.				
Course Objective	1. To understand the kinematics of linkage mechanisms and to draw the velocity and acceleration diagram of simple mechanisms. 2. To expose the different types of frictional elements. 3. To demonstrate ability to construct various follower motion diagrams and understand the advantages and disadvantages of each type of motion; and to be able to design cam profiles for any given follower displacement using graphical methods. 4. To understand the balancing of rotating machinery, gyroscopic couple and its effects. 5. To comprehend the mechanical vibrations; including concepts of natural frequency, damping and resonance.				

Course Outcome	Upon completion of this course, the students will be able to 1. Apply the theory of mechanism, the concepts of mobility, degrees of freedom and inertia and analyze the velocity and accelerations in mechanisms. 2. Apply the concept of friction in machine components and mechanisms. Visualize solid objects and apply AutoCAD commands to generate the models. 3. Analyze the effect of speed and torque in gears and gear trains. 4. Evaluate the effect of gyroscope on Automobiles, ships and airplanes. 5. Distinguish the effect of Dynamics of undesirable free and damped vibrations.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO - 1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	-	3	-	2	2	-	1	2	-	-	-	-
CO-2	2	1	-	3	3	2	2	-	1	2	-	-	-	-
CO-3	1	2	-	2	-	1	2	-	1	2	-	-	-	-
CO-4	1	2	-	3	-	-	-	-	1	2	-	-	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: KINEMATICS OF LINKAGE MECHANISMS	**9**
Kinematic link, pair and chain – Degrees of freedom - Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration – Graphical method – Velocity and acceleration polygons. ***Suggested Reading****: Computer applications in the kinematic analysis of simple mechanisms.*	**CO-1** **BTL-2**
MODULE 2: FRICTION	**9**
Friction in screw and nut– Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive. ***Suggested Reading****: Friction aspects in Brakes, Friction in vehicle propulsion and braking.*	**CO-2** **BTL-4**
MODULE 3: GEARING AND CAMS	**9**
Toothed gearing – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicyclic gear trains - Determination of speed and torque - Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions. ***Suggested Reading****: Helical, Bevel, Worm, Rack and Pinion gears (Basics only), Differentials*	**CO-3** **BTL-4**
MODULE 4: BALANCING AND GYROSCOPIC COUPLE	**9**

Static and dynamic balancing – Single and several masses rotating in same and different planes – Gyroscopic forces and Torques - Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes. ***Suggested Reading**: Balancing machines-Field balancing of discs and rotors.*	**CO-4 BTL-4**
MODULE 5: SINGLE DEGREE FREE VIBRATION	**9**
Single degree of freedom - Free vibration - Equations of motion - natural frequency - Types of Damping - Damped vibration critical speeds of simple shaft – Torsional systems; Natural frequency of two and three rotor systems. ***Suggested Reading**: Vibration measurement and FFT Analysis using MATLAB©*	**CO-5 BTL-3**

TEXT BOOKS	
1.	John J. Uicker. Jr, Gordon R. Pennock, and Joseph E. Shigley,(2014) "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition.
2.	Rattan, S.S,(2014) "Theory of Machines", Tata McGraw-Hill, 4th Edition.
3.	Khurmi, R.S.,(2015),"Theory of Machines", Chand Publications 14th Edition.
REFERENCE BOOKS	
1.	William L. Cleghorn,and Nikolai Dechev (2014),"Mechanisms of Machines", Oxford University Press, 2nd Edition.
2.	Benson H. Tongue,(2007), "Principles of Vibrations", Oxford University Press, 2nd Edition,
3.	Robert L. Norton,(2012), "Kinematics and Dynamics of Machinery", McGraw-Hill Education - Europe, 2nd Edition.
4.	Allen S. Hall Jr.,(2014), "Kinematics and Linkage Design", Prentice Hall, 9th edition.
E BOOKS	
1.	https://books.google.com/books/about/Theory_of_Machines_3_e.html?id=yq0ucr...
2.	The Theory of Machines: A Text-book for Engineering Students Thomas Bevahttps://docs.google.com/file/d/0B5dLUIZfysmqMXBhakRyODhublU/edit
MOOC	
1.	https://docs.google.com/file/d/0B5dLUIZfysmqMXBhakRyODhublU/editories of Machine - S.s.Rattan.pdf. Theories of Machine ...n Snippet view –

COURSE TITLE	**GAS DYNAMICS AND JET PROPULSION**			**CREDITS**	**3**
COURSE CODE	**MEB4303**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course describes the applications of the laws of Thermodynamics to jet and rocket propulsion in engineering applications. The course will provide an insight to various types of compressible flows involved in gas turbines and jet propulsion. The effect of shock in different flows are analyzed in detail and enable the student to solve more advanced problems
Course Objective	1. To understand the fundamental concepts of Compressible and Incompressible fluid flow. 2. To understand the flow through variable area duct with and without friction. 3. To understand the flow through constant area duct with and without friction. 4. To understand the flow through variable area duct with and without shock waves. 5. To understand the principles of flow through nozzles and to design a system for jet and rocket propulsion application and specification.
Course Outcome	Upon completion of this course, the students will be able to 1. Illustrate the basic fundamental concepts of compressible fluid flow, jet propulsion and rocket propulsion phenomena. 2. Describe the subsonic, sonic and supersonic isentropic flows through nozzles and diffusers for air, gases and vapour. 3. Apply the concepts to one dimensional flow in constant area ducts with friction and with heat transfer 4. Apply the concepts to one dimensional isentropic and non-isentropic flow involving normal shocks. 5. Apply the basic laws for the thermodynamics analysis of jet and rocket propulsion.

Prerequisites: Engineering Thermodynamics, Thermal Engineering

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1	2	2	2	1	1	1	-	-	3	-
CO-2	3	3	2	1	2	2	2	-	1	1	-	-	3	-
CO-3	3	3	2	1	2	2	2	-	1	1	-	-	3	-
CO-4	3	3	2	1	2	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: COMPRESSIBLE FLOW - FUNDAMENTALS 9

Energy and momentum equations for compressible fluid flows, various regimes of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility ***Suggested Reading**: Infinitesimal pressure waves (sound waves), Non-steep pressure waves with finite amplitude, Steep pressure waves (shock waves), and Expansion waves*.	**CO-1** **BTL-3**
MODULE 2: FLOW THROUGH VARIABLE AREA DUCTS	**9**
Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles. ***Suggested Reading**: Comparison of isentropic and adiabatic processes for expansion and compression processes*	**CO-2** **BTL-4**
MODULE 3: FLOW THROUGH CONSTANT AREA DUCTS	**9**
Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer. Isothermal flow with friction in constant area ducts ***Suggested Reading**: Variation of flow properties for isothermal flow with friction*	**CO-3** **BTL-4**
MODULE 4: NORMAL SHOCK	**9**
Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl - Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flow with oblique shock (elementary treatment only) ***Suggested Reading**: Wind tunnel and Supersonic wind tunnel used for observing flow and shocks; Plot the variations of flow properties from entry to exit of a diffuser / nozzle undergoing normal shock waves using MATLAB©*	**CO-4** **BTL-4**
MODULE 5: JET PROPULSION	**9**
Aircraft propulsion, types of jet engines, energy flow through jet engines, study of turbojet engine components-diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbojet engines, thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbojet engine, ram jet and pulse jet engines. Rocket propulsion, rocket engines thrust equation, effective jet velocity specific impulse, rocket engine performance, solid and liquid propellants, comparison of different propulsive systems ***Suggested Reading**: Air breathing engines, Emerging trends like Scramjet, Difference between turbojet engines, ramjet engines, pulsejet engines and scramjet engines.*	**CO-5** **BTL-4**
TEXT BOOKS	

1	Ethirajan Rathakrishnan,(2017), Gas Dynamics, PHI Learing Private Limited, Delhi, Sixth Edition,
2	Forrest E Ames,(2018) An Introduction to Compressible Flow, Momentum Press.
3	S. M. Yahya,(2012), Fundamentals of Compressible Flow: With Aircraft and Rocket Propulsion, New Age Science, Fourth Edition.
REFERENCE BOOKS	
1	Frank M White,(2012), Viscous Fluid Flow, Tata McGraw Hill Education Private Limited, New Dehli, Third Edition.
2	H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix,(2017) Gas Turbine Theory, Prentice Education Limited.
3	Frank M White,(2010), Fluid Mechanics, Tata McGraw-Hill New Delhi, 5th Edition.
4	I.G. Currie,(2013) Fundamental Mechanics of Fluids, USA,Fourth Edition.
E BOOKS	
1	https://books.google.co.in/books?id=-zTOBQAAQBAJ&printsec=frontcover&dq= compressible +flow&hl=en& sa=X&ved=0ah UKEwiBsr GzrMrZAhUKtI 8KHUvbD YUQ6 AEIPz AI#v=onepage&q= compressible% 20flow&f=false Patrick H Oosthuizen, William E. Carscallen
2	https://books.google.co.in/books?id=GVjiDQAAQBAJ&printsec=frontcover &dq =Ethirajan +Rathakrishna n&hl=en&sa=X&ved=0ahUKEwjK9 qbhrcrZAhU HN48KHaGMB UIQ6AEIK jAE#v=onep age&q=Ethirajan%20 Rathakrishnan&f=false -- Ethirajan Rathakrishnan
3	https://books.google.co.in/books?id=nCeSQAAACAAJ&dq=compressible +flow+yahya&hl=en&sa=X&ved=0ahUKEwjZi9_crsrZAhUFpY8KHewV BHwQ6AEIHzAC --- S.M.Yahya
4	https://books.google.co.in/books?id=Op7mBQAAQBAJ&printsec=front cover&d q=yahya +fourth+e dition,+Fundamental+of+compressible+ flow&hl=en &sa=X&ved =0ahUKEwi B3JmxsMrZAhUFsY8KHQm MBTU4FBDoAQg1MAY#v=onepage&q&f=false_ --- V. Babu
5	https://books.google.co.in/books?id=hvEmDwAAQBAJ&dq=yahya+ fourth+edition ,+Fund am ental+of+compressible+flow&hl=en&sa= X&ved= 0ahUKEw i0ldeurs rZAhUdS 48KHd8TBU kQ6AEIPDAH ---- H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix
6	https://books.google.co.in/books?id=vTlJnAEACAAJ&dq= Compressi ble+Flow&hl= en&sa =X&ved=0a hUKEwj__uTXssrZAhX EMY8KHZYEDTQ4FBDoAQgzMAY_--- Shih-I Pai
MOOC	
1	http://nptel.ac.in/courses/112106056/
2	http://nptel.ac.in/courses/112103021/
3	http://nptel.ac.in/courses/112106166/
4	http://nptel.ac.in/courses/101106040/
5	http://nptel.ac.in/courses/101106044/
6	http://nptel.ac.in/courses/101101002/
7	http://nptel.ac.in/courses/101104019/
8	http://nptel.ac.in/courses/101103004/
9	http://scpd.stanford.edu/search/publicCourseSearchDetails.do?method=load

	&courseId=11396
10	https://www.mooc-list.com/course/hypersonics-shock-waves-scramjets-edx
11	https://www.my-mooc.com/en/mooc/hypersonics-shock-waves-scramjets-uqx-hypers301x-2/

COURSE TITLE	MECHATRONICS & PNEUMATICS			CREDITS	3
COURSE CODE	MEB4304	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	To understand the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.				
Course Objective	1. To Impart knowledge about the elements and techniques involved in Mechatronics systems 2. To understand the emerging field of automation.				
Course Outcome	Upon completion of this course, the students will be able to 1. Identify an appropriate sensor for certain tasks 2. Describe various actuation systems existing in industries. Design the Building blocks of Mechanical, Electrical, Fluid and Thermal Systems. 3. Control loops and various modes of control and designing of linear control systems 4. Apply the concepts of PLC 5. Apply the design process a Mechatronics system				
Prerequisites: Basic Electrical and Electronics Engineering					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	1	-	2	-	-	-	1	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	1	-	2	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: MECHATRONICS, SENSORS AND TRANSDUCERS	**9**
Introduction to Mechatronics Systems – Measurement Systems – Control Systems – Microprocessor based Controllers. Sensors and Transducers–Performance Terminology–Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors – Selection of Sensors ***Suggested Reading:****Detailed design and development of strain gauge, load cell and accelerometers*	**CO-1** **BTL-3**
MODULE 2: PNEUMATICS AND ACTUATION SYSTEMS	**9**
Pneumatic Components: Air supply unit and distribution unit, Control valves, Linear and rotary actuators - applications - Speed control circuits, synchronizing circuit, Electro Pneumatic circuits, Pneumatic and Electro Pneumatic Sequential circuit design for simple applications using cascade method. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors. ***Suggested Reading:*** *Learning Pneumosim software and designing virtual pneumatic circuits using the software.*	**CO-2** **BTL-3**
MODULE 3: SYSTEM MODELS AND CONTROLLERS	**9**
Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational–Translational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers–Control Mode–Two–Step mode–Proportional Mode–Derivative Mode–Integral Mode–PID Controllers–Digital Controllers–Velocity Control–Adaptive Control – Digital Logic Control – Micro Processors Control. ***Suggested Reading:*** *Learning Matlab© control toolbox and designing a PID controller for actuating robot arm.*	**CO-3** **BTL-3**
MODULE 4: PROGRAMMING LOGIC CONTROLLERS	**9**
Programmable Logic Controllers–Basic Structure–Input/Output Processing Programming–Mnemonics–Timers, Internal relays and counters–Shift Registers–Master and Jump Controls–Data Handling –Analogs Input / Output – Selection of a PLC Problem. ***Suggested Reading:*** *PLC for temperature control inside a room*	**CO-4** **BTL-3**
MODULE 5: DESIGN OF MECHATRONICS SYSTEM	**9**
Stages in designing Mechatronics Systems–Traditional and Mechatronic Design-Possible Design Solutions Case Studies of Mechatronics Systems, Pick and place robot–automatic Car Park Systems– Engine Management Systems. ***Suggested Reading:*** *Case study of household washing machine and refrigerator.*	**CO-5** **BTL-3**
TEXT BOOKS	
1	W. Bolton,(2016) "Mechatronics", Pearson Education, 4th Edition.
REFERENCE BOOKS	

1	S. K. Singh, R. Purohit, (2016),"Industrial Engineering, Robotics and Mechatronics", Made Easy Publications.
2	T. Thakur,(2016) " Mechatronics", Oxford University Press.
3	I. L. Krivits, G. V. Krejnin,(2016) "Pneumatic Actuating Systems for Automatic Equipment" Taylor and Francis.
4	W. Bolton, (2010),"Mechatronics: Electronic Control Systems for Mechanical and Electrical Engineering" Pearson Education. 4th Edition.
E BOOKS	
1	https://books.google.co.in/books?id=3h5Hb9l0xYC&printsec=frontcover&dq=mechatronics +in+action hl=en&sa=X&ved=0ahUKEwjRkoGBtNTZAhWBRo8KHQsHC x0Q6AEIJjAA#v=onep age&q=mechatron ics%20in%20action&f=false – D. Bradley, D. W. Russel
2	https://books.google.co.in/books?id=LAlkDAAAQBAJ&printsec=frontcover&dq= m echatronics+in+a tion&hl=en&sa=X&ved=0ahUKEwjRkoGBtNTZAhW BRo8K HQsHCx0Q6A EIKzAB #v=onepage&q=me chatronics%20in%20action&f=false - Peter Hehenberger
3	https://engineeringstudymaterial.net/ebook/essentials-of-mechatronics-by-john/ - John Billingsley
4	https://engineeringstudymaterial.net/ebook/mechatronics-introduction-by-robert/ - Robert H. Bishop
MOOC	
1	http://nptel.ac.in/courses/112105047/
2	http://nptel.ac.in/courses/112102011/
3	http://nptel.ac.in/courses/112102011/
4	http://nptel.ac.in/courses/112105046/

COURSE TITLE	**DYNAMICS LAB**			**CREDITS**	**1**
COURSE CODE	**MEB4331**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**

ASSESSMENT SCHEME

CIA	**ESE**
80%	**20%**

Course Description	Dynamics laboratory deals with the practical study on balancing of rotating and reciprocating masses, working principle of different types of governors. It also discusses the different types of vibration and its characteristics, jump phenomenon in CAMS and whirling of shaft.

Course Objective	1. To acquire knowledge on various measurement methods 2. To acquire knowledge on balancing of rotating and reciprocating masses 3. To acquire knowledge on CAMS 4. To acquire knowledge on Governors 5. To acquire knowledge on different types of vibration
Course Outcome	Upon completion of this course, the students will be able to 1. Develop the concept of various measurement methods 2. Describe about the laws governing the dynamics of machines such as Balancing of Rotating and Reciprocating Mass 3. Illustrate Jump phenomenon in Cams 4. Identify and measure sensitivity, effort in governors 5. Differentiate the types of vibrations and its applications

Prerequisites: Engineering mechanics, Strength of materials, Mechanics of machines

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	-	2	-	2	-	-	2	-	-	-	-
CO-2	2	2	2	-	-	-	-	-	-	2	-	-	-	-
CO-3	2	2	2	-	-	-	2	-	-	2	-	-	-	-
CO-4	2	2	2	-	2	-	2	-	-	-	-	-	-	-
CO-5	2	2	2	-	2	-	2	-	-	2	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1	Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Hartnell governors
2	Cam - Study of jump phenomenon and drawing profile of the cam
3	Motorised Gyroscope-Verification of laws -Determination of gyroscopic couple
4	Whirling of shaft-Determination of critical speed of shaft.
5	Balancing of reciprocating masses
6	Balancing of rotating masses
7	Determination of moment of inertia by oscillation method for connecting rod and flywheel
8	Vibrating system - Spring mass system-Determination of damping co-efficient of single degree of freedom system
9	Determination of influence co-efficients for multidegree freedom suspension system
10	Determination of transmissibility ratio - vibrating table
11	Determination of torsional frequencies for compound pendulum and flywheel system with Moment of inertia
12	Transverse vibration -free- Beam. Determination of natural frequency and deflection of beam

LIST OF EQUIPMENTS (For a batch of 30 students)

1.	Cam analyzer.

2	Motorised gyroscope
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors
4	Whirling of shaft apparatus.
5	Dynamic balancing machine
6	Static and dynamic balancing machine
7	Vibrating table
8	Vibration test facilities apparatus

COURSE TITLE	THERMAL ENGINEERING LAB-II			CREDITS	1
COURSE CODE	MEB4332	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	To impart experimental knowledge on the performance and operations of fuel properties, performance of I.C. Engines and steam generators
Course Objective	1. To learn about IC engines, lubricants and fuels 2. To understand the Various dynamometers used for testing IC engines, 3. To learn Operating boilers and understand the turbines and power generation
Course Outcome	Upon completion of this course, the students will be able to 1. Conduct experiments on fuels and lubricants and understand its properties. 2. Analyze the heat balance of an IC engine and understand the significance of the performance, combustion and emission parameters. 3. Measure the friction power and indicated horse power in an engine 4. Identify the quality of steam based on the dryness fraction 5. Plot the performance and energy balance of the steam generator and steam turbine

Prerequisites: Thermodynamics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-2	3	3	1	1	3	2	2	1	2	1	-	3	3	-

CO-3	**3**	**3**	**1**	**1**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**3**	**3**	**-**
CO-4	**3**	**3**	**1**	**1**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**3**	**3**	**-**
CO-5	**3**	**3**	**1**	**1**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**3**	**3**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1	Conducting an experiment and drawing the valve timing diagram for a diesel engine		
2	Conducting an experiment and drawing the port timing diagram for a gasoline engine		
3	Conducting a performance test on 4-stroke diesel engine and plotting its performance characteristics curves.		
4	Conducting heat balance test on 4-stroke diesel engine and plotting it on a pie chart.		
5	Conducting a Morse test on multi-cylinder gasoline engine and estimating the indicated power of each engine.		
6	Determination of frictional power of a diesel engine by conducting a retardation test on a slow speed diesel engine.		
7	Determination of viscosity of the fuel by using Redwood Viscometer.		
8	Determination of flash point and fire point of the fuel.		**BTL-4**
9	Emission analysis of exhaust of an IC engine using gas analyser		
10	Combustion analysis of the diesel engine and plotting the pressure Vs crank angle at various load conditions		
11	Determination of dryness fraction of the steam using calorimeter and estimating the quality of steam.		
12	Conducting an experiment on performance and energy balance test on a steam generator		
13	Conducting an experiment on performance and energy balance test on a steam turbine		
14	Plot the performance characteristic curves for given a given fuel at various load conditions using Matlab®		

LIST OF EQUIPMENTS (For a batch of 30 students)

Red Wood Viscometer
Apparatus for Flash and Fire Point
I.C Engine - 2 stroke and 4 stroke model
4-stroke diesel engine with mechanical Loading
4-stroke diesel engine with hydraulic Loading
4-stroke diesel engine with electrical Loading
Multi-cylinder gasoline engine
Single cylinder Petrol Engine

Combustion analysis setup for CI Engine
Emission gas analyser
Data Acquisition system with any one of the above engines
Steam Boiler with turbine and calorimeter setup

COURSE TITLE	MECHATRONICS AND PNEUMATICS LAB			CREDITS	1
COURSE CODE	MEB4333	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Continuous Assessment	ESE
80 %	20%

Course Description	The main purpose of this laboratory is to make the students aware of the pneumatic system components. The pneumatic system has been widely used in the manufacturing industry. So engineering students must get exposure to pneumatic systems.
Course Objective	1. To study single-acting and double-acting cylinder and direction control valve. 2. To select the proper cylinder and direction control valve. 3. To build a pneumatic circuit. 4. To understand the working of the control valve.
Course Outcome	Upon completion of this course, the students will be able to 1. Construct pneumatic circuits for different industrial applications 2. Operate electro pneumatic circuits 3. Solve real time problems using softwares 4. Describe stepper motor control using PLC 5. Design virtual instruments to control temperature, fluid flow etc.

Prerequisites: Engineering Physics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO-2	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO-3	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO-4	3	2	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	3	2	-	-	2	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS
1. Design and testing of pneumatic circuits for different applications
2. Design of circuits with logic sequence using Electro pneumatic trainer kits.
3. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software.
4. Circuits with multiple cylinder sequences in Electro pneumatic using PLC.
5. Servo controller interfacing for open loop
6. Servo controller interfacing for closed loop
7. Stepper motor interfacing with 8051 Micro controller 8. (i)full step resolution (ii) half step resolution
9. Modelling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW
10. Computerized data logging system with control for process variables like pressure flow and Temperature.
MATLAB ASSIGNMENTS
1. Pneumatic Motor Circuit 2. Pneumatic Actuation Circuit 3. Pneumatic Actuator with Humidity 4. Robust Control of an Active Suspension 5. Friction Modeling: MATLAB File Modeling of Static SISO System
LIST OF EQUIPMENTS (For a batch of 30 students)
1. Basic Pneumatic Trainer Kit with manual and electrical
2. Basic Pneumatic Trainer Kit with PLC control
3. HYDROSIM & PNEUMOSIM Software /Automation
4. 8051 - Microcontroller kit with stepper motor and drive
5. LABVIEW software
6. LAB VIEW software with Sensors to measure Pressure,
7. Flow rate, direction, speed, velocity and force.

COURSE TITLE	DESIGN PROJECT III			CREDITS	1
COURSE CODE	MEB4334	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-6
ASSESSMENT SCHEME					
CIA		ESE			
80%		20%			
Course Description	Strategies and methods of designing, manufacturing, and testing of mechanical products. Engineering drawing and CAD, design methods, material properties, failure modes, selection methodology, fundamental GD&T, and selected manufacturing processes.				

Course Objective	1. To provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To understand the engineering aspects of design with reference to simple products 3. To foster innovation in design of products, processes or systems 4. To develop design that add value to products and solve technical problems 5. To develop skills in doing literature survey, technical presentation and report preparation.
Course Outcome	Upon completion of this course, the students will be able to 1. Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters. 2. Describe how the product is achieved for solving practical problem. 3. Prepare a technical drawing, technical report and technical presentation skill.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	-	-	-	-	-	-	2	1	2
CO-3	1	2	2	-	3	1	2	2	1	2	2	3	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE

- The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
- The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

BTL-6

ASSESSMENT (%)	
Continuous Assessment	**80**
Viva-voce	**20**
Total	**100**

SEMESTER VI

COURSE TITLE	COMPUTER AIDED DESIGN AND MANUFACTURING			CREDITS	3
COURSE CODE	MEB4316	COURSE CATEGORY	PC	L-T-P-S	3-0-0-2
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course broadly introduces the mechanical design using computer aided design tools and fundamentals of 3D modeling. It prepares the students to learn the assembly of different parts of the components. It also emphasis on the principles 0f manufacturing process integrated with computer.
Course Objective	1. To provide an overview of how computers are being used in mechanical component design 2. To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
Course Outcome	Upon completion of this course, the students will be able to 1. Illustrate the concept of computer graphics and CAD 2. Demonstrate the concept of numerical control and manufacturing 3. Apply Graphic Standards and data exchange 4. Develop CNC Programs 5. Implement the CAD and CAM on real time applications

Prerequisites: Engineering Graphics and Computer Aided Design, Manufacturing Technology II

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	1	-	1	2	2	2	-	-	-	-	-	-
CO-2	2	2	-	-1	2	-	1	-	1	-	-	-	-	-
CO-3	2	2	-	2	2	-	-	1	-	2	-	2	-	-
CO-4	2	2	1	-	2	-	1	-	-	1	-	2	-	-
CO-5	2	2	-	-	2	-	-	1	-	1	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DESIGN AND GEOMETRIC MODELING 9

Introduction to Design process - CAD. Geometric Modeling: Types - Wireframe, surface and solid modeling. Solid modeling techniques: CSG and B-rep - Operations: Boolean - Extrude - Sweep - Revolve. Mathematical Representation- Line - Circle -Ellipse - Parabola - Cubic Spline, Bezier and Bspline (Basic treatment only). *Suggested Reading: NURBS Curve*	**CO-1** **BTL-4**
MODULE 2: CONCEPTS OF COMPUTER GRAPHICS	**9**
Coordinate systems - Transformations: translation, scaling, reflection, rotation – Concatenated transformation - Inverse transformation. Clipping-Hidden line removal - Visibility Techniques- Algorithm-Shading - Enhancement- Colouring - color models- Rendering. *Suggested Reading: Composite Transformation*	**CO-2** **BTL-4**
MODULE 3: SOFTWARE PACKAGES AND LATEST TECHNOLOGY	**9**
Standards for computer graphics – Graphical Kernal System (GKS) – Open Graphics Library (OpenGL) - Brief outline of data exchange standards – GES, STEP, CALS etc – communication standards. Commercial solid modeling packages: Salient features - Technical comparison –Modules and tools. *Suggested Reading:* Initial Graphics Exchange Specification (IGES)	**CO-3** **BTL-4**
MODULE 4: COMPUTER AIDED MANUFACTURING	**9**
Introduction to computer aided manufacturing – Numerical Control – Computer Numerical Control machines - CNC programming – computer assisted part programming - manufacturing cell – flexible manufacturing system (FMS) – components FMS – layouts of FMS – introduction to Computer integrated manufacturing and CAM software. *Suggested Reading: Group technology using FMS*	**CO-4** **BTL-4**
MODULE 5: IMPLEMENTATION OF CAD AND CAM	**9**
Implementation of CAD in - CAM - CIM - RPT, kinematic analysis, Manufacturability Analysis, simulation and Animation – Types – Techniques. *Suggested Reading: Mass property calculation*	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Ibrahim Zeid,(2010), “CAD / CAM - Theory and Practice 2E”, Tata Mcgraw-Hill, NewDelhi.
2.	P. Radhakrishnan, S. Subramanyan, V. Raju (2015),“CAD/CAM/CIM”, New Age International.
REFERENCE BOOKS	
1	Donald Hearn and M. Pauline Baker,(2009), “Computer Graphics”, Prentice Hall, Inc., 2nd edition.
2	Mikell.P.Groover,(2008), “CAD/CAM: Computer-Aided Design and Manufacturing”, Prentice hall of India Pvt. Ltd.,New Delhi.
3	Kant vajpayee S,(2007), “Principles of computer integrated manufacturing”, Prentice Hall, India.
4	Tien-chien chang, Richard A wysk, Hsu-pin wang, (2009),“Computer-Aided Manufacturing”, Pearson Edition.
E BOOKS	
1.	https://books.google.co.in/books?isbn=0070151342
MOOC	
1.	http://www.nptel.ac.in/courses/Webcourse-contents/IITDelhi/

	Computer%20Aided%20Design%20&%20ManufacturingI/index.htm

COURSE TITLE	DESIGN OF MECHANICAL TRANSMISSION SYSTEM			CREDITS	3
COURSE CODE	MEB4317	COURSE CATEGORY	PC	L-T-P-S	3-0-0-2
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	To expose the students on the principles and procedure for the design of power Transmission components				
Course Objective	1. To learn the principles and procedure for the design of power Transmission components. 2. To understand the standard procedure available for Design of Transmission Systems using standard data and catalogues 3. To calculate the force on the tooth.				
Course Outcome	Upon completion of this course, the students will be able to 1. Select the Belts, Pulleys, Wire ropes, Transmission Chains and Sprockets for different applications. 2. Design Pulleys and Sprockets. 3. Describe Gear Terminology and various types of Gears and its applications. 4. Design Gear Boxes with various speeds 5. Design the Cam and Clutches for various speeds and torques				
Prerequisites: Design of Machine Element, Mechanics of Machines					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	1	-	2	-	-	-	1	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	1	-	2	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS	9
Selection of V belts and pulleys - selection of Flat belts and pulleys - Wire ropes and pulleys Selection of Transmission chains and Sprockets. Design of pulleys and sprockets. ***Suggested Reading**: Timing belt drive*	**CO-1** **BTL-3**
MODULE 2: SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	**9**
Gear Terminology-Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials - Module and Face width-power rating calculations based on strength and Darabiling considerations - Parallel axis Helical Gears - Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces and stresses. Estimating the size of the helical gears. ***Suggested Reading**: Cross helical gear*	**CO-2** **BTL-3**
MODULE 3: BEVEL, WORM AND CROSS HELICAL GEARS	**9**
Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Crossed helical gear: Terminology - helix angles - Estimating the size of the pair of cross helical gears. ***Suggested Reading:** Bevel gear in Differential unit*	**CO-3** **BTL-3**
MODULE :4 DESIGN OF GEAR BOXES	**9**
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Constant mesh gear box. - Design of multi speed gear box. ***Suggested Reading**: Gear box with worm gears.*	**CO-4** **BTL-3**
MODULE :5 DESIGN OF CAM, CLUTCHES AND BRAKES	**9**
Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface contain stresses. Design of plate clutches -axial clutches-cone clutches-internal expanding rim clutches-internal and external shoe brakes. ***Suggested Reading**:* Simulation of clutch mechanism using Matlab©-simulink	**CO-5** **BTL-3**

TEXT BOOKS	
1	Juvinall R. C., Marshek K.M., (2012),Fundamentals of Machine component Design - John Wiley & Sons Fifth Edition.
2	Bhandari, V.B.,(2010), Design of Machine Elements, Tata McGraw-Hill Publishing Company Ltd.
REFERENCE BOOKS	
1	Maitra G.M., Prasad L.V., (2009),Hand book of Mechanical Design, Tata McGraw-Hill, II Edition.
2	Shigley J.E and Mischke C. R.,(2010), Mechanical Engineering Design, McGraw-Hill International Editions,New Delhi.
3	Prabhu. T.J.,(2015), Design of Transmission Elements, Mani Offset, Chennai.

4	Norton R.L,(2004), Design of Machinery, McGraw-Hill Book co.
5	Hamrock B.J., Jacobson B., Schmid S.R.,(2014), Fundamentals of Machine Elements, McGraw-Hill Book Co.
E BOOKS	
1	https://books.google.co.in/books?isbn=1118987683
2	https://books.google.co.in/books?isbn=1259083519
3	https://books.google.co.in/books?isbn=0074602381
4	https://books.google.co.in/books?isbn=1482247488
MOOC	
1	https://onlinecourses.nptel.ac.in/noc18_me16/preview
2	http://nptel.ac.in/courses/112106137/
3	http://nptel.ac.in/courses/112105125/
4	http://www.nptelvideos.in/2012/12/design-of-machine-elements.html

COURSE TITLE	**COMPOSITE AND SMART MATERIALS**			**CREDITS**	**3**
COURSE CODE	**MEB4318**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Composites and smart materials deal with the study on different material combinations for composites and smart materials. It provides a means of assessing the suitability of various materials with respect to their chemical nature and physical characteristics.				
Course Objective	1. To acquire knowledge on Classification of different composite materials based on the composition and structure of the composite material 2. To acquire knowledge for Choosing from different manufacturing techniques for making of composites based on type of application 3. To acquire knowledge on Evaluating composite elastic properties based on micro-mechanical behavior 4. To acquire knowledge on Analyzing the composites for their mechanical properties based on macro-mechanical behavior 5. To acquire knowledge on Examining the composite for their failure mechanisms 6. To acquire knowledge on Formulating A, B and D matrices of Composite laminates based on Kirchoff's hypothesis and propose different laminate types 7. To acquire knowledge on different metal matrix reinforcements and base				

	materials along with their applications 8. To acquire knowledge on manufacturing technique in the making of metal matrix composites.
Course Outcome	Upon completion of this course, the students will be able to 1. Classify the different composite materials based on the composition and structure of the composite material 2. Describe the different manufacturing techniques for making of composites based on type of application 3. Formulate and define composite elastic properties based on micro-mechanical behavior 4. Analyze the composites for their mechanical properties based on macro-mechanical behavior 5. Examine the composite for their failure mechanisms

Prerequisites: Engineering Chemistry

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO -4	PO -5	PO -6	PO-7	PO -8	PO-9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	2	-	2	-	2	-	-	-	-	-	-	2	-	-
CO-3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4	2	-	2	-	2	-	-	-	-	-	-	2	-	-
CO-5	2	-	2	-	2	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO COMPOSITES	**9**
Fundamentals of composites - need for composites - Enhancement of properties - classification of composites- Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) - Reinforcement - Particle reinforced composites, Fibre reinforced composites. **Practical component:**Materials identification **Suggested Readings:** *Applications of various types of composites*	**CO-1** **BTL-4**
MODULE 2: POLYMER MATRIX COMPOSITES	**9**
Polymer matrix resins - Thermosetting resins, thermoplastic resins - Reinforcement fibres Rovings - Woven fabrics - Non woven random mats - various types of fibres. PMC processes - Hand lay up processes - Spray up processes - Compression moulding - Reinforced reaction injection moulding - Resin transfer moulding - Pultrusion - Filament winding - Injection moulding. **Practical component:**Classifying resins.	**CO-2** **BTL-4**

Suggested Readings: *reinforced plastics (FRP), Glass fibre reinforced plastics (GFRP).*	
MODULE 3: METAL MATRIX COMPOSITES	**9**
Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages, Limitations, Metal Matrix, Reinforcements - particles - fibres. Effect of reinforcement - Volume fraction - Rule of mixtures. Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting - squeeze casting. **Practical component:**Fabrication of MMC **Suggested Readings:** *Applications of MMC*	**CO-3** **BTL-4**
MODULE 4: CERAMIC MATRIX COMPOSITES	**9**
Engineering ceramic materials - properties - advantages - limitations - applications of Monolithic ceramics - Need for CMC - Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics - non oxide ceramics - aluminium oxide - silicon nitride - reinforcements - particles- fibres- whiskers. Sintering, Hot pressing - Cold isostatic pressing (CIPing) - Hot isostatic pressing (HIPing). **Practical component:** Fabrication of CMC **Suggested Readings:** *Thermal analysis of ceramic matrix composites*	**CO-4** **BTL-4**
MODULE 5: ADVANCES IN COMPOSITES	**9**
Carbon /carbon composites - Advantages of carbon matrix - limitations of carbon matrix Carbon fibre - chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. **Practical component:** Sol gel technique **Suggested Readings:** *Composites for aerospace applications*	**CO-5** **BTL-4**

TEXT BOOKS	
1.	M. Balasubramanian,(2013), Composite Materials and Processing,CRC Press, New York.
REFERENCE BOOKS	
1.	Maitra G.M., Prasad L.V., (2009),Hand book of Mechanical Design, Tata McGraw-Hill, II Edition.
2.	Shigley J.E and Mischke C. R.,(2010) Mechanical Engineering Design, McGraw-Hill International Editions,New Delhi.
E BOOKS	
1.	https://www.amazon.in/Polymer-Nanocomposite-Based-Smart-Materials-Application-ebook/dp/B0891LFFYB
MOOC	
1.	https://www.classcentral.com/course/swayam-nature-and-properties-of-materials-17704
2.	https://nptel.ac.in/courses/112/104/112104173/

COURSE TITLE	**NANO TECHNOLOGY**			**CREDITS**	**3**
COURSE CODE	**MEB4319**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**

Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course introduces the basics of the nano-sized materials, ways of producing it and its characteristics. Characterization techniques of these kind of materials are also dealt with in detail and its societal impact.				
Course Objective	1. To perceive the basic concepts of nano materials. 2. To understand the various synthesis techniques of nano materials. 3. To comprehend the need for using carbon nanotubes, production techniques of the same and its applications. 4. To apprehend the various characterization techniques used by the carbon nano tubes. 5. To learn about the safety aspects when dealing with nano materials.				
Course Outcome	Upon completion of this course, the students will be able to 1. Realize the concepts of nano science and technology 2. Describe the synthesis of nano materials and their applications 3. Recognize the functions and properties of carbon nano tubes 4. Identify the various characterization techniques applicable for nano materials 5. Illustrate health and social impact of nano industry				
Prerequisites: Engineering Materials					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO-6	PO -7	PO -8	PO -9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO-3	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO NANOTECHNOLOGY (9)

Background, Basic concepts of Quantum wire-Quantum well-Quantum, nanotechnology and nano-machines - types, top down and bottom up techniques, Molecular nanotechnology, atomic manipulation-nanodots, self-assembly, Dip pen nanolithography, Applications of nanomaterials in various fields. *Suggested Reading: Analysis Nano- Sized Magnetic Materials Using MATLAB©*	**CO-1** **BTL-3**
MODULE 2: NANOMATERIALS	**(9)**
Preparation of Nanomaterials-Plasma arcing, Chemical Vapor Deposition, Sol-gels techniques, Electrodeposition, Ball Milling, Natural Nanomaterials. Optically useful nanostructured polymers, Photonic Crystals. *Suggested Reading: Application of MATLAB© for Nanocomposite System*	**CO-2** **BTL-3**
MODULE 3: CARBON NANO TUBES	**(9)**
Carbon tubes-types of nanotubes, formation of nanotubes, Assemblies, purification of Carbon nanotubes, Properties of nanotubes, applications of nanotubes, Core shell and hybrid nanocomposites *Suggested Reading: Application of MATLAB© for Molecular Dynamics Simulation Studies of Nano-Oscillators*	**CO-3** **BTL-3**
MODULE 4: CHARACTERIZATION TECHNIQUES	**(9)**
Simple details of characterization tools- SEM, TEM, AFM. X-ray diffraction – X-ray fluorescence spectroscopy – Thermogravimetric Analysis (TGA) – Differential Thermal Analysis (DTA) – Differential Scanning Calorimetry (DSC), Applications of diffraction techniques to nanomaterials; Grain size, phase formation, texture, stress analysis. *Suggested Reading: Application of MATLAB© in Adsorption of Ne Atoms on CNTs*	**CO-4** **BTL-3**
MODULE 5: HEALTH IMPACT OF NANOMATERIALS	**(9)**
Sources of Nanoparticles; Epidemiological Evidence; Entry Routes into the Human Body – Lung, Intestinal Tract, Skin; Nano particle Size - Surface and Body Distribution; Effect of Size and Surface Charges; Nanoparticles, Thrombosis and Lung Inflammation, Nanoparticles and Cellular Uptake; Nanoparticles and the Blood-Brain Barrier. *Suggested Reading: Application of MATLAB© for Solvation Studies of CNTs or FCNTs*	**CO-5** **BTL-3**

TEXT BOOKS	
1	T.Pradeep, (2012) "*A Text Book of Nanoscience and Nanotechnology*", Tata McGraw Hill, New Delhi.
2	G. Cao, Y. Wang, (2011), "*Nanostructures & Nanomaterials: Synthesis, Properties &Applications*", Imperial College Press, 2nd Edition.
REFERENCE BOOKS	
1	H.S. Nalwa, (2004),"*Encyclopedia of Nanoscience and Nanotechnology*", American Scientific Publishers.

2	W.Gaddard, D.Brenner, S.Lysherski and G.J.Infrate(Eds.),(2012), "*Handbook of NanoScience, Engg. and Technology"*, CRC Press.
3	Michael J. O. Connell,(2006), "*Carbon Nanotubes: Properties and Applications*", CRC Press, .
4	Sam Zhang, L. Li, A. Kumar,(2009) "*Materials Characterization Techniques*", CRC Press.
5	M. Zafar Nyamadzi,(2008), "*A Reference handbook of nanotoxicology"*, Dominant publisher.
E BOOKS	
1	https://books.google.co.in/books?id=TzdmAgAAQBAJ&lpg=PP1&dq=isbn%3A1259007324 &pg=PP1#v= onepage&q&f=false
2	https://books.google.co.in/books?id=XfzgEoY9SNkC&lpg=PP1&dq=isbn%3A0471079359&p g=PP1#v=onep age&q&f=false
3	https://books.google.co.in/books?id=HRvNTjo4tZQC&lpg=PP1&dq=isbn%3A9814322504& pg= PP1#v=onepage&q&f=false
MOOC	
1	http://nptel.ac.in/courses/118102003/
2	http://nptel.ac.in/courses/118104008/
3	http://nptel.ac.in/courses/104103019/9
4	http://nptel.ac.in/courses/103103033/43

COURSE TITLE	**BUSINESS ECONOMICS**			**CREDITS**	**2**
COURSE CODE	**GEA4304**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**2-0-0-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-2**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course introduces economic concepts and principles which are useful in understanding the general economic environment within which businesses and other organizations operate. Microeconomics examines how consumers and firms make decisions and how they interact with each other in markets.				
Course Objective	1. To understand the importance of economics 2. To acquire knowledge on cost analysis 3. To know about consumer's and producer's behavior 4. To know about the budget 5. To know about financial services				

Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding the introduction of economics 2. Describe to know knowledge about cost analysis 3. identify consumer's and producer's behavior 4. prepare and estimate budget 5. Educate about financial services

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	-	-	-	-	-	-	-	-	2	2	2	-	-
CO-2	-	-	-	-	2	-	-	-	-	2	2	2	-	-
CO-3	-	-	-	-	-	-	-	2	-	-	2	2	-	-
CO-4	-	-	-	-	-	-	-	2	-	-	2	2	-	-
CO-5	-	-	-	-	-	-	-	2	-	-	2	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO ECONOMICS	**6**
Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics	**CO1 BTL1**
MODULE 2: COST ANALYSIS	**6**
Types of Cost, Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Economies of Scale Cost Classification	**CO2 BTL2**
MODULE 3: CONSUMER'S AND PRODUCER'S BEHAVIOUR	**6**
Consumer Behavior: Law of Diminishing Marginal utility – Equi marginal Utility – Consumer's Equilibrium - Indifference Curve – Production: Law of Variable Proportion – Laws of Returns to Scale – Producer's equilibrium – Economies of Scale Cost Classification	**CO3 BTL1**
MODULE 4: BUDGET	**6**
Process of budgeting in India –classification of budgets trends – evaluation systems – types of deficits – fiscal policy – indicators — taxation – centre, state and local – public debt and management.	**CO4 BTL1**
MODULE 5: FINANCE	**6**
Basics of finance and financial environment – instruments of financial markets – financial intermediation – investment banking and brokerage services – securities – types of securities – market for securities – how and where traded – initial public offering (IPO) – secondary markets – trading on exchanges and trading with margins.	**CO5 BTL2**

TEXT BOOKS	
1	S. Shankaran, (2012), Business Economics, Margham Publications.
2	H.L. Ahuja, (2016), Business Economics – Micro & Macro, Sultan Chand & Sons, New Delhi – 55.
REFERENCE BOOKS	
1	S.A.Ross, R.W.Westerfield, J.Jaffe and Roberts: Corporate Finance, McGraw-Hill.
2	Joseph E Stiglitz: Economics of the Public Sector.
E BOOKS	
1	https://sites.google.com/site/readbookpdf7734/pdf-download-business-economics-by---mark-taylor-read-online
2	https://bookboon.com/en/economics-ebooks

COURSE TITLE	COMPUTER AIDED DESIGN AND MANUFACTURING LAB			CREDITS	1
COURSE CODE	MEB4341	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	Gain practical experience in handling 2D drafting and 3D modelling software systems and hands on training in CNC Machine Tool.
Course Objective	1. To Expose students to latest CAD systems 2. To Know the application of various CNC machines like CNC lathe and CNC Vertical Machining centre
Course Outcome	Upon completion of this course, the students will be able to 1. Prepare solid model and assemble any mechanical component using CAD software 2. Demonstrate Import and export the models in various CAD softwares 3. Develop CNC program for any component for real time machining using CAD/CAM software

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	-	2	-	2	-	-	-	2	-	1	2	-	-
CO-2	1	1	1	-	2	-	-	-	-	-	2	2	-	-
CO-3	2	-	-	-	2	-	-	-	-	-	2	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS	
	COMPUTER AIDED DESIGN (CAD) 30
1	**DRAWING STANDARDS** Code of practice for technical Drawing, BIS specifications–Welding symbols, riveted joints, keys, and fasteners–Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc.
2	**INTRODUCTIONTO GRAPHIC SOFTWARE FOR DESIGN** Drawing, Editing, Dimensioning, Plotting Commands, Layering concepts, Limits, Fits and Tolerances incorporated in design and drawing.
3	**PREPARATION OF SOLID MODELS AND ASSEMBLY** Screw Jack Tailstock of Lathe Stuffing box Piston and connecting rod Plummer block Machine vice Stop valve
4	**COMPUTER AIDED MANUFACTURING (CAM) 15** **1**. MANUALPART PROGRAMMING (Using G and M Codes) in CNC lathe 1.1 Part programming for Linear and Circular interpolation, Chamfering and Grooving 1.2 Part programming using standard canned cycles for Turning, Facing, Taper turning and Thread cutting 2. MANUALPART PROGRAMMING (using G and M codes) in CNC milling 2.1 Part programming for Linear and Circular interpolation and Contour motions. 2.2 Part programming involving canned cycles for Drilling, Peck drilling, and Boring. 3. SIMULATIONAND NC CODE GENERATION NC code generation using CAD/CAM software – Pos processing for standard CNC Controls like FANUC, Hiedenhain etc.

LIST OF EQUIPMENTS (For a batch of 30 students)	
Hardware	
1	Computer server
2	Computer nodes or systems (Intel i3 or higher with 2GB or higher RAM)networked to the server
3	Plotter
4	Laser Printer
5	Trainer CNC lathe
6	Trainer CNC milling
Software	
1	CAD/CAM Software (Pro –E or IDEAS or Unigraphics or CATIA or Solidworks)
2	CAM Software (CNC programming and tool path simulation for FANUC, Sinumeric and Heiden controller)

COURSE TITLE	COMPOSITES AND SMART MATERIALS LAB			CREDITS	1
COURSE CODE	MEB4342	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	Composites and smart materials laboratory deal with the practical study on different material combinations for composites and smart materials. It provides a means of assessing through synthesis, the suitability of various materials with respect to their chemical nature and physical characteristics.
Course Objective	1. To acquire knowledge on development of skills in synthesize composites 2. To acquire knowledge on test requirements of the composites 3. To acquire knowledge on conduct of mechanical test and determine the properties of the composites 4. To acquire knowledge on use of codes and standards in materials processing and testing
Course Outcome	Upon completion of this course, the students will be able to 1. Develop skills in synthesizing composites 2. Illustrate on test requirements of the composites 3. Identify the mechanical test and determine the properties of the composites 4. Apply the codes and standards in materials processing and testing

Prerequisites: Engineering Chemistry

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	-	2	-	2	-	-	-	2	-	-	2	-	-
CO-2	2	-	-	-	2	-	-	-	-	-	2	2	-	-
CO-3	2	-	-	-	2	-	-	-	-	-	2	2	-	-
CO-4	2	-	-	-	2	-	-	-	-	-	2	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1	Manufacturing of composites a. Hand Lay-up techniques b. Vaccum Bag Moulding c. Compression moulding
2	Inspection of composites

3	Estimation of resin / fiber fraction by Burn off method using muffle furnace
4	Estimation of void content of reinforced composites.
5	Tensile test of composite specimen as per the ASTM procedure.
6	Compression test of composite specimen as per the ASTM procedure.
7	Laminar shear strength of composite specimen as per the ASTM procedure.
8	Flexural bend test of composite specimen as per the ASTM procedure.
9	Determine the critical buckling loads for given specimen using Buckling Test.
10	Determine the changes in dimensions of the graphite-reinforced polymer composite cube using MATLAB©.
LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Muffle Furnace
2	Hydraulic Press 50T
3	Vaccum bag moulding apparatus
4	Weighing Scale
5	Universal Testing Machine
6	Ultrasonicator
7	Band Saw
8	Flat Mould
9	Dead Weights

COURSE TITLE	**DESIGN PROJECT IV**			**CREDITS**	**1**
COURSE CODE	**MEB4343**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-6**
ASSESSMENT SCHEME					
CIA		**ESE**			
80%		**20%**			
Course Description	Strategies and methods of designing, manufacturing, and testing of mechanical products. Engineering drawing and CAD, design methods, material properties, failure modes, selection methodology, fundamental GD&T, and selected manufacturing processes.				
Course Objective	1. To provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To understand the engineering aspects of design with reference to simple products 3. To foster innovation in design of products, processes or systems 4. To develop design that add value to products and solve technical problems 5. To develop skills in doing literature survey, technical presentation and report preparation.				

Course Outcome	Upon completion of this course, the students will be able to 1. Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters. 2. Describe the making a product is achieved for solving practical problem. 3. Prepare a technical drawing, technical report and technical presentation skill.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	-	-	-	-	-	-	2	1	2
CO-3	1	2	2	-	3	1	2	2	1	2	2	3	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE

- The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
- The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

BTL-6

ASSESSMENT (%)	
Continuous Assessment	**80**
Viva-voce	**20**
Total	**100**

COURSE TITLE	COMPREHENSION			CREDITS	1
COURSE CODE	MEB4344	COURSE CATEGORY	PC	L-T-P-S	1-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-6

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	Student who is seeking to pass the reading comprehension portion of such standardized tests as the SAT, ACT, CLEP, College Placement Test, ACCUPLACER, GRE, MCAT, LSAT, or GMAT, or you need to improve your reading comprehension for work or for other personal reasons, this course is for you. You will learn the best way to approach a variety of reading materials and how to improve both your comprehension and speed when reading those materials.
Course Objective	1. To acquainting the students with reading comprehension strategies and skills that facilitate their understanding and analyzing of written texts effectively and easily 2. To developing the students' writing and paraphrasing skills through writing summaries and short compositions about the topics
Course Outcome	Upon completion of this course, the students will be able to 1. Comprehends any given problem related to mechanical engineering field to face competitive exam for Job, GATE, IES etc. 2. Clear written exam and face interview.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	-	-
CO-2	2	1	-	-	3	2	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE

A student will have to appear for a MCQ Test and Comprehensive Viva-Voce examination covering all the subjects before a board of examiners.

ASSESSMENT (%)	
Continuous Assessment	80
Viva-voce	20
Total	100

SEMESTER VII

COURSE TITLE	HEAT AND MASS TRANSFER			CREDITS	3
COURSE CODE	MEB4401	COURSE CATEGORY	PC	L-T-P-S	3-0-0-2
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course describes the applications of the three modes of heat transfer in engineering applications. The course will provide an insight to various types of mechanical system involving phase change. The combined heat and mass transfer are analyzed in detail and enable the student to solve more advanced problems.
Course Objective	1. To understand the steady state and unsteady state conduction in solids. 2. To understand the natural and forced convection heat transfer. 3. To understand the phase change heat transfer. 4. To understand the radiation heat transfer in solids and gases. 5. To understand the principles of combined heat and mass transfer.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the principles of various modes of heat transfer in practical applications and analyse steady state and unsteady conduction in solids. 2. Describe about the types of convection and correlations to solve problems on free and forced convection. 3. Solve problems on phase change heat transfer like boiling and condensation and to design a heat exchanger. 4. Illustrate the mode of heat transfer, radiation and to study about combined heat transfer with convection and radiation. 5. Analyse convection and diffusion Mass transfer and explain how heat transfer and mass transfer are analogous.

Prerequisites: Engineering Thermodynamics, Thermal Engineering

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1	2	2	2	1	1	1	-	-	3	-
CO-2	3	-	2	1	2	2	2	-	1	1	-	-	3	-
CO-3	3	3	2	1	2	2	2	-	-	1	-	-	3	-

CO-4	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO-5	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**3**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CONDUCTION	**9**
Basic Concepts–Mechanism of Heat Transfer – Conduction ,Convection and Radiation– General Differential equation of Heat Conduction– Fourier Law of Conduction– Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation– Extended Surfaces–Unsteady Heat Conduction–Lumped Analysis–Use of Heisler's Chart. ***Suggested Reading:*** *Numerical methods in conduction, Transient conduction in semi infinite solids, two dimensional conduction problems using MATLAB©, Transient conduction problems using MATLAB©..*	**CO-1** **BTL-4**
MODULE 2: CONVECTION	**9**
Basic Concepts–Convective Heat Transfer Coefficients–Boundary Layer Concept–Types of Convection–Forced Convection–Dimensional Analysis– External Flow–Flow over Plates, Cylinders and Spheres–Internal Flow–Laminar and Turbulent Flow–Combined Laminar and Turbulent Heat Transfer – Flow over Bank of tubes–Free Convection–Dimensional Analysis–Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres ***Suggested Reading****: Transition and turbulence in Free convection, Combined Free and Forced Convection.*	**CO-2** **BTL-4**
MODULE 3: PHASE CHANGE HEAT TRANSFER & HEAT EXCHANGERS	**9**
Nusselt's theory of condensation-pool boiling, flow boiling, correlations in boiling and condensation. Types of Heat Exchangers–LMTD Method of heat Exchanger Analysis– Effectiveness– NTU method of Heat Exchanger Analysis–Overall Heat Transfer Coefficient– Fouling Factors. ***Suggested Reading***: Influence of the presence of non-condensable gases in condensation, Pressure drop and pumping power in the design of heat exchanger, Compact heat exchangers	**CO-3** **BTL-4**
MODULE 4: RADIATION	**9**
Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff Law – Black Body Radiation– Grey body radiation Shape Factor Algebra–Electrical Analogy–Radiation Shields –Introduction to Gas Radiation. ***Suggested Reading:*** *Coefficient of Radiant heat transfer and Radiation combined with convection, Radiation from vapours and flames*	**CO-4** **BTL-4**
MODULE 5: MASS TRANSFER	**9**
Basic Concepts–Diffusion Mass Transfer– Fick's Law of Diffusion–Steady state Molecular Diffusion–Convective Mass Transfer–Momentum, Heat and Mass Transfer Analogy– Convective Mass Transfer Correlations. ***Suggested Reading****: Simultaneous heat and mass transfer, Lewis relation.*	**CO-5** **BTL-4**

TEXT BOOKS	
1	R.C. Sachdeva,(2017), "*Fundamentals of Heat and Mass Transfer*", New age International Publishers, Fifth edition.
2	R.K.Rajput,(2012), "*Heat and Mass Transfer*", S.Chand Publishers, Fifth Edition.
3	Dr.D.S.Kumar,(2013), "*Heat and Mass Transfer", S.K.Kataria & Sons.*
REFERENCE BOOKS	
1	J.P.Holman, (2013),"Heat Transfer", McGraw Hill Publishers, 10th edition.
2	Yunus A.Cengel,(2017), "*Heat and Mass Transfer – Fundamentals & Applications",* Fifth edition.
3	P.K.Nag,(2011) "*Heat and Mass Transfer", Mcgraw Hill Edition, 3 edition.*
4	Incropera F.P, (2016),*"Principles of Heat and Mass Transfer",* Wiley India, 7 th edition.
E BOOKS	
1	https://books.google.co.in/books?isbn=0070634513- J.P.Holman
2	https://books.google.co.in/books?isbn=0073398187- Yunus A.Cengel
3	https://books.google.co.in/books?isbn=0070702535- P.K.Nag
4	https://books.google.co.in/books?isbn=0070664609- Ozisik, M.N.
5	https://books.google.co.in/books?isbn=0470917865 – Incropera F.P.
MOOC	
1	https://www.mooc-list.com/course/heat-transfer-saylororg
2	http://nptel.ac.in/courses/112108149/
3	http://nptel.ac.in/courses/112101097/
4	http://nptel.ac.in/courses/112101002/
5	http://nptel.ac.in/courses/103103032/

COURSE TITLE	**FINITE ELEMENT METHODS**			**CREDITS**	**3**
COURSE CODE	**MEB4402**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course introduces students to the fundamental theory of the finite element method as a general tool for numerically solving differential equations for a wide range of engineering problems.				

Course Objective	1. To learn basic principles of finite element analysis procedure. 2. To learn the theory and characteristics of finite elements that represent engineering structures. 3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the Mathematical Modeling of field problems in Engineering 2. Analyze the One Dimensional Second Order Equations 3. Apply Galarkin approach, Temperature effects stress strain relations, plane problems of elasticity and element equations 4. Apply axisymmetric formulation, Element stiffness matrix and force vector, Galarkin approach and Problems 5. Solve numerical integration and application to plane stress problems, Matrix solution techniques Solutions Techniques to Dynamic problems, Introduction to Analysis Software

Prerequisites: Strength of Materials, Numerical Methods, Engineering Mechanics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-2	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO-3	2	3	-	3	2	-	-	-	-	2	-	2	-	-
CO-4	2	3	-	-	3	-	-	-	-	-	-	2	-	-
CO-5	2	3	-	-	3	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method. **Suggested Readings:** Application to bar element, Application to the continuum.	**CO-1** **BTL-4**

MODULE 2: ONE DIMENSIONAL PROBLEMS **(9)**

One Dimensional Second Order Equations - Derivation of Shape functions and Stiffness matrices and force vectors- Galarkin approach - Assembly of stiffness matrix and load vector - Solution of problems from solid mechanics and heat transfer-Finite element equations - Longitudinal vibration frequencies and mode. **Suggested Readings:** Applications to plane trusses, Quadratic shape functions.	**CO-2** **BTL-4**
MODULE 3: TWO DIMENSIONAL CONTINUUM	**(9)**
Introduction - Finite element modelling - Scalar valued problem - Poisson equation - Laplace equation - Triangular elements - Element stiffness matrix - Force vector - Galarkin approach - Temperature effects - stress strain relations – plane problems of elasticity – element equations – assembly – need for quadrature formulae – transformations to natural coordinates – Gaussian quadrature – example problems in plane stress, plane strain using MATLAB© and Abaqus. **Suggested Readings:** Structural mechanics applications.	**CO-3** **BTL-4**
MODULE 4: AXISYMMETRIC CONTINUUM	**(9)**
Axisymmetric formulation - Element stiffness matrix and force vector - Galarkin approach - Body forces and temperature effects - Stress calculations - Boundary conditions - Applications to cylinders under internal or external pressures - Rotating discs - Plate and shell elements. **Suggested Readings:** Axisymmetric applications.	**CO-4** **BTL-4**
MODULE 5: ISOPARAMETRIC FORMULATION	**(9)**
Natural co-ordinate systems – Isoparametric elements with mat lab coding – Shape functions for iso parametric elements – One and two dimensions– Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software. **Suggested Readings:** Application of four node quadrilateral.	**CO-5** **BTL-4**

TEXT BOOKS	
1	C Krishnamoorthy,(2017), Finite Element Analysis: Theory and Programming, McGraw Hill Education; 2nd edition.
2	Anand V. Kulkarni,(2017), A PRIMER ON FINITE ELEMENT ANALYSIS, Laxmi Publications, First edition.
REFERENCE BOOKS	
1	Randy Shih*,(2016), Introduction to Finite Element Analysis Using SOLIDWORKS Simulation*, SDC Publications.
2	A.J DaviesRao S.S.,(2017), *The Finite Element Method with An Introduction Partial Differential Equations* by Oxford, Second edition.
3	Salome Meca, Syllignakis Stefanos, Petr Vosynek,,(2018), Finite Element Analysis, Aster Kindle Edition, Amazon Digital Services LLC.
4	Mary Kathryn Thompson, John Martin Thompson, Butterworth-Heinemann;(2017), *ANSYS and Matlab© Mechanical APDL for Finite Element Analysis*, Kindle Edition, 1 edition .
E BOOKS	

1	https://books.google.co.in/books/about/Applied_Finite_Element_Analysis.html?id=wzZ7BkQgMnAC - G. Ramamurty
2	https://books.google.co.in/books/about/Finite_Element_Analysis.html?id=M0cK 4Tocx9MC - C. S. Krishnamoorthy
3	https://books.google.co.in/books/about/The_Finite_Element_Method_in_Engineering.html?id=nBgZqyepUGwC - S. S. Rao
4	https://books.google.co.in/books/about/Finite_Element_Analysis.html?id=CwO KP1a70Y4C - S. S. Bhavikatti
MOOC	
1	https://onlinecourses.nptel.ac.in/noc16_me02/preview
2	http://nptel.ac.in/courses/112104193/
3	http://nptel.ac.in/courses/112104193/4
4	https://onlinecourses.nptel.ac.in/noc16_me10/preview
5	http://nptel.ac.in/courses/112104116/3
6	http://nptel.ac.in/courses/112104205/

COURSE TITLE	**ROBOTICS AND AUTOMATION**			**CREDITS**	**3**
COURSE CODE	**MEB4403**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	The course describe the basics of robots, structural designing and programming of robots and low cost automation				
Course Objective	1. To understand the functions of the basic components of a Robot. 2. To study the use of various types of End of Effectors and Sensors 3. To impart knowledge in Robot Kinematics and Programming 4. To learn Robot safety issues and economics.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the types, principles and applications of industrial robots. 2. Design the drive mechanism and power transmission method used in robot based on applications, elaborate types of end effectors and grippers. 3. Illustrate and select sensors for industrial robots for sensing the environmental variables, related to various applications. 4. Develop an application oriented robot by applying the concepts of kinematics and programming language. 5. Select of suitable robot configuration for a manufacturing environment.				

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	1	-	2	-	-	-	1	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	1	-	2	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**9**
Definition of Robot, History of robotics, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration, Robot motions, Joints, Work volume, Applications of Robots – material handling and processing. ***Suggested Reading:*** Recent developments in industrial robots	**CO-1** **BTL-3**
MODULE 2: DRIVE SYSTEMS AND END EFFECTORS	**9**
Robot drive mechanisms – hydraulic, pneumatic and electric drives, power transmission methods, Construction of Manipulators, Classification of End effectors, grippers – mechanical, pneumatic, hydraulic, vacuum gripper, fingered grippers, internal and external gripper, selection of grippers and design considerations, simulate and visualize robot arm motion using Simscape multibody of Matlab©, Simulink® schematic of the speed reducer model. ***Suggested Reading:*** Interfacing of drive system with a microcontroller	**CO-2** **BTL-3**
MODULE 3: ROBOT SENSORS AND MACHINE VISION SYSTEM	**9**
Sensor characteristics, Position sensors, Displacement sensor, Velocity sensor, Acceleration sensors, Force and Pressure sensors, Torque sensors, Touch and tactile sensor, Proximity sensors, Machine Vision System - Introduction to Machine vision, sensing and digitizing function in Machine vision, Image processing and analysis, application of Vision systems in robotics, acquiring and logging sensor data using Simulink of Matlab© ***Suggested Reading:*** Building a robot that avoids obstacles	**CO-3** **BTL-3**
MODULE 4: ROBOT MOTION ANALYSIS AND ROBOT PROGRAMMING	**9**

Translations, Rotations and Transformations - Forward and reverse transformation, homogeneous transformations – coordinate system transformations using Matlab© - Forward and inverse Kinematics Of three & four Degree of Freedom Robot Arm, Robot Arm dynamics, manipulator path control, manipulator algorithms using Matlab© Robot programming and languages**:** Methods of programming, lead-through programming methods, textual robot languages – motion commands, sensor commands, end effector commands, graphical simulation facilities. ***Suggested Reading:*** Robotic arm manipulation (kinematics & control)	**CO-4** **BTL-3**
MODULE 5: AUTOMATION	**9**
History of Automation, Reasons for automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies, Automated Manufacturing Systems - Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems, Types of FMS, Robot cell, Robot process automation, ***Suggested Reading:*** PLC used in automation.	**CO-5** **BTL-3**

TEXT BOOKS	
1	Mikell P. Groover, Mitchell Weiss, (2012), "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International Editions, 1st Edition.
2	Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, (2012),"Robotic Engineering - An Integrated Approach", Prentice Hall India.
REFERENCE BOOKS	
1	Saeed B. Niku,(2011) “Introduction to Robotics: Analysis, Systems, Application” , Pearson education.
2	Deb S R,(2010), "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi.
E BOOKS	
1	http://www.robotics.org/
2	http://www.robotbooks.com/general-robotics-links.htm
3	https://books.google.co.in/books?id=P1ljICxFA_AC&printsec=frontcover#v=onepage&q&f=false
MOOC	
1	https://www.mooc-list.com
2	http://nptel.ac.in/courses/112101098/

COURSE TITLE	**ADDITIVE MANUFACTURING TECHNOLOGY**			**CREDITS**	**3**
COURSE CODE	**MEB4404**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-2**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course gives the knowledge in various additive manufacturing techniques and the materials used in these processes.
Course Objective	1. To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies 2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the principles of this manufacturing process to produce the product. 2. Identify the characteristics of those materials and tools that can be used for this process. 3. Handle the softwares applicable to the product. 4. Identify areas of applications for this process. 5. Do research in medical and bio-additive manufacturing

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	2	-	-	-	-	-	-	-	-	2	-	-
CO-2	-	2	2	-	-	-	-	-	-	-	-	2	-	-
CO-3	1	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	-	-	2	-	-
CO-5	1	-	2	-	-	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**9**
Overview –Need-Classification -Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology – Tooling – Applications. ***Suggested Reading**: 3D printing , 3D Scanning, parametric equation for line, triangle, circle and Plot using Matlab©,*	**CO-1** **BTL-3**
MODULE 2: CAD & REVERSE ENGINEERING	**9**

Basic Concept – 3D Design- Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation- Design to STL format conversion – Part Orientation and support generation – Model Slicing –Tool path Generation ***Suggested Reading**: Software practice for Additive Manufacturing Technology: Flash Print/ Auto Maker.*	**CO-2** **BTL-3**
MODULE 3: LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS	**9**
Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications ***Suggested Reading**: Laminated Object Manufacturing.*	**CO-3** **BTL-3**
MODULE 4: POWDER BASED ADDITIVE MANUFACTURING SYSTEMS	**9**
Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting. ***Suggested Reading**: Powder production technique, characterisation technique*	**CO-4** **BTL-3**
MODULE 5: MEDICAL AND BIO-ADDITIVE MANUFACTURING	**9**
Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies. ***Suggested Reading**: Application in* Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others	**CO-5** **BTL-3**

TEXT BOOKS	
1	Chua C.K., Leong K.F., and Lim C.S., (2017), 3D Printing and Additive Manufacturing: Principles and Applications: World Scientific Publisher, Fifth Edition of Rapid Prototyping.
2	Gebhardt A.,(2011), Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Hanser Publications, 1st edition.
REFERENCE BOOKS	
1	Ian Gibson, David Rosen, Brent Stucker.,(2015) Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing , Springer, 2nd Edition
2	Clifford T Smyth., (2017),— Functional Design for 3D Printing: Designing 3d printed things for everyday use , Clifford Smyth - 3rd edition,
E BOOKS	
1	https://www.newcastlesys.com/the-essentials-of-lean-manufacturing-ebook
2	www.vebridge.com/contact-us/lean-manufacturing-ebook/
MOOC	
1	https://www.edx.org/course/lean-production-tumx-qpls3x

COURSE TITLE	HEAT TRANSFER LAB			CREDITS	1
COURSE CODE	MEB4431	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	To enable the student to apply conduction, convection and radiation heat transfer concepts to practical applications. Also to analyse the phase change heat transfer in various mechanical devices.
Course Objective	1. To learn about thermal conductivity of insulating and building materials. 2. To understand the heat transfer coefficient of condensation, free and forced convection. 3. To learn about the radiation constant and emissivity of specimen.
Course Outcome	Upon completion of this course, the students will be able to 1. Perform steady state conduction experiments to estimate thermal conductivity of different insulating and building materials. 2. Estimate heat transfer coefficients in forced convection, free convection, condensation and correlate with theoretical values 3. Obtain variation of temperature along the length of the pin fin under forced and free convection 4. Perform radiation experiments: Determine surface emissivity of a test plate and Stefan-Boltzmann's constant and compare with theoretical value

Prerequisites: Thermodynamics, Heat Transfer

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-2	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-3	3	3	1	1	3	2	2	1	2	1	-	3	3	-
CO-4	3	3	1	1	3	2	2	1	2	1	-	3	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

	1	Thermal conductivity measurement by Guarded Plate Method	
	2	Thermal conductivity of pipe insulation using Lagged Pipe apparatus	
	3	Thermal conductivity measurement in composite wall apparatus	
	4	Natural convection heat transfer from a vertical cylinder	
	5	Forced convection inside a tube	
	6	Heat transfer from pin fin (both natural & free convection modes)	
	7	Determination of Stefan Boltzman's constant	
	8	Determination of emissivity of Grey surface	
	9	Effectiveness of Parallel/Counter flow heat exchanger	BTL-4
	10	Determination of overall heat transfer coefficient and effectiveness of Shell & Tube heat exchanger.	
	11	Steady state conduction problem using MATLAB©.	
	MATLAB ASSIGNMENTS		
	1. Nonlinear Heat Transfer In a Thin Plate 2. Solving a Heat Transfer Problem With Temperature-Dependent Properties 3. Determining Heat Transfer and Mass Flow Rate in a Ramjet Combustion Chamber 4. Heat Conduction in a Spherical Multidomain Geometry with Nonuniform Heat Flux 5. Temperature Control in a Heat Exchanger		

LIST OF EQUIPMENTS (For a batch of 30 students)	
1	Guarded Plate apparatus
2	Lagged pipe apparatus
3	Composite wall apparatus
4	Natural convection- vertical cylinder apparatus
5	Forced convection inside tube apparatus
6	Pin – fin apparatus
7	Stefan-Boltzman's apparatus
8	Emissivity measurement apparatus
9	Parallel and Counter flow heat exchanger apparatus
10	Shell and Tube heat exchanger apparatus

COURSE TITLE	**COMPUTER AIDED SIMULATION AND ANALYSIS LAB**			**CREDITS**	**1**
COURSE CODE	**MEB4432**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
CIA			**ESE**		
80%			**20%**		

Course Description	Deals with various analysis like structural and thermal analysis in mechanical related components
Course Objective	1. To obtain knowledge in Various structural analysis 2. To obtain knowledge in thermal analysis
Course Outcome	Upon completion of this course, the students will be able to 1. Determine of stress, nodal displacements and reactions of different bar and truss. 2. Compute the shear force and bending moment diagram for the cantilever, simply supported and fixed beam with different load 3. Do thermal analysis for the 2-D heat conduction and convection for the temperature distribution within the rectangular plate.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO-8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	-	2	-	2	-	-	-	2	-	1	2	-	-
CO-2	1	1	1	-	2	-	-	-	-	-	2	2	-	-
CO-3	2	-	-	-	2	-	-	-	-	-	2	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1	Stress analysis of bar of constant cross-section area.
2	Stress analysis of bars of tapered cross section area.
3	Stress analysis of stepped bar.
4	Stress analysis of composite stepped bar.
5	Stress analysis and nodal displacements of Two bar Truss
6	Stress analysis and nodal displacements of Four bar Truss
7	Stress analysis and nodal displacements of multiple bar Truss
8	Compute the shear force and bending moment diagram for the cantilever, simply supported and fixed beam with point load
9	Compute the shear force and bending moment diagram for the simply supported beam with Uniformly distributed load
10	Compute the shear force and bending moment diagram for the simply supported beam with Uniformly varying load
11	Modal analysis of cantilever, simply supported and fixed beam for free vibration.
12	Stress analysis of rectangular plate with hole subjected to axial load Stress analysis of rectangular plate with multiple hole subjected to axial load
13	Thermal analysis for the 2-D heat conduction for the temperature distribution within the rectangular plate.
14	Thermal analysis for the 2-D heat convection for the temperature distribution within the

	rectangular plate.
15	Develop a program to find the response of a multidegree-of-freedom system using modal analysis.
16	Develop a program to find the response of a multidegree-of-freedom system using modal analysis.
LIST OF EQUIPMENTS (For a batch of 30 students)	
HP Pro6200 – 30 systems	
1	Mother board : Intel i5
2	Processor: 3.1 GHz
3	RAM : 4 GB
4	HDD : 500 GB
5	Monitor : 18.5”LCD
6	Key board & Mouse: PS/2
ACER- 30 systems	
1	Mother board : Intel i3
2	Processor: 3.6 GHz
3	RAM : 4 GB
4	HDD : 500 GB
5	Monitor : 18.5”LCD
6	Key board & Mouse: PS/2

COURSE TITLE	**ROBOTICS AND AUTOMATION LAB**			**CREDITS**	**1**
COURSE CODE	**MEB4433**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-1**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

CIA	**ESE**
80%	**20%**

Course Description	Students get the practical knowledge in sensors, robot programming and designing of robotic cell.
Course Objective	1. To know about different types of kinematics and select a suitable robot for a specific application. 2. To Know about Robot Vision
Course Outcome	Upon completion of this course, the students will be able to 1. Identify different types of robots and their applications 2. Differentiate sensors usage 3. Develop basic programming in Robots

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	-	2	-	2	-	-	-	2	-	-	2	-	-
CO-2	-	-	-	-	2	-	-	-	-	-	2	2	-	-
CO-3	2	-	-	-	2	-	-	-	-	-	2	2	-	-
1: Weakly related, 2: Moderately related and 3: Strongly related														

LIST OF EXPERIMENTS	
1	Study of different types of robots based on configuration and application.
2	Study of different type of links and joints used in robots
3	Study of components of robots with drive system and end effectors.
4	Simulate and Visualize Robot Arm Motion using Simscape - Matlab©
5	Programming of Industrial Robot for material handling application
6	Programming of industrial robot for processing application
7	Interfacing of conveyor with industrial robot and exercises related to robot – conveyor systems
8	Robot programming exercises for various applications (Point-to-point and continuous path programming)
9	Teaching to robot using teach pendant
10	Design a Pick and Place Robotics Application with MATLAB© and Simulink
11	Vision inspection and sorting
12	Simulation of welding, painting and de-burring
13	Developing robotic applications with robotics system toolbox of Matlab©,
14	Test robotics algorithms on a physical robot Using MATLAB© and Simulink

LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Any one type of robot configuration with at least five degree of freedom.
2	Robot programming software inclusive of computer system.
3	Models of different types of end effectors drive systems Links and Joints.
4	Models of different configuration robots
5	Vision system for sorting and inspection
6	Matlab© software R2017

COURSE TITLE	DESIGN PROJECT - V			CREDITS	1
COURSE CODE	MEB4434	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-6
ASSESSMENT SCHEME					
CIA		ESE			
80%		20%			

Course Description	Strategies and methods of designing, manufacturing, and testing of mechanical products. Engineering drawing and CAD, design methods, material properties, failure modes, selection methodology, fundamental GD&T, and selected manufacturing processes.
Course Objective	1. To provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To understand the engineering aspects of design with reference to simple products 3. To foster innovation in design of products, processes or systems 4. To develop design that add value to products and solve technical problems 5. To develop skills in doing literature survey, technical presentation and report preparation.
Course Outcome	Upon completion of this course, the students will be able to 1. Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters. 2. Describe the making a product is achieved for solving practical problem. 3. Prepare a technical drawing, technical report and technical presentation skill.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	-	-	-	-	-	-	2	1	2
CO-3	1	2	2	-	3	1	2	2	1	2	2	3	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE

- The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
- The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

BTL-6

ASSESSMENT (%)	
Continuous Assessment	**80**
Viva-voce	**20**
Total	**100**

COURSE TITLE	**INTERNSHIP**			**CREDITS**	**1**
COURSE CODE	**MEB4435**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-6**
ASSESSMENT SCHEME					
1	**Report and Viva-voce - 100**				
Course Description	The Engineering Internship course is a Canvas-based course that offers students the opportunity to explore and develop their careers through professional practice. The structured plan of education impacts student work readiness through a number of professional development skill-building activities, including goal setting; analysis and reflection; feedback from employer; informational interviewing and debriefing their experience.				
Course Objective	1. To make industrial exposure in various streams in mechanical engineering 2. To understand the current industry needs based on their production 3. To get placement				

Course Outcome	Upon completion of this course, the students will be able to 1. Industrial experience in design and fabricate of device/ machine/ equipment 2. Describe the making a product in the real industries is achieved 3. Prepare a technical drawing, technical report and technical presentation skill.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	2	-	-	-	-	-	2	1	2
CO-3	2	1	2		3	2		2	1	2	1	2	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

SEMESTER VIII

COURSE TITLE	PROJECT AND VIVA-VOCE			CREDITS	8
COURSE CODE	MEB4441	COURSE CATEGORY	PC	L-T-P-S	0-0-24-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-6

ASSESSMENT SCHEME

CIA	VIVA-VOCE
80%	20%

Course Description	Strategies and methods of designing, manufacturing, and testing of mechanical products. Engineering drawing and CAD, design methods, material properties, failure modes, selection methodology, fundamental GD&T, and selected manufacturing processes.
Course Objective	1. To provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To understand the engineering aspects of design with reference to simple products 3. To foster innovation in design of products, processes or systems 4. To develop design that add value to products and solve technical problems 5. To develop skills in doing literature survey, technical presentation and report preparation.
Course Outcome	Upon completion of this course, the students will be able to 1. Design and fabricate a device/ machine/ equipment using the knowledge acquired in the previous semesters. 2. Numerical Analysis of physical engineering problem. 3. Complete understanding of making a product is achieved for solving practical problem 4. Prepare a technical drawing, technical report and technical presentation skill.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	-	3	-	-	2	1	2	2	3	1	2
CO-2	2	1	-	-	3	-	-	-	-	-	-	2	1	2
CO-3	1	2	2	-	3	1	2	2	1	2	2	3	1	2
CO-4	1	2	3	-	1	-	-	2	1	2	1	1	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

NOTE
1. The students in convenient groups of not more than 4 members have to take one small item for design and fabrication or Individual student can do Modeling and Simulation using software like Ansys, CFX, etc. Every project work shall have a guide who is the member of the faculty of the institution.
2. The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc. Numerical Analysis can also be done using commercially available software or by developing own code.
3. The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication, result analysis for numerical simulation.
ASSESSMENT (%)
Continuous Assessment - 80
Viva-voce - 20
Total - 100

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER III

COURSE TITLE	NON-DESTRUCTIVE TESTING METHODS			CREDITS	3
COURSE CODE	MEC4251	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	**Non-destructive testing (NDT)** is a testing and analysis technique used by industry to evaluate the properties of a material, component, structure or system for characteristic differences or welding defects and discontinuities without causing damage to the original part. This course provides a detailed study on different techniques of NDT to detect surface, sub surface and volumetric defects.				
Course Objective	1. To understand the different techniques of Non-Destructive Testing and to study the Visual inspection and its aids 2. To understand the principle behind LPT and to study the different methods involved for the surface inspection. 3. To understand the principle and instrumentation for ECT and AET and the involved methodology in different applications. 4. To understand the principle behind MPT and to study the different equipment's involved in the inspection. 5. To understand the principle behind UT and to study the different methods of ultrasonic scan for various applications.				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the different Non-Destructive Testing procedures and the principle behind various NDT techniques. 2. Identify the operation of various NDT equipment's and accessories. 3. Develop the NDT techniques for practical applications. 4. Compare and select various NDT techniques based on applications 5. Apply the techniques suitable for different materials that could be inspected as per codes, standards and specifications.				
Prerequisites: Engineering Physics, Engineering Chemistry					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2

CO-1	**3**	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO-2	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**-**
CO-3	**2**	**-**	**2**	**2**	**2**	**-**	**-**	**2**	**2**	**1**	**1**	**-**	**-**	**-**
CO-4	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO-5	**1**	**1**	**2**	**2**	**-**	**-**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**
1: Weakly related, 2: Moderately related and 3: Strongly related														

MODULE 1: NON DESTRUCTIVE TESTING: AN INTRODUCTION	**(9)**
Scope of NDT, Introduction to various NDT methods Impact of NDT in disaster prevention, Comparison of Destructive and Non destructive tests, Visual Inspection, Optical aids used for Visual inspection and their applications. **Practical component:**Applications of NDT- Inspection using ROBO NDT-A MATLAB© TOOLBOX approach Robots in NDT to speed up inspection **Suggested Readings:** *International codes, and standards and their importance in NDT, Basic metallurgical processes and defects*	**CO-1** **BTL-2**
MODULE 2: LIQUID PENETRANT TESTING (PT)	**(9)**
Physical principles, Procedure for Penetrant testing, Penetrant Testing materials Penetrant Testing Methods—Water washable, Post emulsifiable, Solvent removable methods Sensitivity, Advantages, Limitations and applications. **Practical component:** Report generation of the method using MATLAB© Report generator **Suggested Readings:** *National and International Standards for Liquid Penetrant Flaw detection*	**CO-2** **BTL-3**
MODULE 3: EDDY CURRENT TESTING AND ACOUSTIC EMISSION TESTING	**(9)**
Principles and Instrumentation for ECT, Absolute- differential probes, Techniques of ECT-High Sensitivity techniques,3D or phased array ECT, Sensitivity, Advantages, Limitations and Applications of ECT. Principles of AET and instrumentation, Sensitivity, Advantages and Limitations of AET, Applications-Testing of metal pressure vessels, Fatigue crack detection in aerospace structures. **Practical component:** Applications- using MATLAB©'s Image Acquisition Tool Box **Suggested Readings:** *Advanced ECT methods and Standards for ECT*. Advanced AET and areas of opportunities for AE development, Standards for AET	**CO-3** **BTL-3**
MODULE 4: MAGNETIC PARTICLE TESTING	**(9)**
Definitions and principles of MPT, Magnetizing techniques, Procedure used for testing a component, Equipment used for MPT, Sensitivity, Advantages, Limitations and Applications **Practical component:** Applications- using MATLAB©'s Tool Box **Suggested Readings:** *Improvements in MPI and Selection of equipment for MPT*	**CO-4** **BTL-3**

MODULE 5: ULTRASONIC TESTING	(9)
Principles of UT, Ultrasonic transducers, Inspection methods, Normal incident pulse-echo, through transmission testing, Angle-beam Pulse- Echo testing, Criteria for selection of Probes, Flaw sensitivity, Techniques for Normal Beam Inspection, law characterization Techniques, Ultrasonic law Detection Equipment, Modes of display, A Scan, B Scan and C Scan Immersion testing, Advantages, Limitations and Applications of UT. **Practical component:** Use of Ultrasound field Simulation tool ULTRA SLIM-A MATLAB© TOOL BOX **Suggested Readings:** *Mechanical Impedance Analysis Technique*	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Baldev Raj,T.Jeya kumar, . M.Thavasimuthu,(2017), *Practical Non Destructive Testing,* Narosa Publishing housing, New Delhi,Third edition.
2.	Peter J. Shull,(2010),:Non Destructive Evaluation: *Theory, Techniques and Applications,* Marcel Dekker, Inc.,New York.
REFERENCE BOOKS	
1.	Kraut krammer .J.,(2010), Ultrasonic Testing of Materials, Springer Verlag Publication, NewYork, 2nd Edition.
2.	Schmmer Jr. L.W. (2016),Fundamentals of Ultrasonic Non-destructive Evaluation, Springer Verlag Publication, New York.
E BOOKS	
1.	https://books.google.com/books/Practical Non Destructive Testing/html?id - Baldev Raj,T. Jaya kumar ,M.Thavasimuthu
2.	https://www.worldscientific.com/worldscibooks/10,1142/6327 Ultrasonic and Advanced Methods for Non destructive Testing and Material characterization - C.H.Chen
3.	https://www.crcpress.com/NondestructiveTesting/book/9781138075962 google - Langenberg, ReneMarklein, Klaus Meyer
MOOC	
1.	https://www.class central.com/tag/non20% destructive20% testing
2.	http:// online coursesnptel.ac.in/noc18mm04
3.	http://nptel.ac.in/courses/114106035/35/
4.	http://www.nde-ed.org/../Intro to NDT/Intro_to NDT ppt
5.	http://nptel.ac.in/courses/113106070/

COURSE TITLE	REVERSE ENGINEERING			CREDITS	3
COURSE CODE	MEC4252	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical	Seminar/ Assignments/	Surprise Test / Quiz	Attendance	ESE

	Assessment	Project			
15%	15%	10%	5%	5%	50%

Course Description	This course describes the basic concepts and digitization techniques in Reverse engineering process. It also discriminates the various tools used for reverse engineering. It pronounces the various data management strategies pertaining to reverse engineering and also outlines the cognitive approach on the integration of reverse engineering.
Course Objective	1. To understand need for and the various tools required for reverse engineering with exposure to the software needed for implementing reverse engineering. 2. To comprehend and select the suitable tools and methodology for reverse engineering for any product 3. To recognize the important research challenges associated with Reverse engineering and its data processing tools 4. To know the important integrating reverse engineering, reuse and specification tool environments to reverse engineering 5. To appreciate with various concepts in quality and reliability principles in the design of an engineering product or a service.
Course Outcome	Upon completion of this course, the students will be able to 1. Familiarize the various tools used in reverse engineering implementation. 2. Recognize the suitable methodologies for any reverse engineered product 3. Formulate and provide solutions to challenges associated with reverse engineering. 4. Apply standard integration and reuse techniques in reverse engineering environment. 5. Recognize the quality and reliability principles in Reverse engineering.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	-	1	1	2	1	-	-	-	1	1	-	-
CO-2	1	1	1	1	2	-	1	1	-	-	-	-	-	-
CO-3	1	-	-	-	2	-	-	-	-	-	1	1	-	-
CO-4	2	2	-	-	1	-	1	1	-	-	-	1	-	-
CO-5	1	-	1	1	3	-	-	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies. ***Suggested Reading:*** *Scope and tasks of RE - Domain analysis- process of duplicating*	**CO-1** **BTL-2**
MODULE 2: TOOLS FOR REVERSE ENGINEERING	**9**
Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application prototyping - verification ***Suggested Reading:*** *Stereo lithography Apparatus, Fused deposition Modeling (FDM) Case studies*	**CO-2** **BTL-2**
MODULE 3: CONCEPTS OF REVERSE	**9**
History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation ***Suggested Reading:*** Selective Laser Sintering (SLS), Laser Engineered Net Shaping (LENS) *Case studies*	**CO-3** **BTL-3**
MODULE 4: DATA MANAGEMENT	**9**
Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics ***Suggested Reading:*** *Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM)*	**CO-4** **BTL-3**
MODULE 5: INTEGRATION OF REVERESE ENGINEERING	**9**
Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering -–coordinate measurement – feature capturing – surface and solid members *Suggested Reading: reverse engineering a simple neural network using MATLAB©*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Kevin Otto & Kristin Wood,(2011), Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE).
2	Robert W. Messler Jr. (2013), Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition
REFERENCE BOOKS	

1	Liou, L.W. and Liou, F.W., (2011),"Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press.
2	Chua, C.K., Leong K.F. and Lim C.S.,(2010), "Rapid prototyping: Principles and applications", World Scientific Publishers, second edition.
3	Kathryn, A. Ingle, Reverse Engineering, McGraw-Hill
E BOOKS	
1	https://books.google.co.in/books/about/Reverse_Engineering.html?id=1_KFldjML8wC &redir_esc=y- Vinesh Raja, Kiran J. Fernandes
2	https://books.google.co.in/books/about/Reverse_Engineering.html?id=sSkfgehm4y QC&redir_esc=y Linda M. Wills, Philip Newcomb
3	https://books.google.co.in/books?isbn=1439806314 - Wego Wang
4	https://books.google.co.in/books?isbn=1118079760 - Eldad Eilam
MOOC	
1	Computer Aided Design and Manufacturing ('Mechanical Engineering' course from IIT Delhi) Video Lectures by Prof. P.V. Madhusudan Rao, Prof. Anoop Chawla. https://youtu.be/9dd3M2a4LKI
2	https://ocw.mit.edu/courses/health-sciences-and-technology/hst-512-genomic-medicine-spring-2004/audio-lectures/lecture-19/
3	https://www.mooc-list.com/course/introduction-reverse-engineering-software-ost
4	https://mooc.live/reverse-engineering-and-exploit-development-online-course/

COURSE TITLE	**MECHANICAL METALLURGY**			**CREDITS**	**3**
COURSE CODE	**MEC4253**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes various types of failures occurs in metals and alloys. The reasons for failures and property changes are also described. The testing procedures for finding various properties of metals and alloys were described as per ASTM standards.				
Course Objective	1. To understand the different types of failures in metals and alloys. 2. To understand the types of fractures and reason behind the fracture. 3. To understand the property changes with respect to various parameters. 4. To understand the various testing procedures of metals and alloys under ASTM standards. 5. To understand the various testing procedures of metals and alloys under ASTM				

	standards.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basics of dislocation in metals and the theory behind its formation. 2. Classify the types of fracture and the mechanisms behind the occurrence of fracture. 3. Recognize how alloying of metals are performed; to read on the phase diagrams and interpreting the property change due to alloying. 4. Identify the mechanical testing procedures and ASTM standards for conducting the tests. 5. Conduct the test procedures for Impact testing, fatigue testing and creep testing-overview on the general results obtained for metals-theory behind the failures; ASTM standards for conducting the tests.

Prerequisites: Engineering Physics, Engineering Chemistry

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	-	-	2	2	2	1	1	1	-	-	3	-
CO-2	3	2	1	1	2	-	-	-	1	1	-	-	-	-
CO-3	3	2	-	-	2	2	2	-	1	1	-	-	-	-
CO-4	-	-	1	1	2	2	2	-	-	-	-	-	3	-
CO-5	3	2	1	1	2	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PLASTIC DEFORMATION	**9**
Dislocations-types, burgers vector, theoretical cohesive strength and practically measured strength, deformation by slip, critical resolved shear stress, deformation by twinning, stacking faults. Dislocation theory- dislocation loop, dislocations in cubic and hexagonal lattices, stress fields and energies of dislocations, dislocation climb, intersection of dislocations, dislocation multiplication, dislocation pile-ups. Strain hardening of single crystals. *Suggested Reading: Stress-Strain Curve, Plastic region vs Elastic region, Study on ductile and brittle materials, View dislocations under a microscope.*	**CO-1** **BTL-3**
MODULE 2: FRACTURE	**9**
Types of Fracture, Griffth's theory of brittle fracture, fractography, effect of temperature, stress raisers and strain rate on fracture behavior. Fracture mechanics-stress intensity factor, fracture toughness, plane- strain toughness testing, crack opening displacement, probabilistic aspects of fracture mechanics. *Suggested Reading: Analyze the fractured samples and find the type of fracture, Reasons for generation of cracks in metals during loading*	**CO-2** **BTL-3**

MODULE 3: ALLOYING THEORY AND PHASE DIAGRAMS	9
Types of solid solutions and compounds - Hume-Rothery rules for formation of substitutional solid solutions-properties of solid solutions, Principles of solidification, Determination and uses of phase diagrams, Types of phase reactions with examples, Phase rule and its application to phase diagrams, lever rule, Detailed discussion of Fe-C equilibrium diagram, Concept of ternary phase diagrams. *Suggested Reading: Difference between solution and solid solution, saturation of salt in water*	**CO-3** **BTL-3**
MODULE 4: MECHANICAL TESTING-I	**9**
Tension test- Engineering stress-strain curve and True stress-strain curve, Instability in tension, measurement of tensile properties, factors affecting flow properties, notch tensile test. Hardness test-Brinell hardness-relationship between hardness and flow curve, Vickers hardness, Rockwell hardness, microhardness tests, hardness-conversion relationships. Torsion Test-Types, torsion test Vs tension test, hot torsion test, Overview of ASTM testing standards for tension, hardness and torsion tests, compression test. *Suggested Reading: Procedures for doing tension, hardness and torsion testing. To take a case study on failures due to tension and torsion action in a material.*	**CO-4** **BTL-3**
MODULE 5: MECHANICAL TESTING-II	**9**
Impact Test-Izod and Charpy tests, significance of transition–temperature curve, DBTT, factors affecting transition temperature. Overview of ASTM testing standard for impact test. Fatigue- S N curve, fatigue testing, factors affecting fatigue properties, structural features of fatigue failures, low cycle fatigue, Paris equation, Residual life estimation. Creep- creep curve, structural changes during creep, mechanisms of creep deformation, Overview of ASTM testing standard for fatigue and creep test. Few case studies on the design of damage tolerant alloys. *Suggested Reading: Practical applications where impact loading, fatigue loading and creep occurs.*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Dieter G. E.,(2013), 'Mechanical Metallurgy', McGraw Hill ,3rd Edition.
2	Thomas H. Courtney, (2013),'Mechanical Behavior of Materials', Overseas Press India Private Limited, 2013.
3	M. N. Shetty, 'Dislocations and Mechanical Behaviour of Materials',Prentice Hall India Learning Private Limited, 2nd Edition.
4	Norman E. Dowling, (2017),'Mechanical Behavior of Materials', Pearson Publication, 4th Edition.
REFERENCE BOOKS	
1	Bhargava A.K. and Sharma. C. P. ,(2011), 'Mechanical Behaviour and Testing of Materials', Prentice Hall India Learning Private Limited.
2	William F. Hosford,(2010), 'Mechanical Behavior of Materials', Cambridge: Cambridge University.
E BOOKS	

1	http://nozdr.ru/biblio/kolxo3/Ch/ChCm/Newnham%20R.E.%20Properties%20of%20 materials..%20Anisotropy,%20symmetry,%20structure%20(OUP,%202005) (ISBN%200198520751)(O)(391s)_ChCm_.pdf – By Robert E Newnham
2	https://books.google.com/books?id=pZL44wHzswsC&printsec=frontcover - By Joachim Roesler, Harald Harders, Martin Baeker
MOOC	
1	http://nptel.ac.in/courses/112106153/3
2	http://nptel.ac.in/courses/122102008/26
3	https://www.class-central.com/course/edx-3-032x-mechanical-behavior-of-materials-2234

COURSE TITLE	**UNCONVENTIONAL MACHINING PROCESS**			**CREDITS**	**3**
COURSE CODE	**MEC4254**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course broadly introduces the various unconventional machining processes and fundamentals of those processes in detail. It prepares the students to learn the basic concepts involved in each and every unconventional machining process and increases the skill of selecting appropriate machining processes for the requirements. It also emphasizes the advantages and limitations of the various processes so that selection of the process becomes easy for the students.
Course Objective	1. To acquire knowledge on the various unconventional machining processes 2. To acquire knowledge on mechanical energy based processes 3. To acquire knowledge on electrical energy based processes 4. To acquire knowledge on chemical and electrochemical energy based processes 5. To acquire knowledge on thermal energy based processes
Course Outcome	Upon completion of this course, the students will be able to 1. Identify appropriate technique to a specific requirement. 2. Demonstrate different machining based on mechanical energy. 3. Execute the processes parameters of electrical energy based machining processes.. 4. Implement the chemical and electro chemical machining techniques. 5. Execute plasma arc and electron beam machining processes for industrial

	applications.

Prerequisites: Engineering Physics, Engineering Materials and Manufacturing Technology I and II

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO -3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	2	-	-	3	-	-	2	-	-	-	-	-	-
CO-2	-	2	2	-	-	-	-	2	-	-	-	-	-	-
CO-3	2	2	-	2	3	2	-	-	-	2	-	2	-	-
CO-4	2	-	-	2	3	-	-	-	-	-	2	2	-	-
CO-5	2	2	1	2	3	-	-	1	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
Unconventional machining Process - Need - clarification - Brief overview of all techniques. ***Suggested Reading:*** Hybrid Processes	**CO-1** **BTL-2**
MODULE 2: MECHANICAL ENERGY BASED PROCESSES	**(9)**
Abrasive Jet Machining - Water Jet Machining - Ultrasonic Machining. (AJM, WJM and USM).Working Principles - equipment used - Applications. ***Suggested Reading:*** Abrasive flow machining and Magnetic Abrasive finishing	**CO-2** **BTL-2**
MODULE 3: ELECTRICAL ENERGY BASED PROCESSES	**(9)**
Electric Discharge Machining (EDM) - working Principles-equipment's-Process Parameters- MRR electrode / Tool - Power Circuits- Dielectric - Flushing - Wire cut EDM - Applications. ***Suggested Reading:*** Electron Beam Machining (EBM), ION Beam machining(IM)	**CO-3** **BTL-3**
MODULE 4: CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES	**(9)**
Chemical Machining and Electro-Chemical Machining (CHM and ECM)-Etchants-Maskant's Techniques of applying Maskant's-Process Parameters, Principles of ECM - equipment Electrical circuit - Process Parameters-ECG and ECH Applications. *Suggested Reading* Biochemical Machining (BM)	**CO-4** **BTL-2**

MODULE 5: THERMAL ENERGY BASED PROCESSES	(9)
Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles-Equipment-Types-Beam control techniques - Applications. *Suggested Reading:* Electro stream Drilling(ED) Demonstration of CNC Laser beam cutting and Laser beam engraving	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Vijay.K. Jain, (2002), Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi, ISBN 81-7764-294-4.
2.	Pandey P.C. and Shan H.S.(2007), Modern Machining Processes Tata McGraw-Hill, New Delhi .
REFERENCE BOOKS	
1.	Paul De Garmo, J.T.Black, and Ronald.A.Kohser,(2001), Material and Processes in Manufacturing Prentice Hall of India Pvt. Ltd., New Delhi (8th Edition) ISBN - 81-203-1243-0.
E BOOKS	
1.	https://books.google.co.in/books?isbn=8177642944
2.	https://books.google.co.in/books?id=xdmNVSio8jUC&printsec=front cover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
MOOC	
1.	http://nptel.ac.in/courses/112104028/

COURSE TITLE	COMPUTER INTEGRATED MANUFACTURING			CREDITS	3
COURSE CODE	MEC4255	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course broadly introduces the various plant operations and emphasis on the need for automation in detail. It prepares the students to learn the basic concepts involved in group technology and computer aided process planning and explains the advantages of such technology. It also describes shop floor control and introduces flexible manufacturing systems. It also emphasis on the advantages and difficulties in CIM implementation, data communication and key technologies for the integration.

Course Objective	1. To acquire knowledge on the changing manufacturing scenario and plant operations 2. To acquire knowledge on group technology and computer aided process planning 3. To acquire knowledge on shop floor control and flexible manufacturing systems 4. To acquire knowledge on CIM Implementation and data communication 5. To acquire knowledge on key technologies for the integration
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate Plant operations and need for automation 2. Select suitable process plan for the plant 3. Design workstation and select suitable computer control systems 4. Integrate the computers efficiently to the manufacturing systems 5. Control the shop floor effectively and able to be comfortable with using CAD/CAM systems and with programming and operating of CNC machine Tools

Prerequisites: Manufacturing technology II

CO, PO AND PSO MAPPING

CO	PO - 1	PO -2	PO -3	PO-4	PO-5	PO -6	PO-7	PO -8	PO-9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	3	2	-	2	3	-	-	2	3	-	2	-	-
CO-2	3	-	-	-	-	2	-	-	-	2	-	2	-	-
CO-3	2	2	2	-	2	2	-	-	2	-	-	-	-	-
CO-4	-	2	-	-	3	-	-	-	-	2	-	2	-	-
CO-5	3	2	2	-	3	2	-	-	2	3	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
The meaning and origin of CIM- the changing manufacturing and management scene - External communication - Islands of automation and software-Dedicated and open systems-Manufacturing automation protocol - Product related activities of a company-Marketing engineering - Production planning - Plant operations - Physical distribution-Business and financial management. *Suggested Reading: Company valuation and risk assessment, Manufacturing Controls*	**CO-1** **BTL-2**
MODULE 2: GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING	**(9)**
History of group technology- Role of G.T. in CAD/CAM integration - Part families - Classification and coding - DCLASS and MICLASS and OPITZ coding systems-Facility design using G.T. -benefits of G.T. - Cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - Approaches to computer aided process planning -Variant approach and generative approaches ***Suggested Reading:*** *CAPP and CMPP process planning systems.*	**CO-2** **BTL-2**

MODULE 3: SHOP FLOOR CONTROL AND INTRODUCTION OF FMS	(9)
Shop floor control-phases - Factory data collection system -Automatic identification methods - Bar code technology-Automated data collection system. FMS-components of FMS - types -FMS workstation -Material handling and storage systems- FMS layout -Computer control systems-Application and benefits. ***Suggested Reading:*** *Handling and Storage with Manufacturing, Design Work station using MATLAB© Simulink.*	**CO-3** **BTL-3**
MODULE 4: CIM IMPLEMENTATION AND DATA COMMUNICATION	**(9)**
CIM and company strategy - System modelling tools -IDEF models - Activity cycle diagram - Manufacturing enterprise wheel-CIM architecture - Product data management-CIM implementation software. Communication fundamentals- Local area networks -Topology - LAN implementations - Network management and installations. *Suggested Reading: - CIM open system architecture (CIMOSA)*	**CO-4** **BTL-3**
MODULE 5: KEY TECHNOLOGIES FOR THE INTEGRATION	**(9)**
Artificial Intelligence, Knowledge-Based Systems, Expert Systems Technology,Applications of Genetic Algorithm, Agent-Based Technology, Virtual Business, e- Commerce Technologies, Global Manufacturing Networks, Digital enterprise technologies. ***Suggested Reading:*** *Manufacturing automations protocol and technical office protocol (MAP /TOP)*	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Mikell.P.Groover (2016),Automation, Production Systems and computer integrated manufacturing, Pearson Education, New Delhi.
2.	Alan Weatherall, (2013), Computer Integrated Manufacturing: From Fundamentals to Implementation.
3.	Justin Riggs,(2016), Computer-Aided Design and Manufacturing, Willford Press; First edition.
REFERENCE BOOKS	
1.	Thomas O. Boucher,(2013), Computer Automation in Manufacturing: An introduction, Springer, Third Edition.
2.	Hermann Kühnle, Günter Bitsch ,(2015), Foundations & Principles of Distributed Manufacturing: Elements of Manufacturing Networks, Cyber-Physical Production Systems and Smart Automation, Springer Education, First edition.
E BOOKS	
1.	https://books.google.co.in/books?id=DREwDwAAQBAJ&lpg=PP1&dq=Mikell. P.Groover%20Automation%2C%20Production%20Systems%20and%20 computer%20integrated%20manufacturing%2C%20Pearson%20Education%2C%20 New%20Delhi%2C%202016.&pg=PP1#v=onepage&q&f=false - Mikell.P.Groover
2.	https://books.google.co.in/books?id=NgKcFcJYxw8C&lpg=PP1&dq=computer%20 integrated%20manufacturing&pg=PP1#v=onepage&q=computer%20 integrated%20manufacturing&f=false - 1. Yorem koren
MOOC	

1.	https://www.coursera.org/specializations/cad-design-digital-manufacturing
2.	https://www.coursera.org/specializations/digital-manufacturing-design-technology
3.	https://ocw.mit.edu/courses/mechanical-engineering/2-830j-control-of-manufacturing-processes-sma-6303-spring-2008/
4.	https://www.coursera.org/learn/advanced-manufacturing-process-analysis
5.	https://www.coursera.org/learn/intelligent-machining#syllabus
6.	https://ocw.mit.edu/courses/mechanical-engineering/2-96-management-in-engineering-fall-2012/

COURSE TITLE	IC ENGINE AND STEAM TURBINE			CREDITS	3
COURSE CODE	MEC4256	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course describes the applications of the laws of Thermodynamics to various advanced energy system in engineering applications. The course will provide an insight to various thermal cycles applied for petrol, diesel and aircraft engines. The machineries such as IC engines, hybrid vehicles, steam nozzles & turbines are analyzed in detail and enable the student to solve more advanced problems				
Course Objective	1. To understand the features of Gas power cycles and efficiency enhancement methods. 2. To understand the combustion phenomena in SI and CI engines. 3. To understand the working principles of supercharging and scavenging. 4. To understand the working principles of steam nozzles and turbine and to analyze the performance. 5. To understand the principles of flow through turbine blades and to design a system for the given application and specification.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the working principle, performance parameters and testing of IC Engine. 2. Describe the combustion phenomena in SI and CI engines and factors influencing combustion chamber design. 3. Illustrate the concept of SI and CI engine combustion with respect to supercharging and scavenging 4. Apply the basics principles of steam turbine and its nozzle flow Characteristics.				

	5. Describe on the theories of fluid flow through turbine blades.

Prerequisites: Thermal Engineering, Gas dynamics and Jet Propulsion

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-2	1	-	-	-	-	1	2	-	-	-	-	-	-	-
CO-3	2	-	-	-	-	1	1	3	-	-	-	-	-	-
CO-4	2	-	-	-	-	2	2	1	1	-	1	-	-	-
CO-5	2	-	-	-	-	1	1	2	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: I C ENGINE	**9**
Principle of working and Construction of IC engine; Comparison of air standard cycles; Air cycle analysis with variable specific heats; Introduction to fuel air cycle analysis; Availability analysis for engine processes. **Suggested Reading:** Actual cycles; MEP; Thermal efficiency	**CO-1** **BTL-3**
MODULE 2: COMBUSTION	**9**
Combustion calculations related to I.C. Engine fuels. Desirable characteristics of fuels for I.C. Engine. Mixture requirements for S.I Engine; Carburation pressure drop - flow relation; fuel air ratio; complete carburettor. Petrol injection. Ignition system in S.I. Engine: Battery, Magneto, and electronic ignition systems; Fuel injection systems; Injection pumps and nozzles. **Suggested Reading:** Ignition timing and spark advance, Thermodynamic modelling using Matlab©.	**CO-2** **BTL-4**
MODULE 3: SUPERCHARGING AND SCAVENGING	**9**
Theories of combustion in S.I and C. I. Engines - Methods for reduction of detonation and knock; Octane number and Cetane number. Supercharging and Scavenging: Supercharging in I.C. Engine; Supercharging limits; Scavenging of I.C. engines, two stroke S.I. and C.I. engines; Scavenging parameters; **Suggested Reading:** Actual scavenging; Scavenging pump, Ideal scavenging processes	**CO-3** **BTL-3**
MODULE 4: STEAM TURBINE	**9**
Steam Generation - introduction to Boilers; Principles of action of turbines, Classification, relative advantages of turbines as prime movers, Isentropic flow through nozzle, Nozzle shape, Critical pressure ratio and maximum flow, Effect of friction in nozzle flow. **Suggested Reading:** Under-expansion and over-expansion in nozzles, Supersaturated flow through nozzles.	**CO-4** **BTL-4**
MODULE 5: FLOW THROUGH TURBINE BLADE	**9**

Flow through impulse turbine blade, Velocity diagram, Blade work, Blade efficiency, Optimum velocity ratio, Multi-staging and its advantage, Velocity compounded impulse turbine, Pressure compounded impulse turbine, Reheat factor, Internal efficiency, State point locus. Flow through reaction turbine blade, Velocity diagram, Degree of reaction, Blade work, Blade height and Stage efficiency. **Suggested Reading:** Stage efficiency, Optimum velocity ratio, Axial thrust in reaction turbine, erosion of turbine blades.	**CO-5** **BTL-4**

TEXT BOOKS	
1	V Ganesan.,(2017), "Internal Combustion Engines", McGraw-Hill Education; 4th Edition.
2	S SThipse.,(2008), "Internal Combustion Engines", Jaico Publishing House; 1st Edition.
3	R K Rajput.,(2005), "Internal combustion Engines", Laxmi Publication.
REFERENCE BOOKS	
1	John B Heywood, (2017),"Internal Combustion Engine Fundamentals", McGraw Hill Education, 1st Edition (Indian Edition) **.**
2	Richard Stone, (2012),"Introduction to Internal Combustion Engines", Palgrave publishers, 4th Edition.
3	John H.Weaving, "Internal Combustion Engineering: Science & Technology", Elsevier Applied Science,
4	William J. Kearton,(2011), Steam Turbine Theory and Practice, CBS Publication.
E BOOKS	
1	https://books.google.co.in/books?id=u9FSAAAAMAAJ&q=IC+engine&dq=IC+engine& hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHbNvBh8Q6AEILTAB – John B Heywood
2	https://books.google.co.in/books?id=hfejAwAAQBAJ&printsec=frontcover&dq= IC+engine&hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHbNvBh8Q6 AEIKDAA#v=onepage&q=IC%20engine&f=false – V Ganesan
3	https://books.google.co.in/books?id=UtxI5gXM1yQC&printsec=frontcover&dq= IC+engine&hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHbNvBh8Q6AEIOD AD#v=onepage&q=IC%20engine&f=false – R K Rajput
MOOC	
1	http://nptel.ac.in/courses/101106037/
2	http://nptel.ac.in/courses/112104033/
3	http://nptel.ac.in/courses/101104014/
4	http://nptel.ac.in/courses/101104070/

COURSE TITLE	**PROCESS PLANNING & COST ESTIMATION**			**CREDITS**	**3**
COURSE CODE	**MEC4257**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course provides an introduction about process planning and its activities. It introduces the procedure of cost estimation of products manufactured in different shops and also machine time evaluation
Course Objective	1. To introduce the process planning concepts to make cost estimation for various products after process planning
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic concepts of work study and ergonomics. 2. Develop manufacturing logic and optimize process cost 3. Appreciate the basic concepts of cost accounting 4. Estimate cost for any value-added activity and incorporate allowances in estimation 5. Develop cost estimation and analyze profitability

Prerequisites: Manufacturing Technology II

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	-	-	3	2	-	-	-	-	2	1	2	1
CO-2	-	2	2	1	-	-	-	3	2	-	-	-	2	-
CO-3	3	2	-	-	-	-	-	-	-	-	2	1	-	-
CO-4	2	-	-	-	2	1	-	-	-	-	-	-	2	1
CO-5	3	3	-	-	2	1	-	-	-	-	2	1	2	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: WORK STUDY AND ERGONOMICS	**10**
Method study - Definition - Objectives-Motion economy- Principles - Tools and Techniques- Applications - Work measurements- purpose - use - procedure - tools and techniques- Standard time -Ergonomics - principles - applications. ***Suggested Reading**: Standard notations used in work measurement and motion study - case study on work measurement and motion study for any 2 industrial process*	**CO-1 BTL-2**
MODULE 2: PROCESS PLANNING	**10**
Approaches to process planning activities - Finished part requirements- operating sequences- machine selection - Set of documents for process planning- selection of jigs & fixtures- production time calculation - selection of cost optimal process – use of Optimization	**CO-2 BTL-2**

tool box in MATLAB© ***Suggested Reading**: Plant layout, process flow chart for any mechanical component manufacturing units*	
MODULE 3: INTRODUCTION TO COST ESTIMATION 7	
Objective of cost estimation- costing - cost accounting- classification of cost- Elements of cost. ***Suggested Reading**: machine cost per hour*	**CO-3** **BTL-3**
MODULE 4: COST ESTIMATION 8	
Types of estimates - methods of estimates - data requirements and sources- collection of cost- allowances in estimation.. ***Suggested Reading**: Design cost, depreciation cost , cost of quality*	**CO-4** **BTL-3**
MODULE 5: PRODUCTION COST ESTIMATION 10	
Estimation of machining time – factors to calculate machining time – calculation of machining time for processes like casting, sheet metal, forging *Suggested Reading: cost estimation of any process industry*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Sinha.B.P.,(1995), Mechanical Estimating and Costing, Tata McGraw-Hill, Publishing Co.
REFERENCE BOOKS	
1.	Russell.R.S and Tailor, B.W,(2003), Operations Management, PHI, 4th Edition.
2.	Chitale.A.V. and Gupta.R.C.,(2007), Product Design and Manufacturing, PHI, 2nd Edition.
E BOOKS	
1.	https://www.elsevier.com/books/process-planning/scallan/978-0-7506-5129-5
2.	http://www.sanfoundry.com/best-reference-books-facilities-process-planning-layout-design/
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc16_ce02/announcements
2.	http://nptel.ac.in/courses/105103023/35

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER IV

COURSE TITLE	**REFRIGERATION AND AIR CONDITIONING**			**CREDITS**	**3**
COURSE CODE	**MEC4266**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**

	Assessment				
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	Refrigeration and air conditioning deals with the below atmospheric temperature applications. It deals with refrigeration thermodynamic cycle, working of the major components involved, usage of refrigerant tables and charts, applications and non-conventional systems.
Course Objective	1. To understand and apply the basic refrigeration cycles 2. To understand the various components used in Refrigeration and air conditioning systems 3. To know the parameters of the psychrometric chart and how to use in air conditioning applications 4. To know the working principles of various air conditioning system 5. To know the other conventional and unconventional air conditioning systems
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic principles of refrigeration, describe and compare the various refrigeration cycles 2. Identify the various components in Refrigeration and air conditioning systems used in applications 3. Plot the various Air conditioning processes in the psychometric chart and how to apply in air conditioning applications 4. Demonstrate the working principle of air conditioning systems, types and design methods. 5. Demonstrate the working principles of vapor absorption refrigeration system and other unconventional air conditioning systems

Prerequisites: Thermodynamics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1	2	-	2	1	1	1	-	-	3	-
CO-2	-	3	-	1	-	2	-	-	1	1	-	-	-	-
CO-3	3	3	2	-	2	-	2	-	-	-	-	-	3	-
CO-4	-	-	2	1	2	2	2	-	1	1	-	-	-	-
CO-5	3	3	2	1	-	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: REFRIGERATION CYCLE 7

Review of thermodynamic principles of refrigeration. Carnot refrigeration cycle – Vapour compression refrigeration cycle – use of P.H. charts – multistage and multiple evaporator systems – cascade system – COP comparison. Air Refrigeration cycles. **Suggested Reading:** Deviations of ideal cycles from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration.	**CO-1** **BTL-2**
MODULE 2: REFRIGERANTS AND SYSTEM COMPONENTS	**10**
Compressors – reciprocating and rotary (elementary treatment), Types of condensers, evaporators, cooling towers – Functional aspects. Refrigerants – properties – selection of refrigerants, Alternate Refrigerants, Cycling controls. **Suggested Reading: -** Refrigerants Desirable properties with respect to ODP & GWP	**CO-2** **BTL-4**
MODULE 3: PSYCHROMETRY	**10**
Psychometric processes use of Psychrometric charts – Grand and Room Sensible Heat Factors – bypass factor – air washers, requirements of comfort air conditioning, summer and Winter Air conditioning. **Suggested Reading:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature; Psychrometric of air-conditioning processes, mixing of air streams.	**CO-3** **BTL-4**
MODULE 4: AIR CONDITIONING SYSTEMS	**9**
Working principles of – Centralized Air conditioning systems, Split, Duct able split, Packaged Air conditioning, VAV & VRV Systems. Indoor Air quality, Cooling load calculation, Duct Design methods. **Suggested Reading:** Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls. Design and plot load curves of indoor summer air conditioning system using MATLAB©	**CO-4** **BTL-4**
MODULE 5: UNCONVENTIONAL REFRIGERATION CYCLES	**9**
Vapor Absorption system – Steam jet refrigeration, thermo electric refrigeration. Applications in ice plant, food storage plants, milk chilling plants. **Suggested Reading:** Working principles of adsorption cooling systems - Ejector refrigeration systems- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems. Perform thermodynamic analysis of Vapor Absorption system and plot COP curves with respect to generator temperature using MATLAB©	**CO-5** **BTL-3**
TEXT BOOKS	

1.	Arora, C.P.,(2017), "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 3 rd edition.
2.	Roy J. Dossat, (2009),"Principles of Refrigeration", Pearson Education Asia, 4th edition.
REFERENCE BOOKS	
1.	Stoecker, W.F. and Jones J. W.,(2014), "Refrigeration and Air Conditioning", McGraw Hill, New Delhi.
2.	Andrew D, Althouse , Carl H, Turnquist, Alfred F, Bracciano., (2016)"Modern Refrigeration and Air Conditioning", Goodheart-Willcox Publication; 20 edition.
3.	ASHRAE Hand book, Fundamentals, 2010.
4.	Jones W.P.,(2001), "Air conditioning engineering", Elsevier Butterworth-Heinemann, 5 th edition.
E BOOKS	
1.	https://drive.google.com/open?id=0B7JWdKw_4Q07VWNrLVNkRXpyUmM-TROTT, WELCH.
2.	https://drive.google.com/open?id=0B7JWdKw_4Q07Q3VwSlBxMFd0Vjg- REX MILLER.
3.	https://drive.google.com/open?id=0B9bpsTYXP4ceTC0ycVVMX3RxSGs
MOOC	
1.	http://www.nptelvideos.in/2012/12/refrigeration-and-airconditioning.html
2.	http://nptel.ac.in/courses/112105128/

COURSE TITLE	**POWER PLANT ENGINEERING**			**CREDITS**	**3**
COURSE CODE	**MEC4267**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes the various equipment's used in modern steam power plant and steam boilers and its selection. Power generation in Nuclear and Hydel power plant are dealt in detail. The various types of diesel and gas turbine power and its operational cycle are elaborated. The working performance, loading problems and environmental hazards in connection with power plants and boilers are discussed.				
Course Objective	1. To classify the various equipment's used in steam power plant and to improve its performance 2. To choose the modern boilers principle to increase productivity 3. To compare the utilization of Hydel & Nuclear power plant 4. To understand the technology in the application of wind & solar power plant 5. To inspect the economics of various power plant and reduce pollutants				

Course Outcome	Upon completion of this course, the students will be able to 1. Categorize the various major equipment's used in steam power plant. 2. Demonstrate the boiler in increasing productivity. 3. Formulate better utilization of Nuclear and Hydel power plants 4. Recognize the technology applied in solar and wind power generation. 5. Differentiate the methodologies to reduce environmental pollution.

Prerequisites: Thermal Engineering

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	-	-	-	2	-	-	-	-	-	-	-	-
CO-2	1	2	-	1	-	1	2	-	-	-	-	-	-	-
CO-3	2	-	1	2	-	1	1	3	-	-	-	-	-	-
CO-4	2	2	2	-	-	2	2	1	1	-	1	-	-	-
CO-5	2	-	-	-	-	1	1	2	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: MODERN STEAM POWER PLANT	**5**
Modern Steam power plants: layout, selection, working, application of Rankine cycle. Auxiliary equipment, fuels and ash handling equipment Electrostatic precipitator, draught system. Furnace, boiler drum, circulation, air pre heaters, Economizers, Super heaters, Reheater, Deaerator , feed water heaters, feed water treatment .Condenser, sea water cooling system, cooling towers, **Suggested Reading:** Calculate the efficiency of boiler by direct and indirect method and compare the results. Visit to Thermal power plant	**CO-1** **BTL-2**
MODULE 2: MODERN STEAM BOILERS	**10**
Steam Boilers: Working of Super critical boilers & Circulating fluidized bed combustion boilers, materials used in sub critical & supercritical boilers, factors to be considered for selection of boilers for various fuels. **Suggested Reading:** Analyse the issues in various Sub critical, supercritical CFBC boilers. Visit to Thermal Power plant.	**CO-2** **BTL-2**
MODULE 3: NUCLEAR AND HYDEL POWER PLANTS	**8**
Lay out, Nuclear Energy, Fission, Fusion Reaction, Types of Reactors, Pressurized water reactor, Boiling water reactors, Waste disposal and safety. Layout, Hydal Power Plant: Essential Elements, Selection of Turbines, Governing of turbines, Micro Hydel Development. **Suggested Reading**: Constraints and remedial measures in Nuclear and hydel power plants. Model Temperature control of a boiler using SIMULINK© Visit to Nuclear &Hydel power plant.	**CO-3** **BTL-3**

MODULE 4: DIESEL AND GAS TURBINE POWER	12
Types of Diesel Plants, Components, Selection of Engine Type, Application of Gas turbine Power Plant, Fuels, gas Turbine Materials, Open and Closed Cycles, Reheating, Regeneration and intercooling, Combined cycle. Waste heat recovery boilers. Integral gasification combined cycles (IGCC) **Suggested Reading**: Reduce pollution in diesel and gas turbine power plants. Visit to Diesel & gas turbine power plant.	**CO-4** **BTL-3**
MODULE 5: OTHER POWER PLANTS , VARIABLE LOAD PROBLEMS AND ENVIRONMENTAL HAZARDS	**8**
Geo Thermal-OTEC- Tidal- Pumped Storage. Solar: Types of solar Thermal Power plants, Roof top solar, solar drying, Performance of solar plants. Wind power plant: working principle & issues. load curves, effect of variable load on plant design and operation, load dispatch. Power station Economics analysis. Power plants Environmental issues **Suggested Reading**: Environmental pollution monitoring & CFD Modelling. Visit to all Wind & solar power plants.	**CO-5** **BTL-4**

TEXT BOOKS	
1	P.K.Nag,(2014), Power Plant Engineering, McGraw-Hill Education.
2	R.K. Rajput,(2007),A textbook on Power Plant Engineering, Laxmi publications, 5th edition.
REFERENCE BOOKS	
1	M.M. El-Wakil,(2013), Power Plant Technology, McGraw-Hill Education.
2	R.K.Rajput, (2010),Thermal Engineering, Laxmi Publication.
3	V Ganeshan,(2010), Gas Turbines, McGraw Hill Education.
4	William J. Kearton, (2011),Steam Turbine Theory and Practice, CBS Publication.
E BOOKS	
1	https://drive.google.com/open?id=0B7JWdKw_4Q07VWNrLVNkRXpyUmM- TROTT, WELCH.
2	https://drive.google.com/open?id=0B7JWdKw_4Q07Q3VwSlBxMFd0Vjg- REX MILLER.
3	https://drive.google.com/open?id=0B9bpsTYXP4ceTC0ycVVMX3RxSGs
MOOC	
1	http://nptel.ac.in/courses/112105128/

COURSE TITLE	**COMPUTATIONAL FLUID DYNAMICS**			**CREDITS**	**3**
COURSE CODE	**MEC4268**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Subject deals with mathematical Behavior of fluid flow and heat transfer domains. It contains governing equations (PDE), boundary conditions and discretization techniques based on FVM/FDM. It provides solution for 1-D/2-D steady/unsteady: Diffusion problems, Convection problems, Convection-diffusion problems, unsteady problems using various approaches and algorithms.
Course Objective	1. To know the equations governing fluid flow and heat transfer. 2. To appreciate the tools available for solving the numerical equations. 3. To appreciate the problems associated with discretization in conductive heat transfer 4. To appreciate the numerical formulations of diffusion and convection 5. To solve the practical problems associated with Fluid Flow and Heat Transfer using commercial software.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the equations governing fluid flow and heat transfer. 2. Identify the tools available for solving the numerical equations. 3. Identify the problems associated with discretization in conductive heat transfer 4. Demonstrate the numerical formulations of diffusion and convection 5. Solve the practical problems associated with Fluid Flow and Heat Transfer using commercial software.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO-4	PO-5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	1	-	-	-	-	-	-	1	3	2
CO-2	2	-	-	2	-	-	-	-	-	-	-	3	-	-
CO-3	3	3	3	2	1	-	-	-	-	-	-	1	3	-
CO-4	2	3	-	2	-	-	-	-	-	-	-	2	3	1
CO-5	3	3	3	2	1	-	-	-	-	-	-	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics - Governing equations of fluid dynamics - Continuity, Momentum and Energy equations - Physical boundary conditions - Time-averaged equations for Turbulent flow Turbulence -Kinetic -Energy Equations - mathematical behaviour of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations. **Suggested Reading:** Laplace equation and Poisson equation	**CO-1** **BTL-3**
MODULE 2: DISCRETISATION AND SOLUTION METHODOLOGIES	**9**
Methods of Deriving the Discretisation Equations - Taylor Series formulation - Finite difference method - Control volume Formulation. Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method. **Suggested Reading:** Studying the formulation of central, forward and backward schemes using Taylor series	**CO-2** **BTL-4**
MODULE 3: HEAT CONDUCTION	**9**
Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two- and three-dimensional conduction problems. Suggested Reading: Heat conduction in a room using Ansys Fluent software.	**CO-3** **BTL-4**
MODULE 4: CONVECTION AND DIFFUSION	**9**
Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two-dimensional convection and diffusion. Suggested Reading: Gauss-Siedel method for central upwind scheme in C++	**CO-4** **BTL-4**
MODULE 5: CALCULATION OF FLOW FIELD	**9**
Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE algorithm and its variants. Turbulence models: mixing length model, Two equation (k-ϵ) models. Suggested Reading: Implementing SIMPLE algorithm in Matlab©	**CO-5** **BTL-4**

TEXT BOOKS	
1	C. Pozrikidis,(2012), Introduction to theoretical and computational fluid dynamics, Oxford, 2nd edition.
2	H. Lomax, T. H. Pulliam, D. W. Zingg,(2013), Fundamentals of Computational Fluid Dynamics.
REFERENCE BOOKS	
1	G. D. Mallinson, S. E. Norris,(2010), "Fundamentals of Computational Fluid Dynamics, Springer.
2	Patankar, S.V.,(2009), Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 1980. Ane - Books Indian Edition.
3	Muralidhar, K and Sundarajan .T.,(2008), Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi,2nd Edition.
E BOOKS	

1	http://bookboon.com/en/computational-fluid-dynamics-ebook - Naser Sayma
2	http://www.e-booksdirectory.com/details.php?ebook=2832 - Abdulnaser Sayma
3	http://www.engineering108.com/pages/Mechanical_Engineering/Computational_Fluid_Dynamics/mason-cfd_ebooks-free-download.html - W. H. Mason
MOOC	
1	http://nptel.ac.in/courses/112107080/
2	http://nptel.ac.in/courses/112107079/
3	http://nptel.ac.in/courses/103106073/

COURSE TITLE	**HEAT TREATMENT OF METALS AND ALLOYS**			**CREDITS**	**3**
COURSE CODE	**MEC4269**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	The course is designed to introduce the students to various types of heat treatment processes for ferrous and nonferrous metals. The various heat treatments defects and the inspection methods are included.				
Course Objective	1. To expose to the various heat treatment processes practiced in Industries 2. To provide knowledge as to how mechanical properties can be improved by these processes applicable to ferrous metals 3. To provide comprehensive understanding of microstructure and property created by controlled heat treatment processes				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basics of phase diagrams, different types of furnaces used and about its accessories. 2. Analyze the various heat treating techniques for steel and knowing on the property change due to the same. 3. Identify the surface techniques that are to be used for various metals and the procedural ways for doing the same. 4. Analyze the various heat-treating techniques for ferrous and nonferrous alloys and knowing the property change due to the heat treatment. 5. Describe the surface defects caused due to heat treatment and the control measures to prevent them				
Prerequisites: Engineering materials					

CO, PO AND PSO MAPPING														
CO	**PO**	**PO**	**PO-**	**PO-**	**PO**	**PO-**	**PO-**	**PO-**	**PO**	**PO**	**PO**	**PO-**	**PSO-1**	**PSO-2**

	-1	-2	3	4	-5	6	7	8	-9	-10	-11	12		
CO-1	3	2	2	2	-	2	2	2	-	-	2	-	-	-
CO-2	3	2	-	-	-	2	2	2	-	-	-	-	-	-
CO-3	3	2	2	2	-	2	2	2	-	-	2	-	-	-
CO-4	3	-	2	2	-	2	2	2	-	-	2	-	-	-
CO-5	3	2	2	2	-	2	2	2	2	2	2	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: HEAT TREATMENT EQUIPMENTS	**(8)**
Review of phase diagrams and transformations, Furnaces, Calibration of thermocouple, Quenching methods, fixtures, control of furnace atmosphere, temperature control, Design of heat treatment furnaces. **Suggested Readings:** Theoretical and practical resolution of microscopes	**CO-1** **BTL-2**
MODULE 2: HEAT TREATMENT OF STEEL	**(8)**
Effect of alloying elements on Fe-C diagram, Annealing (different types), normalizing, hardening - Quenching media - Martensite formation, TTT and CCT diagrams, Hardenability and measurement of hardenability-Influence of alloying elements. Tempering-Temper brittleness, Subzero treatment-Control of retained austenite. Austempering, Martempering and Thermo-mechanical treatments. **Suggested Readings:** *Iron -Iron Carbide phase diagram, Significance of the phases present in alloys, Full annealing, Cryogenic atmosphere.*	**CO-2** **BTL-3**
MODULE 3: SURFACE ENGINEERING TECHNIQUES	**(8)**
Flame and induction hardening. Carburising, nitriding, carbonitriding, boriding, electron beam and laser beam hardening. PVD and CVD processes, sputter coating, ion plating, ion implantation, spray coatings. **Suggested Readings:** *Surface engineering techniques to be chosen for a metal, Difference between plating and surface hardening.*	**CO-3** **BTL-4**
MODULE 4: HEAT TREATMENT OF FERROUS & NON FERROUS ALLOYS	**(8)**
Plain carbon steel, Stainless steels, Tool steels and Cast irons, maraging steels, HSLA steels, and dual phase steels. Heat treating of Aluminium -precipitation hardening, Copper, Magnesium and Titanium alloys, Ni-base alloys. **Suggested Readings:** *Properties of Al, Cu,Mg,Ti and Ni alloys, Non heat treatable nonferrous alloys.*	**CO-4** **BTL-3**
MODULE 5: INSPECTION AND QUALITY CONTROL	**(8)**
Defects during heat treatment, Causes and remedies for defects (like low hardness and strength, soft spots, oxidation and decarburization, overheating and burning, quench cracks, distortion and warping) in heat-treated parts. Design for heat treatment. **Suggested Readings:** *QC techniques*	**CO-5** **BTL-2**
TEXT BOOKS	

1	Rajan.T.V , Sharma.R.C and Ashok Sharma ,(2010)"Heat Treatment: Principles and Techniques" Prentice Hall India Learning Private Limited, 2nd Edition.
2	Porter.D.A and Easterling.K.E (2017),"Phase Transformations in Metals and Alloys'" Taylor and Francis/CRC Press.
REFERENCE BOOKS	
1	Prabhudev. K. H.,(2011),"Handbook of Heat Treatment of Steels", Tata-McGraw Hill Publications. Co. Ltd.
2	Karl Eric Thelning,(2000), "Steel and its heat treatment", Butterworth Publications.
3	Vijendra singh,(2010), "Physical Metallurgy", Standard Publishers distributors.
E BOOKS	
1	https://books.google.co.in/books?id=vmV1cjBtPOAC&printsec=frontcover&source =gbs_ge_summary_r&cad=0#v=onepage&q&f=false - By George E. Totten, Maurice A.H. Howes.
2	https://books.google.co.in/books?id=izvhnQAACAAJ&printsec=frontcover&sourc e=gbs_ge_summary_r&cad=0#v=onepage&q&f=false - By K. H. Prabhudev.
3	https://books.google.co.in/books?id=RMpW7fl85WEC&printsec=frontcover&source=gbs_ge_ summary_r&cad= 0#v=onepage&q&f=false - By T. V. Rajan, C. P. Sharma, Ashok Sharm a
MOOC	
1	http://nptel.ac.in/courses/113104074/
2	http://nptel.ac.in/courses/112104219/

COURSE TITLE	**MECHANICAL VIBRATION**			**CREDITS**	**3**
COURSE CODE	**MEC4270**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Analysis of vibrations in single- and multi degree-of-freedom systems. Free and forced vibrations with various types of damping. Response to transite-state and transient excitations.				
Course Objective	This course should enable the students to 1. To understand the basic concepts and behavior of vibrations in machines 2. To understand the determination of frequencies and other parameters in single degree and two degree vibration systems 3. To understand to determine the critical speeds of rotating shafts 4. To understand how to apply the different measures for controlling the machine				

	vibrations and noise
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic concepts of vibration and writing equation of motion for Single DOF systems and determining natural frequencies of vibrating bodies 2. Determine natural frequencies when vibrating bodies subjected to forced vibration 3. Write Equation of motion for Two DOF systems and determining natural frequencies of suspension systems 4. Determine natural frequencies of Multi DOF using different methods 5. Measure the vibration parameters through experimental approach and can do signal analysis for condition monitoring.

Prerequisites: Mechanics of Machines

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	1	2	3	2	-	-	2	-	-	-	-	-	-	-
CO-3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO-4	2	2	3	2	-	-	-	-	-	-	-	2	-	-
CO-5	2	1	2	2	2	-	3	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF VIBRATION	**(9)**
Introduction: Harmonic and periodic motions – Vibration terminology – Single DOF free vibrations: Vibration model, Equation of motion – Natural Frequency – Newton's Method, Energy method, Rayleigh method and D'Alembert's principle- Viscously damped free vibration - special cases: Oscillatory, non-oscillatory and critically damped motions. Logarithmic decrement, Experimental determination of damping coefficient. **Suggested Readings:** Elements of vibration, Types of vibration, Fourier series and harmonic analysis, Beats, Bifilar suspension, Trifilar suspension.	**CO-1** **BTL-4**
MODULE 2: SINGLE DOF FORCED VIBRATION	**(9)**
Single DOF Forced vibrations- Forced harmonic vibration, Magnification factor, Reciprocating and Rotor unbalance, Transmissibility ratio – harmonic excitation and support motion, Vibration Isolation, Equivalent viscous damping, sharpness of resonance. **Suggested Readings:** Critical speed and critical speed with damping	**CO-2** **BTL-4**
MODULE 3: SYSTEMS WITH TWO DOF	**(9)**
Introduction, Principal modes and Normal modes of vibration, Two-DOF free vibrations	**CO-3**

– Generalized and Principal coordinates, Derivation of Equations of motion, Lagrange's equation, Coordinate coupling, Forced Harmonic Vibration, Applications – vehicle suspension and dynamic vibration absorber **Suggested Readings:** Solutions using Laplace transform and frequency transfer functions	**BTL-4**
MODULE 4: MULTI DOF SYSTEM	**(9)**
Introduction, Derivation of equations of motions, Influence coefficients method, Properties of vibrating system: Flexibility and stiffness matrices, Maxwell reciprocal theorem, Matrix method, Matrix-iteration method, Reyleigh method and Dunkerley's method. **Suggested Readings:** Torsional vibrations of two, three and multi rotor system	**CO-4** **BTL-4**
MODULE 5: EXPERIMENTAL METHODS IN VIBRATION ANALYSIS	**(9)**
Vibration testing equipments: Signal generation, measuring and conditioning instruments. Signal analysis instruments, Vibration tests – Free and forced vibration tests. **Suggested Readings:** Examples of vibration tests – Industrial case studies, Machine condition monitoring and diagnosis, plotting measured to true accelerations	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Rao, S.S., (2014),"Mechanical Vibrations", Pearson Education Inc., Prentice Hall, 6th Edition.
2	V.P. Singh, (2016),"Mechanical vibrations", Dhanpat Rai & company Pvt. Ltd., 5rd edition.
3	G.K.Grover,(2013), "Mechanical vibrations", New chand and Brothers, 8th edition.
REFERENCE BOOKS	
1	Graham Kelly,(2012), "*Scham's outline of Theory and Problems of Mechanical vibrations",* Tata McGraw-Hill, Special Indian edition.
2	W.T. Thomson and Marie Dillion Dahleh,(2017), "Theory of vibration with applications" Pearson Education, New Delhi, 5th Edition.
3	A.R.Mohanty, (2014),"Machinery condition Monitoring: Principles and Practices", CRC Press.
E BOOKS	
1	https://drive.google.com/open?id=0B6pGoYzCs7PgMFF1ZzZXVGtLZHc - Alok Sinha
2	https://drive.google.com/open?id=0B4SQTWiEAAQeMFowVzh Sa2s0Rnc – William J. Bottega
3	https://drive.google.com//open?id=0B6pGoYzCs7PgYXBwc2 szNVQ4LTg – B. Balachandran
MOOC	
1	https://www.mooc-list.com/course/introduction-%C3%A0-la-m%C3%A9canique-des-vibration
2	http://nptel.ac.in/courses/112103112/
3	https://in.mathworks.com/support/learn-with-matlab-tutorials.html

COURSE TITLE	**MODERN CONCEPTS OF ENGINEERING DESIGN**			**CREDITS**	**3**
COURSE CODE	**MEC4271**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The purpose of this course is to introduce to the undergraduate student the fundamental principles of Engineering Design which is very important and relevant in the context of today's engineering professionals. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines. Case studies from field situations and real products will be used to illustrate these principles.
Course Objective	1. To impart and train the student to Design Conceptualization and Philosophy of Product life cycle, Innovation 2. To provide knowledge about Needs and opportunities, 3. To know about the Concepts screening, Concept testing 4. To Know the types of prototypes and their purpose
Course Outcome	Upon completion of this course, the students will be able to 1. Recall the basic product development process 2. Apply the design process for product development 3. Analyze the feasibility of the proposed project. 4. Demonstrate about product Architecture 5. Recall the different prototypes and design for manufacturing concepts.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	-	-	2	-	-	2	-	-	1	-	-	-
CO-2	2	2	1	2	2	-	-	-	-	2	2	2	-	-
CO-3	2	3	-	-	3	2	-	2	-	2	-	3	-	-
CO-4	2	3	-	2	2	-	-	-	-	-	1	-	-	-
CO-5	2	2	1	-	2	-	-	2	-	2	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PRODUCT DESIGN PROCESS 9

Importance of product design - Design process - Design considerations - Morphology of design Marketing Organization for design - Computer aided engineering - Codes and standards - Design review - Technological innovation and design process - Product and process cycles -Societal considerations in design. Suggested Reading topics: establishing markets- market segments- relevance of market research	**CO-1** **BTL-2**
MODULE 2: PRODUCT PLANNING AND SPECIFICATION	**9**
Opportunities identification-Evaluation-Resource allocation - Pre-project planning - Customer need identification - Establishing target specification - Setting the final specification. *Suggested Reading: affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking-*	**CO-2** **BTL-2**
MODULE 3: CONCEPT GENERATION, SELECTION AND TESTING	**9**
Activity of concept generation - Clarification of problem - External and internal searches - Concept exploration - Result analysis - Overview of selection methodologies - Concept screening - Concept scoring - Concept testing - Choice of survey population - Survey formats - measurement of customer response - Interpretation and analysis of results. *Suggested Reading*: Creative thinking –creativity and problem solving- creative thinking methods	**CO-3** **BTL-3**
MODULE 4: PRODUCT ARCHITECTURE	**9**
Decision making –decision theory –utility theory –decision trees –concept evaluation methods – Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture Product architecture - Implications - establishment - platform planning . *Suggested Reading :* system level design	**CO-4** **BTL-2**
MODULE 5: INDUSTRIAL DESIGN,DESIGN FOR MANUFACTURE AND PROTOTYPING	**9**
Industrial design – human factors design –user friendly design – design for serviceability – design for environment Overview of Design for Manufacture process - Steps in DFM – prototyping and testing – cost evaluation –categories of cost –overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing *Suggested Reading:* Design review, Value analysis/engineering.	**CO-5** **BTL-3**

TEXT BOOKS	
1	Karl T Ulrich Steven D Eppinger,(2016), Product design and development “” New York, McGraw-Hill Education.
REFERENCE BOOKS	
1.	G. E. Dieter,(2013), Engineering Design, McGraw – Hill International.
2.	Kavin N Aotto, Kritine I Wood, (2013),Product Design Prentice Hall Publications
E BOOKS	

1.	https://books.google.co.in/books/about/Engineering_Design.html?id=wUgqAQAAMAAJ
2.	https://books.google.co.in/books?isbn=8177588214
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc17_me16/preview
2.	https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1

COURSE TITLE	**CHARACTERIZATION OF MATERIALS**			**CREDITS**	**3**
COURSE CODE	**MEC4272**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course familiarizes students with the various methods for Characterization of Materials using techniques like electron microscopes, X-ray diffraction, Thermal analysis, etc.				
Course Objective	1. To have comprehensive knowledge of the Characterization of materials for studying the structure of materials and to Interpret their properties. 2. To provide fundamental knowledge on Metallography, X-Ray diffraction, Electron diffraction, Scanning electron Microscope, Chemical and Thermal analysis.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the principle of metallurgical microscope and its application 2. Describe the working principle of XRD and its application 3. Illustrate the various characterizing techniques used in XRD 4. Apply the various electron microscopes for testing. 5. Enumerate the various tools available for characterization of different surface characteristics of materials				
Prerequisites: Engineering Physics					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	-	2	-	1	1	-	-	2	2	2	-	-
CO-2	3	2	1	2	2	-	-	-	-	-	-	1	-	-
CO-3	1	1	-	2	2	-	2	2	2	-	-	2	-	-

CO-4	**3**	**2**	**-**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO-5	**3**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: METALLOGRAPHIC TECHNIQUES	**(9)**
Macro examination -applications, metallurgical microscope - principle, construction and working, metallographic specimen preparation, optic properties - magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources lenses aberrations and their remedial measures, various illumination techniques-bright field , dark field, phase-contrast polarized light illuminations, interference microscopy, high temperature Microscopy; quantitative metallographic – Image analysis. **Suggested Readings:** Theoretical and practical resolution of microscopes	**CO-1** **BTL-2**
MODULE 2: X -RAY DIFFRACTION TECHNIQUES	**(9)**
Crystallography basics, reciprocal lattice, X-ray generation, absorption edges, characteristic spectrum, Bragg's law, Diffraction methods – Laue, rotating crystal and powder methods. Stereographic projection. Intensity of diffracted beams–structure factor calculations and otherfactors. Diffracto meter- brief description only. Cameras - General feature and optics, Proportional, Scintillating and Geiger counters. **Suggested Readings:** Advances in Cyber Security: Principles, Techniques, and Applications	**CO-2** **BTL-3**
MODULE 3: ANALYSIS OF X-RAY DIFFRACTION	**(9)**
Line broadening, particle size, crystallite size, Precise parameter measurement, Phase identification, phase quantification, Phase diagram determination X-ray diffraction application in the determination of crystal structure, lattice parameter, residual stress – Quantitative phase estimation, ASTM catalogue of Materials identification. **Suggested Readings:** Characterization of nano particles using X-Ray Diffraction	**CO-3** **BTL-4**
MODULE 4: ELECTRON MICROSCOPY	**(9)**
Construction and operation of Transmission electron microscope – Diffraction effects and image formation, specimen preparation techniques, Selected Area Electron Diffraction, electron- specimen interactions, Construction, modes of operation and application of Scanningelectron microscope, Electron probe micro analysis, basics of Field ion microscopy (FIB),Scanning Tunneling Microscope (STM) and Atomic Force Microscope(AFM). **Suggested Readings:** Chemical analysis by X-ray analysis in electron microscopes	**CO-4** **BTL-3**
MODULE 5: SURFACE ANALYSIS	**(9)**
Surface chemical composition- Mass spectroscopy and X-ray emission spectroscopy (Principle and limitations) - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy-Quadrapole mass spectrometer. Electron spectroscopy for chemical analysis (ESCA), Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron	**CO-5** **BTL-2**

Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Electron Energy Analysers, Secondary ion mass spectrometry - Applications. Unit meshes of five types of surface nets - diffraction from di periodic structures using electron, Low Energy Electron Diffraction (LEED), Reflection High Energy Electron Diffraction (RHEED). **Suggested Readings:** *Software's in surface analysis*	
TEXT BOOKS	
1.	Cullity, B. D.,(2015),“ Elements of X-ray diffraction”, Addison-Wesley Company Inc., New York,3rd Edition.
2.	George F. Vander Voort,(2007),“Metallography, Principles and Practice”, ASM International.
REFERENCE BOOKS	
1.	R. E. Smallman, K. H. G. Ashbee,(2013), “Modern Metallography”, Pergaman Press.
2.	David B. Williams, C. Barry Carter, (2009)“Transmission Electron Microscopy: A Textbook for Materials Science.
3.	Raghavan. V,(2015), “Physical Metallurgy: Principles and Practice”, PHI learning pvt ltd.
4.	C.A. Brebbia, (2015),“Materials Characterization VII”, WIT Press, UK.
5.	Haines, P.J.,(2016),“ Principles of Thermal Analysis and Calorimetry”, Royal Society of Chemistry (RSC), Cambridge.
E BOOKS	
1.	https://books.google.co.in/books?isbn=1292040548
2.	https://books.google.co.in/books?id=pVJ8AAAAIAAJ
3.	https://books.google.co.in/books?id=irHkAAAAMAAJ
4.	https://books.google.co.in/books?isbn=0470031506
5.	https://books.google.co.in/books?isbn=1782620516
MOOC	
1.	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2.	https://onlinecourses.nptel.ac.in/noc18_mm02/
3.	http://nptel.ac.in/courses/113106034/

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER V

COURSE TITLE	**STRUCTURE AND PROPERTIES OF MATERIALS**			**CREDITS**	**3**
COURSE CODE	**MEC4351**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	Students are exposed to the correlation of properties of materials and their structure.
Course Objective	1. To introduce the correlation of properties of materials and their structure. 2. To revise student's knowledge of crystal structure and phase diagrams of various alloy systems. 3. To get knowledge in metals, mainly ferrous and non-ferrous alloys, but also structures and properties of ceramics, polymers, elastomers and composites.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic concepts of Structure And Properties of Materials, crystallography of materials, knowing basics about Nano and isotropic materials 2. Recognize basic microstructure, associate terms with the appropriate structure/phenomena, and be able to differentiate between related structures/ phenomena 3. Describe the fundamental basis for materials phenomena. Assess the effect of ferrous and non-ferrous on material properties 4. Create and analysis composite material, knowing about ceramics 5. Identify the different polymer and elastomer and ability to create the polymer blend

Prerequisites: Engineering Physics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO --3	PO --4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO-2	3	2	2	-	3	-	-	-	-	2	-	-	-	-
CO-3	3	2	-	-	3	-	2	-	-	2	-	-	-	-
CO-4	3	2	-	-	3	-	-	-	-	-	-	2	-	-
CO-5	3	2	3	-	3	-	-	-	-	2	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: STRUCTURE OF SOLIDS	**(10)**
Overview of Crystal Structure – Solid Solutions-Hume Rothery Rules-Defects in Crystal - Point Defects- Line Defects-Surface Defects-Bulk Defects-Critical nucleus size and Critical Free energy- Nucleation-Homogeneous and Heterogeneous Nucleation- Growth - Single crystal -Polycrystalline Materials metallic crystalline structure- crystallography– Advancement in solidification of metals and alloys. Growth of crystals- Planar growth – dendritic growth – Solidification time - Cooling curves - Non-crystalline solids- Glass Transition Temperature-Single walled nanotubes (SWNTs) and multi walled nanotubes (MWNTs)- Isotopic materials **Suggested Readings:** Allotropes of carbon, fullerene structural family	**CO-1** **BTL-2**
MODULE 2: PHASE DIAGRAMS	**(10)**

Phase Rule –Unary System- Binary Phase diagrams- Isomorphous systems-Congruent phase diagrams - Free energy Composition curves- Construction -Microstructural changes 33 during cooling- Tie Line- Lever Rule- Eutectic , Peritectic, Eutectoid and Peritectoid reactions- Hume-Ruthery conditions- Invariant Reaction- Martensitic growth Kinetics -Typical Phase diagrams – Cu-Zn System – Pb-Sn system- Ag-Pt system-Iron-Iron carbide Equilibrium Diagram **Suggested Readings:** super critical fluid, Isobaric **and Isothermal Transitions of fluid**	**CO-2** **BTL-3**
MODULE 3: FERROUS AND NON FERROUS MATERIALS	**(9)**
Classification of steels and cast iron –Microstructure– Effect of alloying elements on steel- Ferrous alloys and their applications - Factors affecting conductivity of a metal – Strengthening and degradation - Temper Designations - Electrical Resistivity in alloys – Thermal conductivity of metals and alloys - High Resistivity alloys –Some important Titanium alloys, Nickel alloys, Copper alloys, Magnesium alloys and Aluminium alloys. **Suggested Readings:** Copper beryllium microstructure, complex resistivity alloy material	**CO-3** **BTL-4**
MODULE 4: CERAMIC AND COMPOSITE MATERIALS	**(8)**
Types - Crystal Structures - Silicate Ceramics - Glasses – Glass Ceramics – Advanced ceramics-Functional properties and applications of ceramic materials – Super hard materials - Tungsten carbide and Boron nitrides – Graphene. Classification of Composites - Fibre reinforced materials – Law of mixtures – Continuous fibres – Discontinuous fibres – Particle-reinforced composites – Cermets – Dispersion strengthened materials – Structural composites- Laminar – Sandwich panel-Application of composites in various fields of technology-Smart Composites- Function of matrix-desired properties of material **Suggested Readings:** Experimental or CAD analysis on natural fiber reinforcement composites	**CO-4** **BTL-3**
MODULE 5: POLYMERS AND ELASTOMERS	**(8)**
Classification of polymer – Mechanisms of polymerisation – Copolymers – polymer blend– Defects in polymers- Thermoplastics - Thermosets – Engineering plastics - Advanced Polymeric materials -Liquid crystal polymers - Conductive polymers – smart materials- application of smart materials - High Performance fibres– Photonic polymers- -Elastomers- Applications-Electronic materials. **Suggested Readings:** Simulation of self-assembling polymer blend using MATLAB© software	**CO-5** **BTL-2**

TEXT BOOKS

1	William D. Callister, Jr.,(2013), “Materials Science and Engineering an Introduction”, John Wiley & Sons, Inc., 9 Edition.
2	Elliot P. Douglas, (2013),“Introduction to Material Science and Engineering”, Pearson, 1st Edition.

REFERENCE BOOKS

1	Sidney H. Avner, (2017),“Introduction to Physical Metallurgy”, Tata Mc-Graw-Hill Inc, 2nd Edition.

2	W.Boltan, (2016),“ Materials for Engineering”, Routledge, 2nd Edition.
3	Susan Trolier-McKinstry, (2017),“Materials Engineering”, Cambridge University Press, 1st Edition.
4	Tim A. Osswald(2012), “Material Science of Polymer for Engineers”, Hanser, 3Edition.
5	William F. Smith, (2014),“Structure and Properties of Engineering Alloys”, Mc Graw Hill India 2Edition.
E BOOKS	
1	https://books.google.co.in/books?isbn=007048287X - V. S. R. Murthy
2	https://books.google.co.in/books?id=exF4rgEACAAJ - John Wulff
3	https://books.google.co.in/books?isbn=0191523402 - Robert E. Newnham
4	https://books.google.co.in/books?isbn=047136469X – John Wiley
MOOC	
1	http://nptel.ac.in/courses/112104203/
2	http://nptel.ac.in/courses/112108150/
3	http://nptel.ac.in/courses/112104122/10

COURSE TITLE	**ENGINEERING ECONOMICS AND COST ANALYSIS**			**CREDITS**	**3**
COURSE CODE	**MEC4352**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Emphasizes the systematic evaluation of the costs and benefits associated with proposed technical projects. The student will be exposed to the concepts of the “time value of money” and the methods of discounted cash flow. Students are prepared to make decisions regarding money as capital within a technological or engineering environment.				
Course Objective	1. To provide knowledge about value engineering 2. To know about the cash slow in Industry. 3. To solve problem on depreciation.				
Course Outcome	Upon completion of this course, the students will be able to 1. Illustrate the basic characteristics of engineering economics and the different cost elements. 2. Identify the time value of money, and the various factors & methods available for				

	comparing alternatives. 3. Demonstrate depreciation, maintenance and replacement affect the economic life of assets. 4. Analyze the maintenance activities 5. Calculate the Depreciation cost for various assests

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	-	-	-	-	-	2	-	-	2	-	-	-
CO-2	2	2	2	-	2	-	-	2	-	-	-	-	-	-
CO-3	-	3	-	-	-	2	-	2	-	-	3	-	-	-
CO-4	2	3	-	-	2	-	-	2	-	-	1	-	-	-
CO-5	2	2	3	-	-	-	-	3	-	-	2		-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO ECONOMICS	**8**
Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V-ratio, Elementary economic Analysis–Material selection for product design selection for a product, Process planning. **Suggested Reading:** Engineer's role in corporate profitability, Economic viability of projects, Cost-Benefit Analysis	**CO-1** **BTL-2**
MODULE 2: VALUE ENGINEERING	**10**
Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications–Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods. **Suggested Reading:** Before- and After-Tax considerations, Compounding other than annually	**CO-2** **BTL-2**
MODULE 3: CASH FLOW	**9**
Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram),Future worth method (Revenue dominated cash flow diagram, cost dominated Cash cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return	**CO-3** **BTL-3**

method, Examples in all the methods. **Suggested Reading:** Estimating capital and other investments	
MODULE 4: REPLACEMENT AND MAINTENANCE ANALYSIS	**9**
Replacement and Maintenance analysis– Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely. **Suggested Reading:** Defining capital and production costs, Fixed and variable costs	**CO-4** **BTL-2**
MODULE 5: DEPRECIATION	**9**
Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset. **Suggested Reading:** Types of Assets, Inflation and Indices	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Panneerselvam, R, (2013),"Engineering Economics", Prentice Hall of India Pvt Ltd, New Delhi, 2nd edition.
REFERENCE BOOKS	
1.	Park, Chan S., (2016),"Contemporary Engineering Economics", Pearson Education Ltd, 6th edition.
2.	Newnan, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P.,(2017), "Engineering Economics Analysis", Oxford University Press, USA, 13th edition.
E BOOKS	
1.	https://books.google.co.in/books?id=AY67AQAAQBAJ - "Engineering Economics", Panneer selvam, R.
2.	https://books.google.co.in/books?id=A-iVDQAAQBAJ – "Engineering Economics", Yates, J.K.
MOOC	
1.	http://www.nptel.ac.in/courses/112107209/
2.	https://onlinecourses.nptel.ac.in/noc18_me35/preview

COURSE TITLE	**TOOL DESIGN**			**CREDITS**	**3**
COURSE CODE	**MEC4353**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**

15%	15%	10%	5%	5%	50%

Course Description	This course imparts knowledge on design of tools such as Jigs, fixtures, Press working and dies.
Course Objective	1. To design the Jigs & Fixtures 2. To design the Presses 3. To design the Dies
Course Outcome	Upon completion of this course, the students will be able to 1. Recognize the materials properties, tool nomenclature and to categories the cutting tools. 2. Interpret the parameters of cutting tools for machining process; identify the types of jigs and fixtures. 3. Distinguish the various locating and clamping methods 4. Design the jig, fixture, press tools and molds 5. Design Dies and various molding operations

Prerequisites: Design of Machine Elements

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	3	-	2	2	-	-	-	-	-	-	-	-	-
CO-3	2	3	-	3	2	-	-	-	-	-	-	-	-	-
CO-4	2	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-5	2	3	-	-	3	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES	**(9)**
Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures - Types of Jigs - Types of Fixtures-Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis. Non Traditional Manufacturing, Forces Developing and Acting In Machine Tools. **Suggested Readings:** Estimation of Machining Time, Conventional Cutting Tool Maths	**CO-1** **BTL-3**

MODULE 2: JIGS	**(9)**
Drill bushes -different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs-Automatic drill jigs-Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components. Jigs For Machine Shops. Concept of Machinability and its Improvement **Suggested Readings:** Material properties, classification, carbide insert type tools.	**CO-2** **BTL-3**

MODULE 3: FIXTURES	(9)
General principles of boring, lathe, milling and broaching fixtures- grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures. Design and development of fixtures for given component. Fixtures For Machine Shops **Suggested Readings:** Fixtures for cutting tools.	**CO-3** **BTL-3**
MODULE 4: PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAY OUT	**(9)**
Press working terminology-Presses and press accessories-Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies: Die block-die shoe. Bolster plate-punch plate - punch holder-guide pins and bushes - strippers - knockouts-stops -pilots-Selection of standard die sets strip lay out-strip lay out calculations. Design and manufacture of drills, hobs and gear shaper cutters. **Suggested Readings:** Basic construction of moulds, types of moulds, mould damping method.	**CO-4** **BTL-3**
MODULE 5: DESIGN AND DEVELOPMENT OF DIES	**(9)**
Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies - development of bending dies-forming and drawing dies-Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies. **Suggested Readings:** Design of dies for sheet metal components, Simulation for Industrial Control of a Sheet-Metal-Rolling Application using MATLAB©	**CO-5** **BTL-3**

TEXT BOOKS	
1	Edward G Hoffman,(2010), Jigs & Fixture Design, Thomson - Delmar Learning, Singapore, 5th Edition.
2	Donaldson. C,(2012), Tool Design, Tata McGraw-Hill,4 Edition.
REFERENCE BOOKS	
1	Luqman M, Sheet Meta, (2015),l Press Tools Design Making, CBS Publishing; First edition.
2	Vukota Boljanovic, (2014),Sheet Metal Forming Processes and Die Design, Industrial Press Inc.,U.S.; 2nd Revised edition.
E BOOKS	
1	https://openlibrary.org/subjects/jigs_and_fixtures
2	https://books.google.co.in/books/about/Jig_and_Fixture_Design.html?id=6UFhomTE8KYC
3	https://drive.google.com/open?id=0B7JWdKw_4Q07WGFSTk8tcGhRVm8
4	https://drive.google.com/open?id=0B7JWdKw_4Q07bEVaSE5uT3VFUTQ
MOOC	
1	http://nptel.ac.in/courses/112105126/34
2	http://freevideolectures.com/Course/2369/Manufacturing-Processes-II/35

COURSE TITLE	**APPLIED HYDRAULICS & PNEUMATICS**			**CREDITS**	**3**
COURSE CODE	**MEC4354**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**

Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes the fundamentals of fluid power systems. The Designing of hydraulic system and pneumatic system circuits were demonstrated. The importance of low cost automation is also explained neatly.				
Course Objective	1. To understand the fundamentals, components and designing of hydraulic systems. 2. To understand the fundamentals, components and designing of pneumatic systems.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the fluid power system and fundamentals. Physics of Pascal's law, laminar and turbulent flow, Reynolds number and Darcy's equation. 2. Illustrate the concept of hydraulics system and various components of hydraulics system like pumping theory, cylinders and Actuators. 3. Design a hydraulic circuits and understanding the concept of hydraulic valves and accumulators and its type. 4. Demonstrate pneumatics systems like compressor, valves, filter regulator and lubricant units and able to design a pneumatic and hydraulic circuit and understand a symbols and standard. 5. Design a pneumatic circuit system with servo motor and understanding the logic circuit and ladder diagram and PLC units.				
Prerequisites: Fluid Mechanics and Machinery, Mechatronics and Pneumatic					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	-	-	2	2	2	1	1	1	-	-	3	-
CO-2	3	2	1	1	2	-	-	-	1	1	-	-	-	-
CO-3	3	2	-	-	2	2	2	-	1	1	-	-	-	-
CO-4	-	-	1	1	2	2	2	-	-	-	-	-	3	-
CO-5	3	2	1	1	2	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FLUID POWER SYSTEMS AND FUNDAMENTALS 9

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids - General types of fluids - Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law- Laminar and Turbulent flow - Reynolds number - Darcy's equation - Losses in pipe, valves and fittings. Suggested Reading: Fluid power Industry in India, Comparison of Properties.	**CO-1** **BTL-3**
MODULE 2: HYDRAULIC SYSTEM & COMPONENTS	**9**
Sources of Hydraulic Power: Pumping theory - Pump classification - Gear pump, Vane Pump, Piston pump, construction and working of pumps - pump performance - Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders - Single acting, Double acting, special cylinders like Tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators - Fluid motors, Gear, Vane and Piston motors. Suggested Reading: Hydrodynamic and hydrostatic pumps, Screw Pump, Cylinder Mounting Configurations, Cylinder Cushioning.	**CO-2** **BTL-3**
MODULE 3: DESIGN OF HYDRAULIC CIRCUITS	**9**
Construction of Control Components : Direction control valve - 3/2 way valve - 4/2 way valve - Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve, Flow control valve - Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers : Types of accumulators - Accumulators circuits, sizing of accumulators, intensifier Applications of Intensifier - Intensifier circuit. Suggested Reading: Unloading Valve, Counterbalance Valve, Proportional Valves, Regenerative Circuits, Design of Safety Circuits in Simulink software.	**CO-3** **BTL-3**
MODULE 4: PNEUMATIC SYSTEMS AND COMPONENTS	**9**
Pneumatic Components: Properties of air - Compressors - Filter, Regulator, Lubricator Unit - Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumatic and Hydraulic circuit, Sequential circuit design for simple applications using cascade method. Suggested Reading:Mufflers, Sizing of Compressors, Air Motors, Vacuum Suction Cup.	**CO-4** **BTL-3**
MODULE 5: DESIGN OF PNEUMATIC CIRCUITS	**9**
Servo systems - Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics - Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting. Suggested Reading: Hydro-pneumatic Systems, Installation and Maintenance of Hydraulic Systems, Design a pneumatic system for sorting of components using MATLAB© software.	**CO-5** **BTL-3**
TEXT BOOKS	

1	Anthony Esposito,(2014), Fluid Power with Applications, Pearson Education, 7th Edition.
2	Majumdar S.R.,(2015), Oil Hydraulics, Tata McGraw-Hill, New Delhi.
REFERENCE BOOKS	
1	Majumdar S.R.,(2013), Pneumatic systems - Principles and maintenance, Tata McGraw Hill, New Delhi.
2	Srinivasan.R,(2006), "Hydraulic and Pneumatic controls", Vijay Nicole.
3	James R. Daines,(2012) Fluid Power: Hydraulics and Pneumatics, Goodheart-Willcox Publisher, Second Edition.
E BOOKS	
1	https://docs.zoho.com/file/2bvxi8191d4a73d1d4f05941a1f132f86ae1a - Fluid power with Applications – Anthony Esposito
2	http://pages.hydraulicspneumatics.com/fluid-power-basics?code=UM_NX7UMB3 – Fluid Power Basics
3	http://controlmanuals.com/files/Automation/Fluid-Power/TSM-363-Fluid-Power-Systems~ppt908.html
4	https://www.pdfdrive.net/industrial-fluid-power-e3104018.html
MOOC	
1	https://www.mooc-list.com/course/hydraulics-%E6%B0%B4%E5%8A%9B%E5%AD%A6-edx
2	https://www.mooc-list.com/course/fundamentals-fluid-power-coursera

COURSE TITLE	**AUTOMOBILE ENGINEERING**			**CREDITS**	**3**
COURSE CODE	**MEC4355**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes the various parts of automobile. The construction and working of various systems involved in the automobile are demonstrated. The environmental issues and future developments are also discussed in detail.				
Course Objective	1. To understand the various parts of automobile and its functions. 2. To understand the environmental issues due to automobile emissions. 3. To know the advanced developments in the automobile sector.				

Course Outcome	Upon completion of this course, the students will be able to 1. Identify the different parts of the automobile. 2. Describe the working of various parts like engine, transmission, clutch, brakes. 3. Describe how the steering and the suspension systems operate. 4. Demonstrate the environmental implications of automobile emissions. 5. Develop a strong base for understanding future developments in the automobile industry.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	-	-	2	2	1	1	1	1	-	-	2	-
CO-2	3	-	-	1	2	-	-	-	-	-	-	-	-	-
CO-3	3	2	-	-	2	2	2	-	1	1	-	-	-	-
CO-4	-	-	1	1	2	-	2	-	-	-	-	-	3	-
CO-5	3	2	1	-	2	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: ENGINES	**9**
Constructional details of engines - engine parts - piston - different types - piston rings cylinder block, cylinder head-gudgeon pin-connecting rod-bearing bushes-different type of bearings. **Suggested Reading:** History and classification of automobiles, Engine classification and trouble shooting.	**CO-1** **BTL-3**
MODULE 2: ENGINE AUXILLARY SYSTEM	**9**
Cooling - purpose of cooling - types of cooling systems - air cooling - water cooling - steam cooling - radiator - types of radiators- constructional details thermostat-temperature indicators. Fuel systems-fuel system components-fuel tank-fuel filters and screens-fuel gauges-fuel pumps- carburetors - petrol injection system-diesel pump-injectors ignition system- battery and coil ignition magneto ignition. **Suggested Reading:** Lubrication- purpose of lubricating systems- grading of oils- service ratings of oils- oil pumps- oil filters- oil pressure indicators.	**CO-2** **BTL-3**
MODULE 3: POWER TRAIN AND CONTROL SYSTEM	**9**
Transmission – clutch-types of clutches-single and multi plate clutches-centrifugal clutch-fluid coupling-torque converter-gear box-sliding mesh-constant mesh-synchro mesh. Brakes- mechanical and hydraulic brakes- vacuum, servo and air brakes – different components of braking systems and their functions-constructional details. Steering mechanism – steering geometry-steering gears-worm and wheel gearspower assisted steering-wheel alignment-caster, camber, toe in, toe out; king pin inclination.	**CO-3** **BTL-3**

Suggested Reading: ABS, air bag, propeller shaft-universal coupling-differential-axle-semi floating, three-fourth floating, fully floating	
MODULE 4: CHASSIS AND SUSPENSION	**9**
Chassis and suspension – chassis lay out-road springs-shock absorbers-independent suspension – torsion bars – air suspension systems – independent rear suspension-wheel balancing-tyres and tubes. Starting mechanism – starter drives-bendix drive-over running clutch. **Suggested Reading:** Tubless tyre**,** wheel balancing. Automobile air-conditioning.	**CO-4** **BTL-3**
MODULE 5: ELECTRICAL AND MODERN TRENDS	**9**
Electrical equipments – battery-battery charging-charging circuit-regulating generator output-wiring circuit Electronic equipments Modern trends in automobiles - Hybrid cars, electric cars and solar power cars – air pollution and control – pollution rating. **Suggested Reading**: Barth and euro emission norms, Driving cycle and vehicle safety	**CO-5** **BTL-3**

TEXT BOOKS	
1	R.B.Gupta,(2016), Automobile Engg, SatyaPrakashan Publication 3 rd edition.
2	N.K. Giri,(2015), Automobile Technology, 2015, Khanna Publication 1st edition.
REFERENCE BOOKS	
1	Joseph Heitner,(2004), Automotive mechanics, D.VanNostrand Company Inc., New York, 2nd Edition.
2	K. Newton,W. Steeds,(2000), Motor Vehicle, ELBS Publishers, London.
E BOOKS	
1	https://books.google.co.in/books?id=nBVefxD_0agC&lpg=PP1&dq=A%20text%20book%20of%20automobile%20engineering&pg=PA843#v=onepage&q=A%20text%20book%20of%20automobile%20 engineering&f=false
2	https://books.google.co.in/books?id=C8UMQDBXBQQC&lpg=PP1&dq=A%20text%20book%20of%20automobile%20engineering&pg=PP1#v=onepage&q=A%20text%20book%20of%20automobile%20engineering&f=false
MOOC	
1	https://www.edx.org/micromasters/chalmersx-emerging-automotive-technologies
2	https://www.udemy.com/automobile-engineering-from-zero-to-100-for-everyone/

COURSE TITLE	**OPERATIONS RESEARCH**			**CREDITS**	**3**
COURSE CODE	**MEC 4356**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**

15%	15%	10%	5%	5%	50%

Course Description	Operations Research (OR) is a discipline that helps to make better decisions in complex scenarios by the application of a set of advanced analytical methods. It couples theories, results and theorems of mathematics, statistics and probability with its own theories and algorithms for problem solving.
Course Objective	The course should enable the students to 1. To acquire knowledge on operations research techniques and apply them in industry applications 2. To know the methods of solving transportations problems 3. To understand the OR tools in wide range of applications in industries 4. To acquire knowledge on current topics in OR 5. To understand the concepts of inventory ,queuing
Course Outcome	Upon successful completion of this course the student should be able to 1. Apply operations research techniques like L.P.P, scheduling and sequencing in industrial optimization problems. 2. Solve transportation problems using various OR methods. 3. Illustrate the use of OR tools in a wide range of applications in industries 4. Demonstrate current topics and advanced techniques In Operations Research for industrial solutions 5. Analyze various OR models like Inventory, Queuing, and apply them for optimization

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	3	1	-	2	-	1	2	-	-	1	2	-	-
CO-2	3	-	-	-	2	-	-	-	-	-	1	-	-	-
CO-3	3	2	2	-	2	-	-	-	-	-	1	2	-	-
CO-4	3	-	1	-	2	-	1	2	-	-	1	2	-	-
CO-5	3	3	1	-	2	-	-	-	-	-	1	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO OPERATIONS RESEARCH	**9**
Introduction- Role of Operations Research in business-Role of O.R in Engineering-Main Phases of OR. Linear Programming Formulation and Graphical method -Network Models-Assignment and Transportation models. Suggested Reading: LPP problem's using TORA and MatLab©.	**CO-1** **BTL-2**
MODULE 2: SEQUENCING MODELS	**9**

Sequencing -assumptions - Johnson's Algorithm – processing of n jobs on two Machines- sequence of n jobs on three machines - processing of n jobs on m machines- processing of two jobs on m machines – Graphical Method. **Suggested Reading: Sequencing problems using** MatLab©**.**	**CO-2** **BTL-2**
MODULE 3: DECISION MODELS	**9**
Game theory – Two-person zero sum games- saddle point- Matrix oddment method- Dominance Property – Graphical Method. **Replacement models** – Items that deteriorate with time - When money value changes – Items that fail completely – Individual replacement and Group replacement. **Suggested Reading: Game theory problems using** MatLab©**.**	**CO-3** **BTL-3**
MODULE 4: QUEUING MODELS	**9**
Queueing system- Kendal's Notation- Poisson arrival -single channel models-Multi channel models .Stochastic Processes and its classification. **Simulation:** uses and Limitation -Monte-Carlo Technique -Generation of random numbers- Simulation applied to queueing and other problems. **Suggested Reading: Queueing problems using** MatLab©.	**CO-4** **BTL-2**
MODULE 5: INVENTORY MODELS	**9**
Types of **inventory** – Deterministic Inventory models - Purchase Model with and without Shortages - Manufacturing Model with and without shortages Probabilistic Model. Probabilistic Model-Inventory models with price breaks. **Suggested Reading: Inventory problems using** MatLab©.	**CO-5** **BTL-2**

TEXT BOOKS	
1	Hamdy A Taha (2016),"Operations Research : An Introduction",Pearson Education, 9th Edition.
2	J.K.Sharma,(2012),"Operations Research: Theory and Applications" ,Macmillan Publishers 5th edition.
REFERENCE BOOKS	
1	S.Kalavathy ,(2013),"Operations Research",Vikas Publishing House Fourth Editon.
2	PKGupta,D.S.Hira,(2014) "OperationsResearch",S.Chand Publishers.
E BOOKS	
1	https://books.google.co.in/books?isbn=8121902819
2	https://books.google.co.in/books?isbn=8121909686
MOOC	
1	https://swayam.gov.in/courses/1342-introduction-to-operations-research
2	https://onlinecourses.nptel.ac.in/noc17_mg10/preview

COURSE TITLE	MAINTENANCE ENGINEERING AND CONDITION	CREDITS	3

	MONITORING				
COURSE CODE	MEC4357	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Maintenance activities are very important activity in Industries to avoid break down of machineries and calculate the machine availability. Preventive maintenance schedule will help to take regular maintenance activities. The basic concepts of condition monitoring gives Identify the machine faults and take corrective action. and to understand the need for safety engineering and its tools
Course Objective	1. To understand maintenance activities and calculate machine availability 2. To develop preventive maintenance schedule 3. To understand and appreciate the basic concepts of condition monitoring 4. To identify machine faults and take corrective action 5. To understand the need for safety engineering and its tools
Course Outcome	Upon successful completion of this course the student should be able to 1. Identify maintenance activities and calculate machine availability 2. Develop preventive maintenance schedule 3. Differentiate and appreciate the basic concepts of condition monitoring 4. Identify machine faults and take corrective action 5. Demonstrate the need for safety engineering and its tools

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	-	-	1	1	-	-	-	2	1	-	-	-
CO-2	-	-	2	-	3	-	-	-	-	-	-	-	-	-
CO-3	2	1	-	-	-	1	-	-	-	2	1	-	-	-
CO-4	2	1	-	-	3	-	-	-	-	1	1	1	-	-
CO-5	-	-	3	-	-	-	1	1	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: PRINCIPLES OF MAINTENANCE PLANNING	**10**
Basic Principles of maintenance planning - Objectives and principles of planned maintenance activity Importance and benefits of sound Maintenance systems - Reliability and machine availability MTBF, MTTR and MWT - Factors of availability - Maintenance organization - Maintenance economics. Suggested Reading: computer aided maintenance management systems, RAM (Reliability, availability ,maintainability)	**CO-1** **BTL-3**
MODULE 2: MAINTENANCE POLICIES	**9**
Maintenance categories - Comparative merits of each category - Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication - TPM Suggested Reading: Statutory requirements on EHS	**CO-2** **BTL-3**
MODULE 3: CONDITION MONITORING	**9**
Condition Monitoring - Cost comparison with and without CM - On-load testing and off-load testing Methods and instruments for CM - Temperature sensitive tapes - pistol thermometers - wear-debris analysis – use of model predictive control tool box in MATLAB© Suggested Reading: vibration analysis and current signature analysis, CBM (Condition based maintenance)	**CO-3** **BTL-3**
MODULE 4: REPAIR METHODS FOR BASIC MACHINE ELEMENTS	**9**
Repair methods for beds, slideways, spindles, gears, lead screws and bearings - Failure analysis Failures and their development - Logical fault location methods - Sequential fault location. Suggested Reading: Science of friction and wear	**CO-4** **BTL-3**
MODULE 5: SAFETY ENGINEERING	**8**
Industrial hazards and safety – Cause of accidents and preventive measures - Safety equipment – Safety Planning Suggested Reading: Factory Act and statutory requirement on industrial safety	**CO-5** **BTL-3**

TEXT BOOKS	
1	Fedele, Lorenzo, (2011), Methodologies and Techniques for Advanced Maintenance.
2	Mishra R C and Pathak K., (2009), Maintenance Engineering and Management, PHI Learning Pvt., New Delhi.
REFERENCE BOOKS	
1	Mishra, R. C. and Pathak, K., (2004), Maintenance Engineering and Management, Second Edition.
2	Duffuaa S: Raouf A, (2015),Planning and control of Maintenance systems : Modeling and Analysis
E BOOKS	

1	https://www.amazon.co.uk/Maintenance-Engineering-Handbook-Eighth-Mobley/dp/0071826610
2	https://www.amazon.in/Maintenance-Engineering...K...ebook/dp/B00K7YGK8K
MOOC	
1	www.nptelvideos.com/lecture.php?id=14763
2	nptel.ac.in/courses/112107142/28

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER VI

COURSE TITLE	**TRIBOLOGY IN DESIGN**			**CREDITS**	**3**
COURSE CODE	**MEC4366**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course deals with Friction, Wear and Lubrication concepts.				
Course Objective	1. To understand the types of Friction and its types. 2. To understand the types of wear and its mechanism. 3. To understand the different type of coatings. 4. To understand the concept of Lubrication.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate surface interaction and friction between mating materials 2. Identify different wear types and surface modification technique 3. Apply the types of lubricants in different machining processes 4. Apply the concepts of tribology in bearing 5. Apply contacts under lubrication				
Prerequisites: Manufacturing Technology II					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	2	3	2	-	-	-	-	-	-	-	-	-
CO-3	3	2	-	-	2	-	-	-	-	-	-	-	-	-

CO-4	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO-5	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: SURFACE INTERACTION AND FRICTION	**(7)**
Topography of Surfaces – Surface features -Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact, effects of friction, wear and lubrication in metal working. Abrasive Wear Resistance of Materials, Transfer films in Adhesion. **Suggested Readings:** Tribology in Metal working industries, measuring surface roughness and analysing surface roughness power spectrum tool in MATLAB©	**CO-1** **BTL-4**
MODULE 2: WEAR AND SURFACE TREATMENT	**(8)**
Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Nonmetals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements **Suggested Readings:** Introduction to Nano Tribology, measuring dimensional surface roughness power spectrum of a profile tool or topography using MATLAB©	**CO-2** **BTL-4**
MODULE 3: LUBRICANTS AND LUBRICATION REGIMES	**(8)**
Lubricants and their physical properties- Viscosity and other properties of oils – Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication- Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication. **Suggested Readings:** Nano Tribology, Measurement tools – fabrication techniques	**CO-3** **BTL-4**
MODULE 4: : THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION	**(10)**
Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Somerfield boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings **Suggested Readings:** Nano Tribology, ,Seals – types of seals ,Friction in seals – characteristics	**CO-4** **BTL-4**
MODULE 5: HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION	**(12)**
Rolling contacts of Elastic solids- contact stresses – Hertz an stress equation-Spherical and	**CO-5**

cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for Elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives **Suggested Readings:** Nano Tribology, Measurement techniques – contact and non-contact type.	**BTL-4**

TEXT BOOKS	
1	R. Arnell ,Tribology: (14 June 2012), Principles and Design Applications, Springer; Soft cover reprint of the original 1st edition..
2	J.Paulo davim (8 September 2012), Tribology in Manufacturing Technology (Materials Forming, Machining and Tribology)Springer; 1st edition
3	Michael M. Khonsari , E. Richard Booser, Wiley (1 August 2017), Applied Tribology: Bearing Design and Lubrication (Tribology in Practice Series); 3rd edition
4	T. A. Stolarski , (22 October 2013), Tribology in Machine Design, Newnes
REFERENCE BOOKS	
1	V.B.Bhandari (2012),"Design of Machine Elements ",Tata McGraw hill Edition Pvt, third edition.
2	Paulo Davim J,(2013), Green Manufacturing Processes and Systems (Materials Forming, Machining and Tribology) Springer, 1st edition.
E BOOKS	
1	https://drive.google.com/open?id=0B7JWdKw_4Q07QzJaZVpaeXBPOFU
2	https://www.whsmith.co.uk/dept/ebooks-technology-and-engineering-tribology-friction-and-lubrication-05x02119
3	https://www.ellibs.com/book/9783642036538/advanced-tribology
MOOC	
1	https://www.edx.org/course/lean-production-tumx-qpls3x

COURSE TITLE	**QUALITY AND RELIABILITY ENGINEERING**			**CREDITS**	**3**
COURSE CODE	**MEC4367**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Develop on quality management philosophies, SQC tools, and frameworks for reliability, availability, models, using field and test data and maintainability. Implement strategies for improving reliability of repairable and non-repairable				

	systems
Course Objective	1. To understand and develop on quality management philosophies and frameworks for reliability in Engineering. 2. To analyze the SQC tools, concepts of reliability, availability and maintainability. 3. To apply the QMS tools and Build system reliability models for different configurations. 4. To asses reliability of components and systems using field and test data. 5. To implement strategies for improving reliability of repairable and non-repairable systems
Course Outcome	Upon completion of this course, the students will be able to 1. Develop an understanding on quality management philosophies and frameworks for reliability in Engineering. 2. Analyze the SQC tools, concepts of reliability, availability and maintainability. 3. Apply the QMS tools and Build system reliability models for different configurations. 4. Assess reliability of components and systems using field and test data. 5. Implement strategies for improving reliability of repairable and non-repairable systems

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	1	1	-	1	1	-	1	1	-	-	-
CO-2	-	-	2	-	3	-	-	1	1	-	-	-	-	-
CO-3	2	1	-	-	-	1	-	-	-	-	1	1	-	-
CO-4	-	-	-	-	3	-	-	-	-	-	1	-	-	-
CO-5	2	1	3	-	-	1	1	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: QUALITY	**9**
Quality: Definition, History, Importance, Cost of Quality, Approaches of Quality Management. Hierarchy of Quality management: Inspection & Test, Quality Control, Quality Assurance, Total Quality Management: Definition, Models of TQM, Elements of TQM, Principles of TQM - Edward Deming's approach, PDCA cycle, Joseph M. Juran's approach, JIT, Training for Quality management - Quality Improvement Programme: Histogram, Charts, Brain-storming, Cause & Effect diagram, Pareto analysis. **Suggested Reading:** Quality Function Deployment, Quality cost systems and Quality Policy Deployment.	**CO-1** **BTL-2**
MODULE 2: STATISTICAL QUALITY CONTROL	**9**

SQC tools, Benefits of SQC, Concept of variation, Assignable & Chance causes, Attributes & variables, Frequency Distribution curve & its types. Normal Distribution curve, Problems on Frequency Distribution curve & Normal Distribution curve. Control chart for variable: Definition, Formulae & its problems. Control chart patterns, Process capability. Problems on X & R chart and Process capability. Control chart for attribute: Definition, Formulae & its problems. Problems on p-charts and c-charts. **Suggested Reading:** Sampling: Definition, types of sampling, importance, benefits and limitations of sampling.	**CO-2** **BTL-3**
MODULE 3: QUALITY MANAGEMENT SYSTEMS	**9**
Quality Assurance (QA): Introduction, Definition, Management principles in QA, Forms of QA, QA in different stages - Quality planning, QA program, QA aspect, Quality in material management, Vendor selection & development - ISO: Introduction, ISO 9000 series of standard, ISO 9001 clauses, Registration process, Benefits of ISO - ISO 9001 clauses, Registration process, Benefits of ISO - Quality survey: Scope, Types of audit, inspection methods, Quality budget, Vendor Quality Rating. **Suggested Reading:** Quality Circle: Quality Circle structure, Its operation, Characteristics of Quality Circle, Basic problem solving techniques. Introduction to Six Sigma and Taguchi concepts.	**CO-3** **BTL-3**
MODULE 4: RELIABILITY CONCEPTS	**9**
Elements of probability, Reliability engineering fundamentals, Failure data analysis and examples, Failure rate, Failure density, Probability of failure, Mortality rate, mean time to failure, Reliability in terms of Hazard rate and Failure Density, examples, Useful life and wear out phase of a system, Concept of burnperiod. Hazard Models, Conditional Probabilities and examples, Multiplication rule and examples, Bayes theorem and examples. **Suggested Reading:** Weibull model, system reliability, series, parallel and mixed configuration – simple problems	**CO-4** **BTL-2**
MODULE 5: SYSTEM RELIABILITY AND IMPROVEMENT	**9**
Reliability of series and parallel connected systems and examples, Logic diagrams, An r-out of -n structures, Improvement of components, Element Redundancy, Unit redundancy, Standby redundancy. **Suggested Reading**: Product design – Product analysis – Product development – Product life cycles.	**CO-5** **BTL-2**

TEXT BOOKS	
1	Samunel. K. H.,(2011), TQM - an integrated approach, Crest publishing House.
2	Grant, Eugene. I.,(2013), "statistical quality control", McGraw-hill.
3	Srinath. I. S.,(2012), "Reliability Engineering" Affiliated east west press.
REFERENCE BOOKS	
1	Douglas. C. Montgomery,(2016) ,"Introduction to Statistical quality control", John Wiley ,

	13th edition, .
2	Besterfield. D. H., (2017). "Quality Control", Prentice Hall.
3	John. S. Oakland. (2015), "Statistical process control", Elsevier.,9th edition.
MOOC	
1	https://www.csudh.edu/qa-ms/certificates/reliability-engineering/

COURSE TITLE	**PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING**			**CREDITS**	**3**
COURSE CODE	**MEC4368**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	**Productivity management** is done to plan and organize the resource and to direct and control the productivity to improve the projects and studies. **Re-engineering** involves the examination and redesign of the processes and workflows in an organization. This course provides a detailed study on the basic principles of Productivity Models and the applications of Re-Engineering Concepts required for various organizations.				
Course Objective	1. To understand the various factors that affects productivity and learns the system approach to measure productivity. 2. To understand the productivity conceptual frame work. 3. To understand the organizational transformation and the methods to manage it. 4. To understand the business process re-engineering process 5. To study the improvement models and its implementation.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the productivity concepts and its measurement methods 2. Analyze and apply the principles of organizational transformation. 3. Compare different strategies including business strategy and marketing strategy. 4. Develop Business Process Re-engineering Methodologies. 5. Apply the Re-engineering models in practice.				
Prerequisites: NIL					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2

CO-1	**3**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-2	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**2**	**-**
CO-3	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**
CO-4	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO-5	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PRODUCTIVITY CONCEPTS AND MEASURES	**(9)**
Productivity Concepts, Partial-Factor Productivity, Total Factor Productivity, Productivity Measures, Use of Productivity Measures, Factors Affecting Productivity, Productivity Index, Improving Productivity, Productivity at the National level. **Suggested Reading:** Investments in physical capital, human capital and innovation drive productivity	**CO-1** **BTL-2**
MODULE 2: PRODUCTIVITY CONCEPTUAL FRAME WORK	**(9)**
Business strategy, Marketing strategy, Management strategy, Segmentation, Targeting, Marketing mix, Management by Objectives (MBO), Performance Objectives Productivity (POP) – Methodology and application to manufacturing and service sector. **Suggested Reading:** Materials management function in a firm.	**CO-2** **BTL-3**
MODULE 3: MANAGING ORGANISATIONAL TRANSFORMATION	**(9)**
Elements of Organisational Transformation, key stages for managing organizational transformation - Types of Transformation - Improving Operation, Strategic Transformation, Corporate Self Renewal - Phases of Transformation. **Suggested Reading:** Organizational goals and planning	**CO-3** **BTL-3**
MODULE 4: BUSINESS PROCESS RE-ENGINEERING	**(9)**
Business Process Reengineering Methodologies-Introduction into Business Reengineering, Identification of Business Processes, Selection of Business Processes, Understanding of Selected Business Processes, Redesign of the Selected Business Processes, Implementation of Redesigned Business Processes. **Suggested Reading:** PDCA improvement cycle in manufacturing industries	**CO-4** **BTL-3**
MODULE 5: RE-ENGINEERING MODELS AND IMPLEMENTATION	**(9)**
PMI LES Model, COBRA, LMI CIP Transformation Model, DSMC Q & PMP model, Moen and Nolan Strategy for process improvement, NPRDC Model- Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases. **Suggested Reading:** Surrogate models, Product oriented models	**CO-5** **BTL-3**
TEXT BOOKS	

1.	James Cox III, John Schleier, (2010) "Theory of Constraints for Personal Productivity Dilemmas", McGraw Hill Professional.
2.	Robert D. Pritchard, Sallie J. Weaver, ElissaAshwood, (2012), "Evidence-Based Productivity Improvement" Routledge.
3.	Jeffrey Magee, (2015), "The Managerial Leadership Bible" FT Press,
4.	James F. Chang, (2016), "Business Process Management Systems: Strategy and Implementation", CRC Press,
5.	Carolina Machado, J. Paulo Davim, (2017), "Productivity and Organizational Management", Walter de Gruyter GmbH & Co KG,
REFERENCE BOOKS	
1.	Matthew P. Stephens, (2010), "Productivity and Reliability-Based Maintenance Management Purdue" University Press.
2.	2012, Productivity Measurement in the Retail and Food Industry, Asian Productivity Organization (APO), Tokyo.
3.	Kurt Lehberger (2016),"Management Concept of Business Process Reengineering", GRIN Verlag.
4.	Giles Johnston (2017), "Business Process Re-Engineering: A Simple Process Improvement Approach to Improve Business Performance "The Business Productivity Series.
5.	Matthew P. Stephens, (2010), "Productivity and Reliability-Based Maintenance Management Purdue" University Press,.
E BOOKS	
1.	https://books.google.co.in/books?isbn=1574440578- David J. Sumanth
2.	https://books.google.co.in/books?isbn=0873893395- Joseph N. Kelada
3.	https://books.google.co.in/books?isbn=038734876X- J. Browne, David O'Sullivan
4.	https://books.google.co.in/books?isbn=1317463005 - Evan Berman
MOOC	
1.	https://www.mooc-list.com/course/fundamentals-project-planning-and-management-coursera
2.	http://nptel.ac.in/courses/112107143
3.	http://nptel.ac.in/downloads/110105034/
4.	http://nptel.ac.in/courses/110105033/
5.	http://nptel.ac.in/courses/112107142/12

COURSE TITLE	**POLYMER SCIENCE AND ENGINEERING**			**CREDITS**	**3**
COURSE CODE	**MEC4369**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First	**Second**	**Seminar/**	**Surprise Test**	**Attendance**	**ESE**

Periodical Assessment	Periodical Assessment	Assignments/ Project	/ Quiz		
15%	15%	10%	5%	5%	50%
Course Description	This course introduces the basics of the polymer materials and providing an overview on the polymerization processes. It also briefs on the polymer characteristics and the various manufacturing methods of producing polymer products in large scale.				
Course Objective	1. To perceive the basics of polymerization. 2. To understand the different methods by which molecular weights are calculated for polymers. 3. To comprehend the physical transition of the polymer and the techniques to identify the same. 4. To apprehend the solubility characteristics of the polymer. 5. To learn about the different manufacturing processes to form polymer products.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic concepts of Polymer, Nano materials and smart materials 2. Calculate molecular weight of the Polymer materials 3. Describe Transitions, crystallization in Polymers and the concept of metastable state, simulation of self-assembling polymer blend using MATLAB© software 4. Demonstrate the Solution Properties of Polymers and Its Size Exclusion chromatography and Confinement 5. Identify the polymer and process in making polymer components and Create mould design using CAD/CAM Software Packages				

Prerequisites: Engineering Chemistry

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	2	-	2	-	-	-	-	-	3	2	-	2	-	-
CO-3	-	-	2	-	-	1	-	-	-	-	-	2	-	-
CO-4	2	-	-	2	-	-	-	-	-	-	-	2	-	-
CO-5	3	2	3	2	-	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: POLYMERIZATION (9)

Fundamentals of polymers – monomers – functionality - Classification – characterization –. Types of Polymerization: cationic polymerization – anionic polymerization – coordination polymerization – free radical polymerization. Copolymerization concepts - Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity. Poly condensation – kinetics of poly condensation - Carother's equation – Linear polymers by poly condensation – Interfacial polymerization – crosslinked polymers by condensation – gel point- smart gel and smart polymer material – nano materials *Suggested Reading: graphene, carbon nanotubes, smart polymer nano composites*	**CO-1** **BTL-3**
MODULE 2: MOLECULAR WEIGHTS OF POLYMERS	**(9)**
Number average and weight average molecular weights – Degree of polymerization – molecular weight distribution – Polydispersity – Molecular weight determination- Different methods – Gel Permeation Chromatography - Renegade Distributions - Tromsdorff effect - size exclusion chromatography- MALDI mass spectrometry. *Suggested Reading: calculate molecular weight of the Polymer materials*	**CO-2** **BTL-3**
MODULE 3: TRANSITIONS IN POLYMERS	**(9)**
First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures. Crystallinity in polymers – differential scanning calorimeter – factors affecting crystallization, crystal nucleation and growth – Relationship between Tg and Tm – Structure–Property relationship- PerkinElmer Analysis. *Suggested Reading:* Gaining knowledge about the concept of metastable state, simulation of self-assembling polymer blend using MATLAB© software	**CO-3** **BTL-3**
MODULE 4: SOLUTION PROPERTIES OF POLYMERS	**(9)**
Size and shape of the macromolecules – Solubility parameter – Ideal chain & Gaussian Chain– polymer/solvent interaction parameter – temperature – size and molecular weight. Solution properties of polymers. Importance of Rheology – Newtonian and Non-Newtonian flow behaviour – Polymer melts Rheology - Thermodynamics of Dilute Polymer Solutions *Suggested Reading: Flory-Huggins Mean-Field Theory, Size Exclusion Chromatography and Confinement*	**CO-4** **BTL-3**
MODULE 5: POLYMER PROCESSING	**(9)**
Overview of Features of Single screw extruder –Tubular blown film process - Coextrusion.- Injection Moulding systems – Compression & Transfer Moulding - Blow Moulding – Rotational Moulding – Thermoforming – Vacuum forming - Fiber Spinning process –Structural Foam Moulding – Sandwich Moulding. Processing for Thermosets- Reaction Injection Moulding & Reinforced Reaction Injection Moulding. *Suggested Reading: Create mould design using CAD/CAM Software Packages*	**CO-5** **BTL-3**
TEXT BOOKS	

1	R. Griskey (2012). "Polymer Process Engineering", springer.
2	Richard A. Pethrick, (2013). "Polymer Products and chemical Process", Chapman & Hall, New York.
REFERENCE BOOKS	
1	Joel R. Fried ,(2014),"polymer science and technology", Prentice Hall; 3 edition.
2	Sebastian Koltzenburg,(2017), "Polymer Chemistry", 1st Edition.
3	Hal F. Brinson, (2014)," Polymer Engineering Science and Viscoelasticity" 2nd edition.
4	Donald G. Baird, (2014)" Polymer Processing", Wiley; 2 edition
5	A. Gandini (2013), "Advancement in polymer Science", Springer.
6	R. R. Morrison, R. N. Boyd and S. K. Bhattacharjee, (2011), *Organic Chemistry* , Dorling Kindersley (India) Pvt. Ltd, New Delhi.
E BOOKS	
1	https://books.google.co.in/books?isbn=0123821797 - Alfred Rudin
2	https://books.google.co.in/books?isbn=1932078754 - Paul C. Painter
3	https://books.google.co.in/books?isbn=0299146944 - Robert Byron Bird
4	https://books.google.co.in/books?isbn=3527341315 - Stoyko Fakirov
5	https://books.google.co.in/books?isbn=0471811815 - Herman Francis Mark
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	http://www.open.edu/openlearn/science-maths-technology/science/chemistry/introduction-polymers/content-section-0?active-tab=description-tab
3	http://nptel.ac.in/courses/113105028/
4	http://nptel.ac.in/courses/116102010/

COURSE TITLE	**ADVANCED I.C. ENGINE**			**CREDITS**	**3**
COURSE CODE	**MEC4370**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes the applications of the laws of Thermodynamics to various advanced Internal Combustion engines. The course will provide an insight to various modelling and simulation. The advancements such as LHR engines, Stratified charge and lean burn engines, Sensors, Computer Controls are analyzed in detail and enable the student to solve more advanced problems				

Course Objective	1. To understand the features of Gas power cycles and efficiency enhancement methods. 2. To understand the combustion phenomena in SI and CI engines. 3. To understand the concept of engine cycle modelling and simulation. 4. To understand the working principles LHR, Surface Ignition engine and to analyze their performance. 5. To understand the principles of operations of Sensors, Computer Controls to lower engine emission.
Course Outcome	Upon completion of this course, the students will be able to 1. Identify and compare the various cycle of operation under compression and spark ignition engine 2. Analyse the combustion chemistry under constant volume and pressure considerations with emphasizes on premixed and diffusive combustion. 3. Apply the concept of engine cycle simulation considering adiabatic flame temperature, heat release correlations and other thermodynamic models. 4. Demonstrate the advances concepts of IC engine like LHR, surface ignition and stratified engine leading to better engine performance 5. Apply their knowledge on electronics parts used in SI and CI engine for lower emission and better performance.

Prerequisites: Thermal Engineering, IC Engine and Steam turbine

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-2	1	-	-	-	-	1	2	-	-	-	-	-	-	-
CO-3	2	-	-	-	-	1	1	3	-	-	-	-	-	-
CO-4	2	-	-	-	-	2	2	1	1	-	1	-	-	-
CO-5	2	-	-	-	-	1	1	2	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: ENGINE CYCLE ANALYSIS	**9**
Otto, Diesel, Dual, Stirling and Brayton cycles, Comparison of air standard, Fuel air and actual cycles, Simple problems on the engine cycles. **Suggested Reading:** Urp and Hrp analysis, Combustion chemistry	**CO-1** **BTL-3**
MODULE 2: COMBUSTION	**9**
Combustion reactions and stoichiometry, heat of reaction, adiabatic flame temperature in constant pressure and constant volume systems, fuels for internal combustion engines and their properties, premixed and diffusion combustion as applicable to SI and CI engines. **Suggested Reading:** Concepts of burning rate and flame velocity, Fuel spray characteristics and combustion in diesel engines.	**CO-2** **BTL-4**

MODULE 3: COMBUSTION MODELLING	9
Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI engines. Adiabatic flame temperature, Heat release calculations. **Suggested Reading:** Thermodynamic and Fluid mechanic based models using Matlab©	**CO-3** **BTL-4**
MODULE 4: ADVANCES IN IC ENGINES	**9**
LHR engines, Surface ignition concept, Stratified charge and lean burn engines, Performance and emission characteristics, Merits and demerits. **Suggested Reading:** Concept of HCCI engine and multi fuel engines, Magnetic engine	**CO-4** **BTL-4**
MODULE 5: ELECTRONIC ENGINE	**9**
Computer control of SI & CI engines for better performance and low emissions, closed loop control of engine parameters of fuel injection and ignition **Suggested Reading:** Digital data acquisition system (DDAS), Interfacing of piezo-electric sensor and fuel monitoring sensor.	**CO-5** **BTL-4**

TEXT BOOKS	
1	John B Heywood, (July 2017), "Internal Combustion Engine Fundamentals", McGraw Hill Education, 1st Edition (Indian Edition)
2	V Ganesan,(July 2017), "Internal Combustion Engines", McGraw-Hill Education; 4th Edition.
REFERENCE BOOKS	
1	Kenneth W. Raglan and Kenneth M.Bryde. (2011) "Combustion Engineering", CRC Press – Taylor and Francis Group. New York, Second Edition.
2	Jerald A. Caton, (2016), "An Introduction to Thermodynamic Cycle Simulation for Internal Combustion Engines", John Wiley and Sons,.
3	A J Martyr and M A Plint, (2007), "Engine Testing – Testing and Practice", Butterworth-Heinemann Publication.
E BOOKS	
1	https://books.google.co.in/books?id=UtxI5gXM1yQC&printsec=front cover&dq =IC+engine &hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAh VGNI8KHbNvB h8Q6AEIODAD# v=onepage &q=IC%20engine&f= false – R K Rajput
2	https://www.elsevier.com/books/engine-testing/martyr/978-0-7506-8439-2
3	https://books.google.co.in/books?id=u9FSAAAAMAAJ&q=IC+engine& dq=IC+engine& hl=en &sa =X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHb NvBh8Q6AEILTAB – John B Heywood
4	https://books.google.co.in/books?id=hfejAwAAQBAJ&printsec=front cover&dq= IC+engine&hl =en&sa=X&ved=0ahUKEwiLuPjhl8jZAh VGNI8KHb NvBh8Q6AEIK DAA#v=onepage &q =IC%20engine&f=false – V Ganesan
MOOC	
1	http://nptel.ac.in/courses/101104070/
2	http://nptel.ac.in/courses/101104014/
3	http://nptel.ac.in/courses/101106037/
4	http://nptel.ac.in/courses/112104033/

COURSE TITLE	CREEP AND FATIGUE BEHAVIOR OF MATERIALS			CREDITS	3
COURSE CODE	MEC4371	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course will introduce to the useful life of components which is often limited by the fracture, fatigue and creep properties of the materials used. The students study the fundamental principles leading to failure of technical components.
Course Objective	1. To Know the structure of materials and their defects 2. To understand the behaviors of materials when subject to creep and fatigue loads leading to their failure in service 3. To identify the privative methods to be adopted to overcome their failures 4. To get Knowledge in failure mechanisms due to creep and fatigue 5. To understand the methods to be adopted in the design stage of the product to avoids their failure.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the structure of materials, their defects and the principles behind deformation 2. Demonstrate the Creep and Fatigue behavior of the materials when subjected to their respective loads while in service 3. Calculate the Creep rupture data and its extrapolation, Fatigue life estimation and reasons for Macro fracto graphic Fatgue failures 4. Apply the principles and methods of Creep and Fatigue in the design stage of the product to avoid their failures 5. Conduct Fracture and failure analysis

Prerequisites: Engineering Physics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-2	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-3	3	-	2	2	2	1	-	-	-	2	-	-	-	-

CO-4	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**
CO-5	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
Strength of perfect crystals- Lattice resistance to dislocation movement, Elastic properties of dislocation multiplication—Slip and Twinning in crystalline solid. **Suggested Readings:** Lattice structure defects, Types of dislocations. Mechanical properties of metals	**CO-1** **BTL-2**
MODULE 2: HIGH TEMPERATURE DEFORMATION RESPONSE	**(9)**
Creep of Solids-- Temperature stress—Strain rate relation—Deformation mechanism—Super plasticity deformation mechanism maps—Extrapolation procedure for Creep rupture Data—Materials for elevated temperature roles using MAT LAB Curve fitting Tool Box **Suggested Readings:** Creep behaviour of Metals, Inferences from Creep curves	**CO-2** **BTL-3**
MODULE 3: CYCLIC STRESS AND STRAIN FATIGUE	**(9)**
Macro fractography, fatigue failures-- cyclic stress and strain controlled fatigue- fatigue life estimation for Notched components—Crack initiation mechanisms using MAT LAB's Statistical Tool Box **Suggested Readings:** S-N curves, Inferences from fatigue types, Design considerations	**CO-3** **BTL-4**
MODULE 4: FATIGUE CRACK PROPAGATION	**(9)**
Stress and crack length correlations with FCP—Fracture modes in Fatigue—Microscopic fracture mechanisms – Crack growth behaviour at Δk extremes—Influences- Microstructural aspect of FCP in metal box Alloys using MATLAB©'s Data Acquisition Tool Box **Suggested Readings:** Types of Mode failures- Design considerations	**CO-4** **BTL-3**
MODULE 5: ANALYSIS OF ENGINEERING FAILURES	**(9)**
Typical defects—Microscopic surface examination—Metallographic and Fracto graphic examination Component failure analysis—Fracture surface preservation—Cleaning and replication techniques and Image interpretation using Matlab©'s Image Acquisition Tool box **Suggested Readings:** Fracture Mechanics and Failure Analysis	**CO-5** **BTL-2**
TEXT BOOKS	

1	Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg (2012), "Deformation and Fracture Mechanics of Engineering Materials" John Wiley and Sons, 5th edition.
2	Anderson T.L. (2017), "Fracture Mechanics: Fundamentals and Applications" CRC Pres 4th edition.
3	Jean Lemontre and Rodrigue Desmorat, (2010),"Engineering Damage Mechanics: Ductile, Creep, Fatigue and Brittle Failures" Springer.
REFERENCE BOOKS	
1	Courtney T.H.(2005), " Mechanical Behaviour of Materials" Wave Land Press.
2	Hull &Bacon (2011), "Introduction to Dislocations" Elsevier Ltd, 5th edition.
3	Michael E. Kassner (2015),"Fundamentals of Creep in Metals and Alloys" Elsevier, 3rd edition.
4	Norman E.Dowling,(2013), "Mechanical Behaviour of Materials" Pearson Publishing,4th edition.
E BOOKS	
1	https://www.amazon.in/Mechanical-Behavior-Matrial-Courtney…/BOOGHVBHO
2	https://www.Wiley.com/../Dofrmation+and+Fracture+Mechanics+of+ EngineeringMaterials%2C+5th+Edition-10-
3	https//www.goodreads.com/book/../285369Deformation_and_Fracture_Mechanics_of_ Engineering_Materials
MOOC	
1	Edu.epfi.ch/course book/en/fracture-of-materials-MSE-424
2	https//www.edx.org/…/mechanical-behavior of materials-part-1-mifx-3-032-1
3	https://en.wikipedia.org/wik/creep_(deformation)

COURSE TITLE	**PRODUCTION PLANNING AND CONTROL**			**CREDITS**	**3**
COURSE CODE	**MEC4372**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	With the global marketplace constantly changing, it is crucial that your Manufacturing Planning and Control (MPC) system evolve to stay current with technology, product, and market conditions. Regardless of what industry or business you work in, understanding all the various systems involved in Manufacturing Planning and Control is ideal 'Planning and control' is concerned with managing the ongoing activities of the operation to satisfy customer demand. All operations require plans and require controlling, although the degree of				

	formality and detail may vary.
Course Objective	1. To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control. 2. To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise
Course Outcome	Upon completion of this course, the students will be able to 1. Recall the various functions of production 2. Demonstrate the various steps of industry planning 3. Illustrate the various components of scheduling. 4. Describe the various components of controlling 5. Appraise the recent trends of Manufacturing Requirement Planning (MRPII) and Enterprise Resource Planning (ERP).

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO -4	PO -5	PO -6	PO -7	PO-8	PO -9	PO - 10	PO-11	PO -12	PSO-1	PSO-2
CO-1	2	-	-	-	-	2	2	2	-	-	-	2	-	-
CO-2	2	1	1	2	-	2	-	2	2	-	-	2	-	-
CO-3	2	1	2	-	-	-	-	-	2	2	-	3	-	-
CO-4	2	-	-	2	-	-	-	-	2	2	3	3	-	-
CO-5	2	1	-	-	-	-	-	-	2	2	3	3	2	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PRODUCTION FUNCTIONS	**9**
Functions of production control-Types of productions-Product development and design-Marketing aspect –Functional aspects-Operational aspect-Durability and dependability aspect-aesthetic aspect. -Economics of a new design, Method study, work measurement, Self Study: Investments in physical capital, human capital and innovation drive productivity	**CO-1** **BTL-2**
MODULE 2: INDUSTRY PLANNING	**9**
Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning-Steps in process planning, Material requirement planning. Suggested Reading: Materials management function in a firm	**CO-2** **BTL-2**
MODULE 3: SCHEDULING	**9**
Scheduling function-Master Scheduling-Scheduling rules- Gantt charts-Perpetual loading-Basic scheduling problems -Line of balance-Flow production scheduling-Batch	**CO-3** **BTL-3**

production scheduling, Loading and -Product sequencing, - kanban–Dispatching-Progress reporting and expediting Suggested Reading: Cycle-time analysis in batch processing environment	
MODULE 4: CONTROL METHODS	**9**
Production Control Systems-Production Control systems- Periodic batch control - Manufacturing lead time-Techniques for aligning completion times and due dates, Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system-Determination of Economic order quantity and economic lot size-ABC analysis Suggested Reading: Kaizen , long-term approach ,5 S program	**CO-4** **BTL-2**
MODULE 5: COMPUTER IN PRODUCTION PLANNING & CONTROL	**9**
Introduction to Computer Integrated Production Planning systems-elements of Just In Time Systems-Fundamentals of MRPII, ERP.SAP Suggested Reading: Business process reengineering in manufacturing industries	**CO-5** **BTL-3**

TEXT BOOKS	
1	John Kenworthy (2013),"Planning and Control of Manufacturing Operations", Routledge.
REFERENCE BOOKS	
1.	Nick T. Thomopoulos, (2013), "Assembly Line Planning and Control", Springer Science & Business Media.
2.	Modrák, Vladimír (2014), "Handbook of Research on Design and Management of Lean Production Systems", IGI Global.
E BOOKS	
1.	https://books.google.co.in/books?isbn=0071817247- Thomas E Vollmann
2.	https://books.google.co.in/books?isbn=0071750320- F. Robert Jacobs
MOOC	
1.	https://www.mooc-list.com/course/lean-production
2.	http://nptel.ac.in/courses/112107143/

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER VII

COURSE TITLE	DYNAMICS AND CONTROL			CREDITS	3
COURSE CODE	MEC4451	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Establish the fundamental techniques for modeling dynamic systems. Analyse and manipulate system models in the time and frequency domain. Develop an understanding of feedback control systems and the parameters that influence their stability and performance.
Course Objective	1. To learn Low order linear mathematical models of physical systems and their manipulation. 2. To know how negative feedback affects dynamic response and its characterization by primary analysis and performance measures. 3. To learn Fundamental mathematical tools used in system analysis and design. 4. To analyze dynamic systems using standard mathematical techniques
Course Outcome	Upon completion of this course, the students will be able to 1. Describe various input and output models of dynamic system. 2. Familiar with frequency domain descriptions and dynamic analysis. 3. Evaluate the stability of systems using various methods. 4. Demonstrate the concept of stability and effect of feedback control on sensitivity. 5. Apply the principles of control theory.

Prerequisites: Mechanics of Machines

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	3	-	2	2	-	1	2	-	-	-	-
CO-2	2	1	-	3	3	2	2	-	1	-	-	-	-	-
CO-3	1	-	-	2	-	1	2	-	1	2	-	-	-	-
CO-4	1	2	-	3	-	-	-	-	-	2	-	-	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: LINEAR SYSTEMS THEORY	**9**
Review of time domain analysis of linear systems dynamics - stability, performance measures and design process - state space and process models - example control systems. System Representation in the s-domain: - free/ forced behaviour and the characteristic equation - system poles and zeros, relative and absolute stability, root loci - steady-state error and the final value theorem. **Suggested Reading:**The Laplace transform and system transfer function, plot free/ forced behaviour using MATLAB©	**CO-1** **BTL-3**
MODULE 2: FREQUENCY RESPONSE OF LINEAR SYSTEMS	**9**
Sinusoidal excitation and Fourier Series - forecasting gain and phase, the frequency response function - graphical representation of frequency response, Bode plots. **Suggested Reading:** Sinusoidal Inputs and response plot, plot the frequency response using MATLAB©	**CO-2** **BTL-3**
MODULE 3: CLOSED-LOOP CONTROL SYSTEMS	**9**
Open/closed loop transfer function definitions - performance measures in control system design control system design examples - PID control system definitions and characteristics. **Suggested Reading:** models of mechanical system , Design PID controller using MATLAB©	**CO-3** **BTL-3**
MODULE 4: CONTROL SYSTEM STABILITY ANALYSIS	**9**
Stability in the s-domain, the Root locus method - stability in the frequency domain, NY Quist criterion - performance measures in the frequency domain - gain and phase margins, closed loop frequency response. **Suggested Reading:** sketching of polar plots, Nichols Plot, performance measures using MATLAB©	**CO-4** **BTL-3**
MODULE 5: DESIGN OF FEEDBACK CONTROL SYSTEMS	**9**
System compensation objectives and characteristics - lead-lag compensation, root locus and frequency response methods **Suggested Reading**: Gain and Phase Margins	**CO-5** **BTL-3**

TEXT BOOKS	
1	N.S. Nise, (2012), Control System Engineering, Wiley & Sons, , 6th edition.
2	C. L. Phillips and R. D. Harbor,(2013), Feedback Control Systems, Pearson Education India, 5th Edition.
3	Craig A Kluever (2015), Dynamic Systems: Modeling, Simulation, and Control , Wiley & Sons,.
REFERENCE BOOKS	
1	Benjamin C. KuoFaridGolnaraghi (2014), Automatic Control System, Wiley Publication, 9th edition.

2	K. Ogata, (2010), Modern Control Engineering, Pearson Education India, 5th Edition.
E BOOKS	
1	https://books.google.co.in/books?id=Gq6T7Pqauk4C&lpg=PP1&dq=Control%20System %20Engineering&pg=PP1#v=onepage&q=Control% 20System%20Engineering&f=false
2	https://books.google.co.in/books?id=mvlQAAAAMAAJ&q=Dynamic+ Systems&dq=Dynamic+Systems&hl=en&sa=X&ved=0ahUKEwjtxObctMjZ AhUCTo8KHcmPB5EQ6AEIKzAB
MOOC	
1	https://www.edx.org/course/dynamics-and-control
2	http://nptel.ac.in/courses/111108066/
3	http://nptel.ac.in/courses/111104025/
4	http://nptel.ac.in/courses/108103007/

COURSE TITLE	**MODAL ANALYSIS OF MECHANICAL SYSTEMS**			**CREDITS**	**3**
COURSE CODE	**MEC4452**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	It helps the students to get familiarized with the modal testing, modal analysis of single and multi-degree of freedom systems.				
Course Objective	1. To impart knowledge on modal testing, modal analysis of single and multi-degree of freedom systems. 2. To make the students to gain the concepts on modal analysis, measurement system, review test procedure and to derive the mathematical models				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the modal testing procedure and measurement methods of vibration parameters. 2. Present the responses of properties of FRF data for SDOF & MDOF system. 3. Design the elements of the measurement scheme and construct the mounting arrangements for measurement of vibration parameters. 4. Present the modal parameters by using different methods for SDOF & MDOF system. 5. Develop/derive mathematical model for the system models in vibration.				
Prerequisites: Mechanics of Machines					

CO, PO AND PSO MAPPING														
CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	2	-	-	2	-	2	-	-	1	2	2	-
CO-2	3	-	-	-	-	-	-	2	2	1	-	1	-	-
CO-3	-	-	-	2	-	2	-	1	3	3	2	1	2	-
CO-4	3	-	-	2	-	-	-	-	-	-	1	-	1	-
CO-5	1	-	1	-	1	2	-	1	-	-	-	2	1	-
1: Weakly related, 2: Moderately related and 3: Strongly related														

MODULE 1: OVERVIEW	9
Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing –Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure. Suggested Reading:Basic components of Measurement System, Nyquist plots	CO-1 BTL-3
MODULE 2: THEORETICAL BASIS	**9**
Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOF System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF FRF Data – Complete and incomplete models – Non-sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures. Suggested Reading: Definitions of Frequency response functions, Frequency responses of Mass and stiffness elements.	CO-2 BTL-3
MODULE 3: MOBILITY MEASUREMENT TECHNIQUES	**9**
Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure –Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non-linear structures – Multi point excitation methods. Suggested Reading: Elements of measurement chain, Various mounting arrangements used in exciter for measurement	CO-3 BTL-3
MODULE 4: MODAL PARAMETER EXTRACTION METHODS	**9**
Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude –SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method –Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems. Suggested Reading: Properties of Modal Circle, Various terms in Modal series for FRF	CO-4 BTL-3

MODULE 5: DERIVATION OF MATHEMATICAL MODELS	9
Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models. Methods for Structural modification- Applications. Suggested Reading: Mobility plot of Simple Mass-Spring-Mass system, Comparison of Measured and Predicted Mode Shapes and plotting.	CO-5 BTL-3

TEXT BOOKS	
1	D J Ewins, (2016), "Modal Testing Theory, Practice and application", Research studies press Ltd., England, 2nd edition.
2	Rao, S.S.,(2014.), "Mechanical Vibrations", Pearson Education Inc., Prentice Hall, 6th Edition.
3	C. Sujatha, (2009), "Vibration and Acoustics: Measurement and Signal Analysis", Tata McGraw-Hill Education Private Limited, New Delhi.
REFERENCE BOOKS	
1	Graham Kelly. Scham's (2012), outline of Theory and Problems of Mechanical vibrations. Tata McGraw-Hill,. Special Indian edition.
2	M. L. Munjal, (2014), Noise and Vibration Control, World Scientific Press: Singapore.
3	A.R.Mohanty, (2014), "Machinery condition Monitoring: Principles and Practices", CRC Press.
E BOOKS	
1	https://drive.google.com/open?id=0B4SOTWiEAAOeMFowVzhSa2s0Rnc-William J.Bottega
2	https://drive.google.com/open?id=0B6pGoYzCs7PgMENHa2lOSEpreTQ – C.F.Beards
3	https://drive .google.com/open?id=0B7JWdKw_4Q07ZnZVYURuWTJnNTQ-SCHAUM
MOOC	
1	https://www.mooc-list.com/course/introduction-%C3%A0-la-m%C3%A9canique-des-non-linear systems vibration
2	https://courses.iitm.ac.in/course/info.php?id=1395
3	https://in.mathworks.com/support/learn-with-matlab-tutorials.html

COURSE TITLE	NEW PRODUCT DESIGN AND DEVELOPMENT			CREDITS	3
COURSE CODE	MEC4453	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course discusses the step by step process of product development. Every stage of the development cycle is described in detail. It prepares the students to learn the basic concepts involved in each and every step involved in product development and increases the skill of developing a new product for the customer requirements. It also emphasizes the legal and financial aspects of building a new product.
Course Objective	1. To acquire knowledge on product development process and product planning 2. To acquire knowledge on concept development 3. To acquire knowledge on concept testing, product architecture and platform planning 4. To acquire knowledge on manufacturing and managing a product 5. To acquire knowledge on Intellectual Property Rights and Project Economics
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basic product development process 2. Illustrate the concept development process 3. Apply the design process for product development 4. Analyze the feasibility of the proposed project 5. Analyze the IPR related issues and patent registration

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO-4	PO-5	PO -6	PO -7	PO -8	PO-9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	-	-	3	-	-	-	-	2	-	-	-	-
CO-2	2	2	2	-	3	-	-	-	-	-	-	-	-	-
CO-3	2	-	-	2	2		-	-	-	-	-		-	-
CO-4	2	2	2	2	2	-	-	-	-	2			-	-
CO-5	2	2				-	-	-	-	2	-		-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
Product Development Organizations. Development Process, Product Planning, Identification of Customer Needs. **Suggested Reading**: Establishing markets- market segments- relevance of market research	**CO-1** **BTL-2**
MODULE 2: CONCEPT DEVELOPMENT	**(9)**
Product and Target specification, various steps in concept generation, Brainstorming, Morphological analysis, Selection of concepts, EVAD (Design Evaluation) method, Principles of computer aided decision making. **Suggested Reading**: Creative thinking –creativity and problem solving- creative thinking methods	**CO-2** **BTL-2**

MODULE 3: DESIGN PROCESS	**(9)**
Concept Testing, Response and Interpretation. Product Architecture, Platform planning, System level design issues. Embodiment design, Modelling.	**CO-3** **BTL-4**
MODULE 4: PLANNING FOR MANUFACTURE AND MANAGEMENT	**(9)**
Detail Design, Design Management, Project planning and control, Production design specification (PDS), Design review, Value analysis/engineering.	**CO-4** **BTL-2**
MODULE 5: INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS	**(9)**
Intellectual Property Rights, Write the description of the invention, Refine Claims, Pursue application. Economics and Management Accelerating Projects, Project Execution.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	G. E. Dieter, (2013), "Engineering Design", McGraw – Hill International.
2.	Ken Hurst, (2014), "Engineering Design Principles", Elsevier Science and Technology Books.
REFERENCE BOOKS	
1.	Karl T Ulrich, Steven D Eppinger, (2016), "Product design and development", McGraw-Hill Education, New York.
2.	Kavin N Aotto, Kritine I Wood, (2013), "Product Design", Prentice Hall Publications.
E BOOKS	
1.	https://books.google.co.in/books/about/Engineering_Design.html?id=wUgqAQAAMAAJ
2.	https://books.google.co.in/books?isbn=8177588214
3.	https://books.google.co.in/books?isbn=082477565
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc17_me16/preview
2.	https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1

COURSE TITLE	**ADVANCED STRENGTH OF MATERIALS**			**CREDITS**	**3**
COURSE CODE	**MEC4454**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This Course deals with theory of elasticity, plane-stress and plane-strain, engineering beam theory, beam on elastic foundation, strain energy, curved flexural members, unsymmetrical bending, torsion, geometric nonlinearity, and axisymmetric ally loaded members.
Course Objective	1. To Use approximate theories of strength of materials for engineering stress and strain analyses of open and closed thin-walled sections subjected to torsion and unsymmetric bending. 2. To Analyze curved beam, beams on elastic foundation, shear deformation of beams, and stress concentration problems.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basic principles of structural elasticity, including statically determinate and indeterminate systems, and the factors which affect their strength and stiffness. 2. Demonstrate an understanding of the relationships between loads, member forces and deformations and material stresses and strains. 3. Possess the contemporary analytical, experimental and computational tools needed to solve the engineering problems. 4. Analyze and design structural members subjected to tension, Compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials. 5. Acquired the independent judgment required to interpret the results of the engineering problems.

Prerequisites: Strength of Material

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	-	-	-	-	-	-	-	-	-	-	1	-
CO-2	3	3	2	-	-	-	-	2	-	-	1	-	-	-
CO-3	3	3	2	-	-	-	-	-	-	-	3	2	-	-
CO-4	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-5	3	2	-	-	3	-	-	2	-	-	1	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: ELASTICITY (8)

Stress strain relations and general equations of elasticity in Cartesian, Polar and Spherical coordinates differential equations of equilibrium - Compatibility - boundary conditions - representation of 3 - dimensional stress of a tensor - Generalized Hooke's law - St. Venant's principle - plane strain - plane stress - Airy's stress function. Shear Center: Location of Shear center for various sections - shear flows. Unsymmetrical Bending: Stresses and deflections in beams subjected to unsymmetrical loading - Kern of a section. **Suggested Readings:** Statically determinate – indeterminate, Stress on inclined planes under axial loading, bending of unsymmetrical beams - composite.	**CO-1** **BTL-4**
MODULE 2: CURVED FLEXURAL MEMBERS	**(8)**
Circumferential and radial stresses- deflections- curved beam with restrained ends-closed ring subjected to concentrated load and uniform load chain links and crane hooks. **Suggested Readings:** Instability – failure mode - Necking – tensile member – plastic buckling.	**CO-2** **BTL-4**
MODULE 3: STRESSES IN FLAT PLATES	**(8)**
Stresses in circular and rectangular plates due to various types of loading and end conditions - buckling of plates and stress concentrations. **Suggested Readings:** plane stress – plane strain - Fracture – ductile specimen – brittle specimen.	**CO-3** **BTL-4**
MODULE 4: TORISION OF NON - CIRCULAR SECTIONS	**(8)**
Torsion of rectangular cross sections-St. Venant's theory - Elastic membrane Analog:y-Prandtl's stress function-Torsional stresses in hollow thin-walled tubes. **Suggested Readings:** Torsion – rectangular shaft – thin walled shaft – Study on beams under torsion in MATLAB©.	**CO-4** **BTL-4**
MODULE 5: STRESSES DUE TO ROTATION	**(13)**
Radial and tangential stresses in solid disc and ring of uniform, thickness and varying thickness-allowable speeds. Theory of Contact Stresses: Methods of computing contact stresses – Deflection of bodies in point and line Contact-Applications. **Suggested Readings:** Strain energy due to torsion.	**CO-5** **BTL-4**

TEXT BOOKS	
1	JP. Den Hartog, (2017), "Advanced Strength of Materials", Dover/BSP Books, First Edition.
2	Stephen Timoshenko, "Theory of Elasticity", McGraw Hill Education, Third edition,.
REFERENCE BOOKS	
1	Nash W.A, (2013), "Theory and problems in Strength of Materials", Schaum Outline Series, McGrawHill Book Co, New York.
2	Popov E.P,(2015), "Mechanics of Materials ", Pearson Education India; Second edition.
3	A. C. Ugural, Saul K. Fenster, (2012), "Advanced strength and applied elasticity" Prentice Hall, Fifth edition.
4	Beer F. P. and Johnston R, (2015), "Mechanics of Materials", McGraw-Hill Book Co, Seventh Edition,.

5	S.S. Bhavikatti, (2013), "Advanced Strength of Materials", Vikas Publishing, Fouth edition.
6	Hibbeler,R.C, (2016), "Mechanics of materials" Pearson Education, 10th edition.
E BOOKS	
1	https://goo.gl/ArHdiY - Popov E.P
2	https://goo.gl/EgypX3 - Beer F. P. and Johnston R
3	https://goo.gl/VroJEj - R K Bansal
4	https://goo.gl/bqvlA8 - Rattan S S
MOOC	
1	http://nptel.ac.in/courses/112101095/
2	https://goo.gl/lCHuKR
3	http://nptel.ac.in/courses/112107147/
4	http://nptel.ac.in/courses/112107146/
5	http://nptel.ac.in/courses/112101095/
6	http://nptel.ac.in/courses/105105108/

COURSE TITLE	**THERMAL TURBO MACHINES**			**CREDITS**	**3**
COURSE CODE	**MEC4455**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes the applications of the laws of Thermodynamics to various advanced energy system in engineering applications. The course will provide an insight to different power developing and power absorbing turbo machines. The course will provide an opportunity to analyze and design turbines and compressors.				
Course Objective	1. To apply basic flow equations related to turbines and compressor. 2. To acquire the knowledge and skill of design and analyze different turbo machines. 3. To compare and chose machines for various operations				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of thermal turbo machines, its governing equation along with basic terminologies and parameters used in this domain 2. Demonstrate the basics of centrifugal compressor, blower and various diffuser used for energy transformation, its performance parameters 3. Analyze the basics of an axial compressor and fan used for energy				

	transformation, its theory and performance parameters 4. Illustrate the basics of an axial turbine, its theory along with losses and performance parameters 5. Demonstrate the basics of radial flow turbines, wind turbine, various types and working of a horizontal wind turbine and performance parameters.

Prerequisites: Thermal Engineering, Heat Transfer, IC Engine and Steam turbine

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	2	1	2	2	2	1	1	1	-	-	3	-
CO-2	3	3	2	1	2	-	-	-	1	1	-	-	3	-
CO-3	3	3	-	-	2	2	2	-	-	-	-	-	-	-
CO-4	-	-	2	1	2	2	2	-	1	1	-	-	3	-
CO-5	3	3	2	1	2	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO TURBO MACHINES	**9**
Turbines, Pumps, Compressors, Fans and Blowers - Stages of Turbo machines - Energy transfer between fluid and rotor - Stage velocity triangles Thermal Turbo machines - Classification - General energy equation - Modified to turbo machines compression and expansion process - Velocity triangles - Work - T-S and H-S diagram, Total to Total and Total to Static efficiencies. Dimensional analysis - Non dimensional parameters of compressible flow Turbo machines - Similarity laws, applications and limitations. **Suggested Reading:** Shape number, specific speed and its importance in turbo machines.	**CO-1** **BTL-3**
MODULE 2: CENTRIFUGAL FANS AND BLOWERS	**9**
Definition, selection and classifications -Types of blading design-velocity triangles - Stage Parameters - Flow analysis in impeller blades - Design parameter- Volute and Diffusers - Efficiencies and Losses - Fan noises - Causes and remedial measures. Centrifugal Compressors: - Constructional details - Stage velocity triangles -- Stage work - Stage pressure rise - Stage efficiency - Degree of reaction - Slip factor - H-S diagram - Efficiencies Performance characteristics. **Suggested Reading:** Various types of diffusers used for centrifugal compressors and its present status; Plot the W-Q characteristics curve for the centrifugal blower at different mass flow rates using MATLAB©	**CO-2** **BTL-4**
MODULE 3: AXIAL FANS AND PROPELLERS	**9**
Definition and classifications - Stage parameters - Types of fan stages- performance characteristics. Cascade of blades - Cascade tunnel - Blade geometry - Cascade variables - Energy transfer and loss in terms of lift and drag - Axial Flow	**CO-3** **BTL-4**

Compressors: definition and classifications - Constructional details - Stage velocity triangles - Stage work - Stage pressure rise - H-S diagram- Stage efficiencies and losses- Degree of reaction - Radial equilibrium-Surging and Stalling - Performance characteristics. **Suggested Reading**: Twist in the blades; Plot the W-Q characteristics curve for the axial fan at different mass flow rates using MATLAB©	
MODULE 4: AXIAL FLOW TURBINES	**9**
Construction details - 90^0 IFR turbine - Stage work - Stage Velocity triangles - Stage pressure rise - Impulse and reaction stage - Effect of degree of reaction - H-S diagram - Efficiencies and Losses Performance characteristics. **Suggested Reading:** Degree of reaction for a case R = 0.50	**CO-4** **BTL-4**
MODULE 5: RADIAL FLOW TURBINES AND WIND TURBINES	**9**
Constructional details -- Stage velocity triangles - H-S diagram - Stage efficiencies and losses - Performance characteristics. Wind turbines: definition and classifications - Constructional details -Horizontal axis wind turbine- Power developed - Axial thrust - Efficiency. **Suggested Reading:** Vertical axis wind turbine, its different types and arrangement.; Plot the performance characteristics curve for a horizontal axis wind turbine at different wind speeds using MATLAB©	**CO-5** **BTL-4**

TEXT BOOKS	
1	Erik Dick, (2015), "Fundamentals of Turbomachines", Science + Business Media, Springer.
2	S.L Dixon and C.A. Hall, (2015), Fluid Mechanics and Thermodynamics of Turbo machinery, Elsevier, Seventh Edition.
3	S.M. Yahya,(2011), Turbines, Compressors and Fans, Tata McGraw Hill Education Private Limited, New Delhi, Fourth Edition.
REFERENCE BOOKS	
1	H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix, (2017), Gas Turbine Theory, Prentice Education Limited.
2	V. Ganesan, (2010), Gas Turbines, Tata McGraw Hill Education Private Limited, New Delhi, Third Edition.
3	Erich Hau, (2013), Wind Turbines: Fundamentals, Technologies, Application, Economics, Springer, London, Third Translated Edition.
E BOOKS	
1	https://books.google.co.in/books?id=0SEyBwAAQBAJ&printsec=frontcover&dq=turbo machine&hl=en&sa=X&ved=0ahUKEwi8tPeZqdzZAhXCRY8KHW9gAIIQ6AEINjAG #v=onepage&q=turbomachine&f=false --- Erik Dick
2	https://books.google.co.in/books?id=wZoTAAAAQBAJ&printsec=frontcover&dq=turbo machine+2010&hl=en&sa=X&ved=0ahUKEwij2fjcqtzZAhUBto8KHTrDA8oQ6AEIJDAD #v=onepage&q&f=false --- S.L Dixon and C.A. Hall
3	https://books.google.co.in/books?id=MpAl7kJPR1MC&printsec=frontcover&dq= turboma chine

	+2010&hl=en&sa=X&ved=0ahUKEwij2fjcqtzZAhUBto8KHTrDA8oQ6AEIEzAA #v=onepage&q&f =false -- S.M. Yahya
4	https://books.google.co.in/books?id=jX1vKWdUVYMC&printsec=frontcover& dq=turbo ma chine+2010&hl=en&sa=X&ved=0ahUKEwij2fjcqtzZAhUBto8KHTrDA8oQ6AEIHjAC #v=onepage&q&f=false --- V. Ganesan
MOOC	
1	http://nptel.ac.in/courses/101101058/
2	http://nptel.ac.in/courses/112105182/
3	http://nptel.ac.in/courses/112105206/
4	http://nptel.ac.in/courses/112107216/

COURSE TITLE	**POWDER METALLURGY**			**CREDITS**	**3**
COURSE CODE	**MEC4456**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course introduces the metallurgy of metal powders and its stages to manufacture a powder metallurgy part. A brief overview on the various powder testing procedures and the PM part applications is also covered.				
Course Objective	1. To gain an understanding on the various methods to manufacture the metal powders with various sizes and the methods to conditioning the powders. 2. To study the various properties of metal powders and the testing methods for properties. 3. To read and analyze the compaction stage of metal powder and the various methods involved in it. 4. To examine the sintering stage of metal powder and the various methods involved in it. 5. To have a study on the various applications for various metal powders made parts.				
Course Outcome	Upon completion of this course, the students will be able to 1. Identify and distinguish between the various PM manufacturing methods and to realize the need for conditioning. 2. Recognize the importance of testing the powders using standard procedures. 3. Demonstrate about the reasoning in following the compaction with powders 4. Infer the change in the property attained because of sintering. 5. Describe the various applications and identify newer applications in different fields.				

Prerequisites: Engineering Materials and Metallurgy

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	2	-	2	-	-	-	-	2	-	2	-	1	-	-
CO-3	-	-	2	-	-	1	-	2	-	-	-	1	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: POWDER MANUFACTURE AND CONDITIONING	**12**
Mechanical methods Machine milling, ball milling, atomization, shotting- Chemical methods, condensation, thermal decomposition, carbonyl Reduction by gas-hydride, de-hydride process, electro deposition, precipitation from aqueous solution and fused salts, hydro metallurgical method. Physical methods: Electrolysis and atomisation processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending, Self-propagating high-temperature synthesis (SHS), sol-gel synthesis- Nano powder production methods ***Suggested Reading:*** *Powder Making from Vapour Phase, Reduction of Metal Compounds.*	**CO-1** **BTL-3**
MODULE 2: CHARACTERISTICS AND TESTING OF METAL POWDERS	**8**
Sampling, chemical composition purity, surface contamination etc. Particle size and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. Adsorption methods and resistivity methods: particle shape, classifications, microstructure. Apparent and tap density, green density, green strength, sintered compact density, porosity, shrinkage. ***Suggested Reading:*** *Specific Surface Determination, Alloying of Powder, SEM Analysis of Powders.*	**CO-2** **BTL-4**
MODULE 3: POWDER COMPACTION	**7**
Pressure less compaction slips casting and slurry casting. pressure compaction- lubrication, single ended and double ended compaction, iso static pressing, powder rolling, forging and extrusion, explosive compaction. ***Suggested Reading:*** *Injection Moulding, Forming without External Pressure, Methods to Produce Complicated Parts.*	**CO-3** **BTL-3**
MODULE 4: SINTERING	**8**

Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing (HIP), vacuum sintering, sintering furnaces-batch and continuous-sintering atmosphere, Finishing operations – sizing, coining, repressing and heat treatment, special sintering processes-microwave sintering, Spark plasma sintering, Field assisted sintering, Reactive sintering, sintering of nano structured materials. ***Suggested Reading:*** *Sintering in Multicomponent System, Activated Sintering, Sintering Furnaces.*	**CO-4** **BTL-3**
MODULE 5: APPLICATIONS	**10**
Major applications in Aerospace, Nuclear and Automobile industries- Bearing Materials-types, Self lubrication and other types, Methods of production, Properties, Applications. Sintered Friction Materials-Clutches, Brake linings, Tool Materials- Cemented carbides, Oxide ceramics, Cermets- Dispersion strengthened materials. ***Suggested Reading:*** *Products from Hard Materials and Porous Materials, Products from Refractory Materials and Magnetic Materials.*	**CO-5** **BTL-4**

TEXT BOOKS	
1	P.C.Angelo and R.Subramanian.,(2013), " Powder Metallurgy: Science, Technology and Application" Prentice Hall, Reprint.
2	AnishUpadhya and G S Upadhaya, (2011), " Powder Metallurgy: Science, Technology and Materials, Universities Press,.
REFERENCE BOOKS	
1	Sinha A. K., (2005), "Powder Metallurgy", DhanpatRai& Sons. New Delhi.
2	Katsuyoshi Kondoh, (2012), "Powder Metallurgy"
3	ASM Handbook. Vol. 7,(2015), "Powder Metallurgy", Metals Park, Ohio, USA,
4	Animesh Bose.,(2013), "Advances in Particulate Materials", Elsevier Publisher.
E BOOKS	
1	https://books.google.co.in/books/about/POWDER_METALLURGY.html?id=7cmb7BgZtvIC – P. C. Angelo & R. Subramanian.
2	http://allaboutmetallurgy.com/wp/wp-content/uploads/2016/12/ Powder_Metallurgy.pdf - Kondoh
3	https://books.google.co.in/books/about/ASM_Handbook_Volume_7.html?id=epJUAAAAMAAJ – ASM Handbook
4	https://books.google.co.in/books/about/Iron_Powder_Metallurgy.html?id=W3r1BwAAQBAJ&redir_esc=y - Peter K Johnson.
MOOC	
1	http://nptel.ac.in/courses/112101005/downloads/Module_3_Lecture_6_final.pdf
2	http://nptel.ac.in/courses/112107144/12

COURSE TITLE	RENEWABLE SOURCES OF ENERGY			CREDITS	3
COURSE CODE	MEC4457	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Renewable sources of energy deals with the conventional sources and its availability and the emerging new and renewable sources of energy. How to harness these renewable sources, the conventional methods followed and the emerging methods are discussed.
Course Objective	1. To understand the global requirement of energy and the depleting energy sources 2. To understand the properties of solar energy and harness methods 3. To understand the properties of Wind energy and harness methods. 4. To understand the properties of Bio energy and harness methods. 5. To understand the properties of other nonconventional forms of renewable energy and their development.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the energy demand of world, nation and available resources to fulfill the demand 2. Explore the solar energy resources and their effective tapping technologies 3. Effectively utilize of available wind energy resources 4. Illustrate in bio energy system. 5. Apply the modern energy conversion technologies.

Prerequisites: Engineering Thermodynamics, Thermal Engineering

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	2	-	-	2	2	2	1	1	1	-	-	3	-
CO-2	3	2	1	1	2	-	-	-	1	1	-	-	-	-
CO-3	3	2	-	-	2	2	2	-	1	1	-	-	-	-
CO-4	-	-	1	1	2	2	2	-	-	-	-	-	3	-
CO-5	3	2	1	1	2	2	2	-	1	1	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil nadu, India and around the World - Economics of renewable energy systems. **Suggested Reading:** Potentials of renewable energy sources	**CO-1 BTL-3**
MODULE 2: SOLAR ENERGY	**9**
Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications. **Suggested Reading:** Solar energy storage	**CO-2 BTL-4**
MODULE 3: WIND ENERGY	**9**
Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects **Suggested Reading:** Application of wind energy	**CO-3 BTL-4**
MODULE 4: BIO - ENERGY	**9**
Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration **Suggested Reading:** Application of biomass	**CO-4 BTL-4**
MODULE 5: OTHER RENEWABLE ENERGY SOURCES	**9**
Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems Hybrid Systems. **Suggested Reading:** Hybrid Systems.	**CO-5 BTL-4**

TEXT BOOKS	
1	Rai. G.D., (2011), "Non Conventional Energy Sources", Khanna Publishers, New Delhi.
2	Twidell, J.W. & Weir, A., (2006), "Renewable Energy Sources", EFN Spon Ltd., UK,.
REFERENCE BOOKS	
1	Tiwari. G.N.,(2002), " Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi.
E BOOKS	
1	https://books.google.co.in/books?id=Vps3P-S85o8C&printsec=copyright
2	https://books.google.com/books/.../Non_conventional_Energy_Sources_and_Util.htm...
MOOC	
1	http://nptel.ac.in/courses/112105051/#wable sources

COURSE TITLE	**LEAN MANUFACTURING**			**CREDITS**	**3**
COURSE CODE	**MEC4458**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	It gives the clear understanding of the concepts of lean manufacturing system with the various tools for lean manufacturing and the application of various tools to implement LM system, the principles of six sigma, and learn from different case studies of LM
Course Objective	1. To understand the concepts of lean manufacturing system 2. To understand the various tools for lean manufacturing (LM). 3. To understand and apply various tools to implement LM system. 4. To understand the principles of six sigma. 5. To understand and learn from case studies of LM
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate with concepts of lean manufacturing system 2. Identify the various tools for lean manufacturing (LM). 3. Apply various tools to implement LM system. 4. Apply the principles of six sigma for various environments. 5. Determine procedure to implement of LM in Industry

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	-	-	2	-	3	-	-	-	-	-	2	-	-	-
CO-3	2	1	-	-	-	1	-	-	-	-	2	-	-	-
CO-4	2	1	-	-	3	-	-	-	-	-	1	-	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO LEAN MANUFACTURING	**9**
Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools. **Suggested Reading**: Industry Examples	**CO-1 BTL-3**
MODULE 2: CELLULAR MANUFACTURING, JIT, TPM	**9**
Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM. **Suggested Reading**: Toyota Production System (TPS)	**CO-2 BTL-3**
MODULE 3: SET UP TIME REDUCTION, TQM, 5S, VSM	**9**

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles. **Suggested Reading:** TPS tools & techniques	**CO-3** **BTL-3**
MODULE 4: SIX SIGMA	**9**
Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation. **Suggested Reading**: Lean Manufacturing Company Application	**CO-4** **BTL-3**
MODULE 5: CASE STUDIES	**9**
Various case studies of implementation of lean manufacturing at industries. **Suggested Reading**: Toyota Production System (TPS) Company Application	**CO-5** **BTL-3**

TEXT BOOKS	
1	Ronald G. Askin & Jeffrey B. Goldberg,(2003), “Design and Analysis of Lean Production Systems”, John Wiley & Sons.
2	Mikell P. Groover, (2008), “Automation, Production Systems and CIM”, Prentice Hall.
3	Rother M. and Shook J, (2003), “Learning to See: Value Stream Mapping to Add Value and Eliminate Muda”, Lean Enterprise Institute, Brookline, MA.
REFERENCE BOOKS	
1	James P. James P. W, (2017), “Lean Thinking: Banish Waste and Create Wealth in Your Corporation” Create Space Independent Publishing Platform,.
2	Jamie Flinchbaugh, Andy Carlino, (2006), “The Hitchhiker's Guide to Lean: Lessons from the Road” Society of Manufacturing Engineers,.
E BOOKS	
1	https://books.google.co.in/books?id=Vps3P-S85o8C&printsec=copyright
2	Learn to use condition-based maintenance in a Predictive Maintenance program in this online training course on Predictive Maintenance strategy development.
3	https://www.springer.com/in/book/9783662472149
MOOC	
1	This book presents the state-of-the-art in quality and reliability engineering from a product life-cycle standpoint. Topics in reliability include reliability models, life guides.lib.monash. edu/c.php?g=219722&p= 1452921

LIST OF NON DEPARTMENTAL ELECTIVES OFFERED BY MECHANICAL DEPARTMENT WITH GROUPING - SEMESTER WISE

SEMESTER –III

COURSE TITLE	APPLIED THERMO DYNAMICS FOR ENGINEERS			CREDITS	3
COURSE CODE	MED4281	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	Establish the fundamentals of thermodynamics, IC engines, Turbines, compressors and Refrigeration process				
Course Objective	1. To understand the fundamentals of thermodynamics and to be able to use it in accounting for the bulk behavior of the sample physical systems. 2. To integrate the basic concepts into various thermal applications like IC engines, gas turbines, steam boiler, steam turbine, compressors 3. To understand the concepts of refrigeration and air conditioning				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the fundamentals of thermodynamics and to be able to apply in real life systems 2. Demonstrate the concepts of IC engines and identify the applications of IC engines 3. Demonstrate the working of gas turbines, steam boiler and steam turbine and identify its applications 4. Illustrate the basics of compressors and identify its suitable applications 5. Demonstrate and apply the concepts of refrigeration and air conditioning for different applications.				
Prerequisites: Basic Sciences					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	-	3	-	2	2	-	1	2	-	-	-	-
CO-2	2	1	-	3	3	2	2	-	1	-	-	-	-	-
CO-3	1	-	-	2	-	1	2	-	1	2	-	-	-	-
CO-4	1	2	-	3	-	-	-	-	-	2	-	-	-	-

CO-5	**1**	**2**	**-**	**2**	**3**	**2**	**1**	**-**	**1**	**2**	**-**	**-**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC CONCEPTS AND LAWS OF THERMODYNAMICS	**9**
Classical approach: Thermodynamic systems – Control volume - System and surroundings – Universe – Properties - State-process – Cycle – Equilibrium - Work and heat transfer – Point and path functions - First law of thermodynamics for open and closed systems - First law applied to acontrol volume - SFEE equations [steady flow energy equation] - Second law of thermodynamics - Heat engines - Refrigerators and heat pumps - Carnot cycle - Carnot theorem. ***Suggested Reading:*** *IC engine Indicator diagram and problems associated MEP, IP, BP. Solving SFEE applications using Matlab©*	**CO-1 BTL-3**
MODULE 2: IC ENGINES	**9**
Air standard cycles: Otto, diesel and dual cycles and comparison of efficiency - Working Principle of four stroke and two stroke engines - Working principle of spark ignition and compression ignition engines - Application of IC engines. ***Suggested Reading:*** *Simulation of Otto, Diesel and Dual cycles using Matlab©.*	**CO-2 BTL-3**
MODULE 3: STEAM BOILERS AND TURBINES	**9**
Formation of steam - Properties of steam – Use of steam tables and charts – Steam power cycle(Rankine) - Modern features of high-pressure boilers – Mountings and accessories – Testing ofboilers. Steam turbines: Impulse and reaction principle – Velocity diagrams – Compounding and governing methods of steam turbines (qualitative treatment only) - Layout and working principle of a steam power plant. ***Suggested Reading:*** *Case studies on thermal power plants*	**CO-3 BTL-3**
MODULE 4: COMPRESSORS	**9**
Positive displacement compressors – Reciprocating compressors – Indicated power – Clearance volume – Various efficiencies – Clearance ratio - Volume rate - Conditions for perfect and imperfect intercooling - Rotary positive displacement compressors – Construction and working principle of centrifugal and axial flow compressors. ***Suggested Reading****: Compressor selection for different pressure and flow rate in practical applications.*	**CO-4 BTL-3**
MODULE 5: REFRIGERATION AND AIR CONDITIONING	**9**
Modes of heat transfer, Refrigeration - Various methods of producing refrigerating effects (RE) – Vapour compression cycle: P-H and T-S diagram - Saturation cycles - Effect of subcooling and super heating - (qualitative treatment only) - Airconditioning systems – Basic psychrometry - Simple psychrometric processes - Types of air conditioning systems -Selection criteria for a particular application (qualitative treatment only). Cooling of electronic components, Thermoelectric cooling, Chip cooling. ***Suggested Reading:*** *Thermal Load calculation in building and HVAC.*	**CO-5 BTL-3**
TEXT BOOKS	

1	Cengel & Boles. (2017), Thermodynamics: an Engineering Approach, McGraw Hill, 8th Edition.
2	Nag, P.K., Engineering Thermodynamics, Tata McGraw-Hill Publishing Company, 6th Edition.
3	S.Domkundwar, C.P.Kothandaraman & A.V.Domkundwar, (2015), Thermal Engineering, Dhanpat Rai & Co.
REFERENCE BOOKS	
1	Rao, Y.V.C.,(2003), Thermodynamics, Wiley Eastern Ltd.,New Delhi, 4th Edition.
2	Moran and Shapairo, (2015), Principles of Engineering Thermodynamics, Wiley, 8th Edition.
3	Rajput R K ,(2016),"A text book of Engineering Thermodynamics", S. Chand publishers.
4	Stephen J Chapman, (2012), Matlab programing for Engineers, Cengage publishers, 4th edition.
E BOOKS	
1	http://engineeringstudymaterial.net/ebook/schaum-outline-of-thermodynamics-forengineers/
2	http://engineeringstudymaterial.net/ebook/basics-and-applied-thermodynamics/
3	https://books.google.co.in/books?id=YLNGv0bVay0C&dq=thermal+engineering
4	https://books.google.co.in/books/about/Thermal_Engineering.html?id=65gxCX2dC84C
MOOC	
1	http://www.nptelvideos.com/mechanical/
2	http://nptel.ac.in/courses/112106133/
3	http://nptel.ac.in/courses/112103016/
4	http://nptel.ac.in/courses/112106133/

COURSE TITLE	**POWER DEVELOPING MACHINES FOR TRANSPORTATION SECTOR**			**CREDITS**	**3**
COURSE CODE	**MED4282**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course is intended to provide the knowledge on different types of power developing engines for transports like roadways, airways and waterways. The students will able gain knowledge on heavy and medium vehicle engine, aircraft engines and marine engine in detail.				
Course Objective	1. To understand the various aspects of power development in engines 2. To understand the construction and working of road transport engines 3. To understand various types aircraft engine and its basic components				

	4. To understand the various marine engine components 5. To understand the concept of trouble shooting and inspection of transportation engine
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of principle and operation of 2 and 4 stroke engine. 2. Demonstrate the constructional features and principles of road transport engine. 3. Identify various types of aircraft engine and operation. 4. Identify and apply various operational systems of marine engine. 5. Demonstrate the measurement, inspection and troubleshooting method of power developing engines.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	2	-	-	2	-	2	-	-	1	2	-	-
CO-2	3	-	-	-	-	1-	-	2	2	1	-	1	-	-
CO-3	2	1	1	2	-	2	-	1	3	3	2	1	-	-
CO-4	3	-	-	2	-	-	-	-	-	-	1	-	-	-
CO-5	1	-	1	-	1	2	-	1	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Introduction	**9**
Compression ignition and Spark ignition engine, Two stroke and Four Stroke cycle - Timing diagram for 2 and 4 stroke engine, Otto, diesel and dual cycle operation, Deviation from ideal condition in actual engine. ***Suggested Reading:*** *IC engine, Types, Engine Cycles.*	**CO-1** **BTL-3**
MODULE 2: Road transport engine and Components	**9**
Engine Classification, Constructional details of SI and CI engine, Two stroke SI and CI engine – Construction and working, Firing order, Air fuel ration requirements, Carburetion, Fuel injection for CI engine, Need for governor in CI engine, Direct and In-direct combustion chamber for CI engine ***Suggested Reading:*** *Engine construction, Construction and working of SI and CI engine, Fuelling of engine, Combustion chamber.*	**CO-2** **BTL-3**
MODULE 3: Aircraft engine and components	**9**
Types of aircraft engines – Principle of operation – Function of components – Material used – Details of starting the engine – Details of carburetion and injection system for small and large engines – Ignition system components – spark plug details – Engine operation condition at various altitudes. ***Suggested Reading:*** *Aero engines, Operation, engine material, fuelling and ignition, Altitude operations.*	**CO-3** **BTL-3**
MODULE 4: Marine Engine and components	**9**

Comparative study of Slow, medium and high speed marine diesel engine, V-type engine details – Construction and operation, Main propulsion diesel engine, Marine engine starting and reversing system, Safety provisions – Engine slowdown and shutdown – Restoration of operation. ***Suggested Reading**: Slow, medium and high speed engine, marine propulsion, engine starting and slowdown procedures.*	**CO-4** **BTL-3**
MODULE 5: Measurement, Inspection and Trouble-shooting	**9**
Automotive engines Measurement of friction, Cylinder pressure measurement. Engine performance maps, Engine testing standards Aero engines Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting – Inspection of all engine components. Marine engines trouble shooting related to various types of marine diesel engines and condition monitoring – causes, effects, remedies and prevention of engine not turning on Air and Fuel, knocking at TDC and BDC, black smoke in funnel, poor compression and combustion. ***Suggested Reading:** Auto-engine, Marine engine and Aircraft engine- Inspection and trouble-shooting.*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Vikram Gokhale & N.Nanda, (2002),” Marine Engineering Practice and Ship safety and Environmental protection”, Engee Enterprises Mumbai, 3rd Edition.
2	V.Ganesan, (2007), “Internal Combustion Engine” Tata McGrawHill.
REFERENCE BOOKS	
1	Mathur and Sharma, (2002),"Fundamental Combustion Engines" Dhanpat Rai and Sons.
E BOOKS	
1	https://books.google.co.in/books/about/Advanced_Automobile_Engine_Performance.html
2	https://books.google.co.in/books/about/Automotive_Engines.html
3	https://books.google.co.in/books/about/Marine_diesel_engines.html
4	https://books.google.co.in/books/about/The_Development_of_Jet_and_Turbine_Aero.html
MOOC	
1	https://nptel.ac.in/courses/112104033/
2	https://nptel.ac.in/courses/112104033/15
3	https://nptel.ac.in/courses/101101001/28
4	https://nptel.ac.in/courses/112104033/31
5	http://nptel.ac.in/courses/112106141/
6	http://nptel.ac.in/courses/105105108/

COURSE TITLE	**MODERN MANUFACTURING TECHNIQUES**			**CREDITS**	**3**
COURSE CODE	**MED4283**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course is intended to expose the students in the art of manufacturing new products due to the development of new materials and processes. The students will totally get a feel of the relevant suitable process while evaluating and deciding.
Course Objective	1. To make the students aware of the various alternative manufacturing processes available. 2. To develop an altitude to look for the unconventional manufacturing process to machine 3. To make them to understand and appreciate the latest manufacturing process for micro fabrication and devices.
Course Outcome	Upon completion of this course, the students will be able to 1. Identify a suitable non thermal energy based machining processes for applications 2. Demonstrate the thermal energy based machining processes for applications 3. Identify and calculate the various process parameters for advanced unconventional machining processes. 4. Select and apply the in various micro devices fabrication processes.. 5. Describe the various modern micro fabrication techniques in detail.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	2	1	-	1	2	2	2	-	-	-	-	-	-
CO-2	2	2	-	1	2	-	1	-	1	-	-	-	-	-
CO-3	2	-	-	2	2	-	-	1	-	2	-	2	-	-
CO-4	-	2	1	-	2	-	1	-	-	1	-	2	-	-
CO-5	2	2	-	-	2	-	-	1	-	1	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: MACHINING PROCESSES – I	**9**
(Non thermal energy) – Abrasive machining – water jet machining - ultrasonic machining – chemical machining – electro chemical machining – construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications.	**CO-1** **BTL-3**
MODULE 2: MACHINING PROCESS – II	**9**

Wire cut EDM - Electro chemical machining – ECG - Electric discharge machining – construction – principle – types – control - circuits – tool design – merits, demerits & applications.	**CO-2 BTL-3**
MODULE 3: MACHINING PROCESS – III	**9**
Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.	**CO-3 BTL-3**
MODULE 4: FABRICATION OF MICRO DEVICES	**9**
Semiconductors – films and film depurification – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process – Solid free form fabrication.	**CO-4 BTL-3**
MODULE 5: MICROFABRICATION TECHNOLOGY	**9**
Wafer preparation – monolithic processing – moulding – PCB board hybrid & mcm technology – programmable devices & ASIC – electronic material and processing– steriolithography SAW devices and Surface Mount Technology.	**CO-5 BTL-3**

TEXT BOOKS	
1	Serope kelpekijian & stevan R. schmid, (2009), Manufacturing process Engg material, Pearson Publishers, 5th Edition.
REFERENCE BOOKS	
1	Julian W.Gardner, (2002), Micro senors Mems & smart devices.
E BOOKS	
1	www.iste.co.uk/data/doc_ayupatunrlmy.pdf
2	https://lecturenotes.in/subject/570/unconventional-machining-process-ump
3	https://trove.nla.gov.au/nbdid/1727915
4	https://www.panacheehasselt.be › modern machining process by v k jain
MOOC	
1	https://nptel.ac.in/courses/112107078/
2	https://nptel.ac.in/courses/112104162/
3	https://nptel.ac.in/courses/112107077/
4	https://nptel.ac.in/courses/112104028/
5	https://vyujacmulan.cf/1007723408790.php

COURSE TITLE	**CNC MACHINES AND CONTROLS**			**CREDITS**	**3**
COURSE CODE	**MED4292**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**

	Assessment				
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to different types of machining methods adopted recently with the present technologies which provides lesser manufacturing lead-time and accuracy to the components. Therefore studying the fundamentals, construction details and other controls are very much essential for the Mechatronics engineering students
Course Objective	1. To learn the fundamentals of CNC machines. 2. To understand the constructional features of CNC machines and Retrofitting. 3. To learn the concepts of control systems, Feedback devices and tooling. 4. To understand the CNC part programming 5. To learn about the economics and maintenance of CNC machines
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the fundamentals of CNC machines. 2. Demonstrate the concepts of constructional features of CNC machines.. 3. Identify the different controls, Feedback devices, tooling and their selection. 4. Develop the CNC part programming for different profiles 5. Develop the procedure for maintenance of CNC machines.

Prerequisites: Manufacturing Technology

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	2	2	-	-	-	-	-	-	1	-	-	-
CO-2	1	2	2	-	2	-	-	-	-	1	-	-	-	-
CO-3	1	-	2	1	-	-	1	-	-	-	-	-	-	-
CO-4	1	1	-	-	2	-	-	-	-	1	1	2	-	-
CO-5	1	-	2	-	1	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNDAMENTALS OF CNC MACHINES	**9**
Introduction to Computer Numerical Control: CNC Systems – An Overview of Fundamental aspects of machine control, Different types of CNC machines – Advantages and disadvantages of CNC machines. *Suggested Reading: working principle of lathe machine, milling machine*	**CO-1** **BTL-3**
MODULE 2:CONSTRUCTIONAL FEATURES OF CNC MACHINES AND RETROFITTING	**10**

Features of CNC Machines: Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axes motors. Timing belts and pulleys, Spindle bearing – Arrangement and installation. Slide ways. Re - circulating ball screws – Backlash measurement and compensation, linear motion guide ways. Tool magazines, ATC, APC, Chip conveyors. Retrofitting of Conventional Machine Tools: Modification to be carried out on conventional machines for retrofitting *Suggested Reading: hydraulic power system, pneumatic power system, bearing types*	**CO-2** **BTL-3**
MODULE 3:CONTROL SYSTEMS, FEED BACK DEVICES AND TOOLING	**10**
Description of a simple CNC control system. Interpolation systems. Features available in a CNC system – introduction to some widely used CNC control systems. Types of measuring systems in CNC machines – Incremental and absolute rotary encoders, linear scale – resolver – Linear inductosyn – Magnetic Sensors for Spindle Orientation. Qualified and pre-set tooling – Principles of location – Principles of clamping – Work holding devices. *Suggested Reading: sensors classification, types of control system*	**CO-3** **BTL-3**
MODULE 4: CNC PART PROGRAMMING	**9**
Part Program Terminology-G and M Codes – Types of interpolation Methods of CNC part programming – Manual part programming – Computer Assisted part programming – APT language – CNC part programming using CAD/CAM-Introduction to Computer Automated Part Programming. *Suggested Reading: CNC codes in Matlab environment*	**CO-4** **BTL-3**
MODULE 5: ECONOMICS AND MAINTENANCE	**7**
Factors influencing selection of CNC Machines – Cost of operation of CNC Machines – Practical aspects of introducing CNC machines in industries – Maintenance features of CNC Machines – Preventive Maintenance, Other maintenance requirements. *Suggested Reading: classification of cost, types of maintenance*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Yoram Koren, (2005), "Computer Control of Manufacturing Systems", Tata McGraw-Hill Education,.
2	Graham T. Smith, (2013), "CNC Machining Technology", Springer Science & Business Media,.
3	Hans B. Kief, Helmut A. Roschiwal,(2012), "CNC Handbook", McGraw Hill Professional,.
4	Alan Overby, (2010) "CNC Machining Handbook: Building, Programming, and Implementation", McGraw Hill Professional,
REFERENCE BOOKS	
1	Roland Nathan Kalonji, (2018), "CNC Milling Programming. Linear & Circular interpolations for a workpiece", GR,IN Verlag,.
2	S. K Sinha, (2010), "CNC Programming using Fanuc", McGraw Hill Professional,.
3	James Floyd Kelly, Patrick Hood-Daniel, (2010), "Build Your Own CNC Machine", A press,
4	Marcus Bowman, (2013), "CNC Milling in the Workshop", Crowood,.
5	Peter Smid, (2010), "CNC Control Setup for Milling and Turning: Mastering CNC Control Systems", Industrial Press Inc.

E BOOKS	
1	https://books.google.co.in/books?isbn=1418060992- Mike Mattson
2	https://books.google.co.in/books?isbn=3668155267- Krupal Pawar
3	https://books.google.co.in/books?isbn=1447120515- T. Smith
4	https://books.google.co.in/books?isbn=1848003366- Suk-Hwan Suh
MOOC	
1	https://www.mooc-list.com/course/advanced-machine-learning-futurelearn
2	https://nptel.ac.in/courses/112103174/
3	https://nptel.ac.in/courses/112102103/
4	https://nptel.ac.in/courses/112105211/
5	https://nptel.ac.in/courses/108105062/23
6	https://swayam.gov.in/

SEMESTER –IV

COURSE TITLE	UNCONVENTIONAL MACHINING PROCESSES			CREDITS	3
COURSE CODE	MED4291	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the student in various unconventional machining processes
Course Objective	1. To learn the course will impart a good perspective with adequate depth to understand the unconventional machining processes 2. To learn relative advantages over conventional machining techniques.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the working principle of various Unconventional Machining Processes. 2. Compare the relative advantages over conventional techniques and their applications 3. Demonstrate mechanical energy based machining processes 4. Identify electrical energy based machining processes 5. Describe thermal and chemical energy based machining processes

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	2	2	1	-	2	-	-	-	1	-	-	-
CO-2	1	1	1	-	2	-	-	2	-	1	1	-	-	-
CO-3	2	-	2	2	-	-	1	-	-	-	2	-	-	-
CO-4	1	1	2	-	2	-	-	-	-	1	1	2	-	-
CO-5	1	-	2	2	1	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	5
Unconventional machining Process - Need - clarification - Brief overview of all techniques. ***Suggested Reading:*** *need and overview of techniques*	**CO-1** **BTL-3**

MODULE 2: MECHANICAL ENERGY BASED PROCESSES	**10**
Abrasive Jet Machining - Water Jet Machining - Ultrasonic Machining. (AJM, WJM and USM). Working Principles - equipment used - Applications. ***Suggested Reading:*** *AJM, WJM and USM*	**CO-2 BTL-3**
MODULE 3: ELECTRICAL ENERGY BASED PROCESSES	**8**
Electric Discharge Machining (EDM)- working Principles-equipment-Process Parameters- MRR electrode Tool - Power Circuits- Dielectric - Flushing - Wire cut EDM - Applications. ***Suggested Reading:*** Wire cut EDM	**CO-3 BTL-3**
MODULE 4: CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES	**12**
Chemical Machining and Electro-Chemical Machining (CHM and ECM)-Etchants-maskant techniques of applying maskants-Process Parameters, Principles of ECM - equipment Electrical circuit - Process Parameters-ECG and ECH Applications. ***Suggested Reading****: ECM*	**CO-4 BTL-3**
MODULE 5: THERMAL ENERGY BASED PROCESSES	**10**
Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles-Equipment-Types-Beam control techniques - Applications. ***Suggested Reading:*** *LASER and PLASMA*	**CO-5 BTL-3**

TEXT BOOKS	
1	Vijay.K. Jain , (2002), Advanced Machining Processes , Allied Publishers Pvt. Ltd., New Delhi. ISBN 81-7764-294-4.
REFERENCE BOOKS	
1	Pandey P.C. and Shan H.S. (2007), Modern Machining Processes Tata McGraw-Hill, New Delhi.
2	McGeough, Chapman and Halls, (2014), Advanced Machining Methods, UK.
3	Abdel, H. and El-Hofy, G.(2005), "Advanced Machining Processes", McGraw-Hill, USA.
E BOOKS	
1	https://b-ok.cc/book/870376/8a764a
2	https://b-ok.cc/book/2467740/6c8b50
MOOC	
1	http://nptel.ac.in/courses/112105126/36
2	http://nptel.ac.in/courses/112105126/39
3	http://nptel.ac.in/courses/112105127/

COURSE TITLE	**COMPUTER WORKSTATION ERGONOMICS**			**CREDITS**	**3**
COURSE CODE	**MED4293**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course introduce the basic concepts of Ergonomics and the development of Ergonomics and train students to perceive human body as a mechanical structure using human biomechanics
Course Objective	1. To introduce methods of measuring mental workload and to manage occupational stress and strain 2. To provide guidelines based on ergonomics principles for designing computer (office) workstation 3. To expose students to the problems faced by children, women, elders and the disabled for designing computer workstation for the special population
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic concepts of Ergonomics and the development of Ergonomics. 2. Describe the human body as a mechanical structure using human biomechanics. 3. Explore the various methods of measuring mental workload and to manage occupational stress and strain 4. Illustrate guidelines based on ergonomics principles for designing workspaces. 5. Describe the problems faced by special populations such as women, children, elders and the disabled for designing various workspaces.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	-	-	-	2	2	2	1	1	1	-	-	-	-
CO-2	1	-	1	1	2	-	-	-	-	-	-	-	-	-
CO-3	3	-	-	-	2	2	2	-	1	1	-	-	-	-
CO-4	-	-	1	1	-	-	-	-	-	-	-	-	-	-
CO-5	3	-	-	-	-	2	2	-	1	1	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

Module 1: INTRODUCTION TO ERGONOMICS	**7**
The Development of Ergonomics – Evolution of Disciplines, Directions in Europe, Directions in North America; Names for the Discipline ("Ergonomics" and "Human Factors"); The Ergonomic Knowledge Base – Professional Organizations, Sources of Ergonomic Information; Various Workspace Applications of Ergonomics ***Suggested Reading**: Study examples of poor ergonomic designs.*	**CO-1** **BTL-3**
Module 2: ANATOMICAL & MECHANICAL STRUCTURE OF THE HUMAN BODY	**10**

Human Biomechanics – The Musculoskeletal System, Biomechanical Description of the Body, Human Strength, Assessment of Human Strength; Anthropology and Anthropometry, Measurement Techniques, Available Anthropometric Information; "Fitting" Design procedures. ***Suggested Reading**: Study the different types of human movements.*	**CO-2** **BTL-3**
Module 3: HOW THE MIND WORKS	**10**
The "Traditional" and the "Ecological" Concepts; Organization of the Nervous system, Responding to Stimuli; Mental Workload, "Stress" on Individuals and Crews, Strain Experienced by an Individual, Strain Experienced by Confined groups; Enhancing Performance – General Findings, Specific Findings, Enhancing Teamwork ***Suggested Reading:** Study the factors affecting human cognition.*	**CO-3** **BTL-3**
Module 4: THE OFFICE (COMPUTER) WORK STATION	**10**
Theories of Healthy Sitting – Ergonomic Design of the Office Workstation: Designing the Visual Interface – Designing the Sit-Down Workstation. Design Principles: Environment – Design for Change –Furniture –Designing the stand-up workstation – Data Entry Devices – Display Screen – Job Content and Work Organization – Changes through Technological Developments. Improving the body posture: Exercises, methods for correcting postures and Training.	**CO-4** **BTL-3**
Module 5: DESIGNING FOR SPECIAL POPULATIONS	**8**
Special Designs for Women and Men; Designing for Pregnant Women; Designing for Children; Designing for the Aging – Anthropometry; Changes in Biomechanics; Designing for the Aging Vision; Ergonomic Design for Disabled Persons; Ergonomic means to Enable the Disabled. ***Suggested Reading**: Study the various mental and physical conditions that are or are not classified as disabilities by the Government of India*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Karl Kroemer, Henrike Kroemer, Katrin Kroemer-Elbert,(2001), ERGONOMICS - How to Design for Ease & Efficiency, Prentice Hall International Editions.
REFERENCE BOOKS	
1	McCormick, E.J., and Sanders, (2011): Human Factors in Engineering and Design, McGraw-Hill, New York.
E BOOKS	
1	https://uhs.berkeley.edu/sites/default/files/compworkstation_designguidelines.pdf
2	http://ergo.human.cornell.edu/ergodesignguide.htm
MOOC	
1	https://www.mooc-list.com/course/70167012x-human-factors-and-culture-design-edx

COURSE TITLE	**ENERGY AND SAFETY ASPECTS OF MECHANICAL SYSTEM FOR BUILDINGS**			**CREDITS**	**3**
COURSE CODE	**MED4294**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**

Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	The course is intended to impart knowledge on energy conservation and efficiency aspects from mechanical engineering machinery applications. Refrigeration and air conditioning which consumes nearly 40 percent of total power in buildings and fire safety are dealt in detail (only qualitative treatment only)				
Course Objective	1. To understand the various aspects of energy and its conservation. 2. To understand the governing principles of refrigeration and air conditioning. 3. To understand various types of HVAC systems. 4. To understand the application of various types of HVAC systems. 5. To understand the fire safety systems				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate their understanding of Energy sources, its distribution and its conservation 2. Demonstrate the refrigeration cycles and indoor air requirements 3. Identify various air conditioning systems for the required applications. 4. Identify and apply various types of HVAC systems. 5. Demonstrate their understanding of firefighting devices and apply it for different classes of fire.				
Prerequisites: Nil					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	-	3	-	2	2	-	1	1	2	-	-	-
CO-2	1	-	-	3	3	2	2	-	1	-	-	1	-	-
CO-3	1	2	-	2	-	1	2	-	1	2	-	-	-	-
CO-4	-	2	-	3	-	-	-	-	2	1	1	1	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	1	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: HISTORY AND GROWTH OF ENERGY UTILISATION 9

Sources of energy, Energy demand and supply, Load curves of residential and commercial buildings, Energy auditing in buildings, Identifying avenues for Energy conservation, Conservation through periodic maintenance. High performance insulation, Day lighting and harnessing solar energy. Economic analysis. ***Suggested Reading:*** *Renewable and Non-renewable energy sources-power generation methods-Rankine cycle-Various Solar thermal collectors*	**CO-1** **BTL-3**
MODULE 2: BASIC PRINCIPLES OF REFRIGERATION AND AIR CONDITIONING	**9**
Reversed Carnot cycle, refrigerants and Eco friendly refrigerants, tonne of refrigeration, COP, vapor compression refrigeration cycles, vapor absorption refrigeration cycles, Geothermal air conditioning, Maisotsenko cycle, Kalina cycle. Psychrometric processes, Infiltration and indoor air quality. ***Suggested Reading:*** *Role of NH_3-H_2O & H_2O-LiBr vapour absorption systems in solar air conditioning*	**CO-2** **BTL-3**
MODULE 3: RECENT ADVANCES IN HVAC SYSTEMS	**9**
Air conditioning systems for various types of buildings: Window air conditioning, Split air conditioning, unitary air conditioning, Packed air conditioning, Centralized systems: single zone and multi zone systems. Economizer cycle, and Heat pumps. HVAC systems: Predictive and Preventive maintenance. Energy conservation through periodic maintenance of HVAC systems. ***Suggested Reading:*** *Various type of air handling devices, compressors and condenses used in HVAC-designing HVAC circuits for buildings.*	**CO-3** **BTL-3**
MODULE 4: EMERGING TRENDS IN ENERGY CONSERVATION AND MANAGEMENT	**9**
Thermal modelling, Star ratings - Energy efficient refrigerators and air conditioners, Energy efficient ventilation of large enclosures, Energy efficiency in domestic buildings, school and college environments, Hospital buildings, auditoriums theaters and malls. ***Suggested Reading****: Green buildings.*	**CO-4** **BTL-3**
MODULE 5: FIRE SAFETY AND CASE STUDIES	**9**
Fire triangle, fire classification and extinguishers, Cause of fire in buildings, Fire, smoke and heat Detectors – fire alarm Systems –Manual and Automatic Sprinklers - Fire Drills - Dry and Wet Risers, Fire protection of single and Multi-storied Building. Methods of handling the physically challenged and the elderly people during emergency. Energy conservation methods in fire fighting equipment. ***Suggested Reading:*** *Designing of fire safety circuits for buildings*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Tom Dontigny,(2006), An Introduction to Building Mechanical Systems, Author house publications, , ISBN-10: 142594857X, ISBN-13: 978-1425948573.
2	Khurmi and Gupta, (2015), Refrigeration and air conditioning - S. Chand publisher.
REFERENCE BOOKS	
1	P.N. Ananthanarayanan, (2013), Basic refrigeration and air conditioning, TMH.
2	ASHRAE (2015), Hand book – HVAC Systems & Equipment, HVAC Applications.
3	Grandzik, (2011), Air conditioning System Design Manual, Elsevier Publications, Second edition, , ISBN-10: 938093128X, ISBN-13: 978-9380931289.

4	Albert Thumann and Scott Dunning, (2011), Plant Engineers & Managers Guide to Energy Conservation, The Fairmont Press, 10th Edition.
5	Dale R. Patrick, Stephen W. Fardo, Ray E. Richardson, (2007), Energy Conservation Guidebook, Fairmont Press; 2nd Edition, , ISBN-10: 0849391784 ISBN-13: 978-0849391781
6	Joel Levitt, (2009), Handbook of Maintenance Management, Industrial Press Inc.,U.S.; 2nd edition, , ISBN-10: 0831133899 and ISBN-13: 978-0831133894
E BOOKS	
1	https://books.google.co.in/books?isbn=178262578X-*Gopal Nath Tiwari*
2	https://books.google.co.in/books?isbn=0080984576-A. A. M. Sayigh
3	https://books.google.co.in/books?isbn=3319110470 - Javad Khaza
MOOC	
1	https://nptel.ac.in/courses/112104225/22
2	https://nptel.ac.in/courses/105102175/
3	https://nptel.ac.in/courses/112105221/
4	https://nptel.ac.in/downloads/112105129/

SEMESTER – V

COURSE TITLE	MECHANICAL MEASUREMENTS			CREDITS	3
COURSE CODE	MED4381	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course is intended to provide the knowledge on different types advanced metrological devices available to measure the dimension of the components and the correct procedure to be adopted to measure the dimension of the component.				
Course Objective	1. To understand about the fundamentals of General Measurement system & Errors in Measurement 2. To understand the Surface Metrology Concepts and terminology 3. To understand the Basics of Optical Interference and Interferometry Optoelectronic measurements 4. To understand the contact measuring devices and method of measurements. 5. To understand the working principle and various non-contact measuring devices.				

Course Outcome	Upon completion of this course, the students will be able to 1. Illustrate basics of principle and operation metrological devices. 2. Demonstrate the different measurement technologies. 3. Identify various types of measurement technologies used in industries. 4. Identify and apply the various contact and non-contact measuring device in industrial sector. 5. Measure the various frequently used parameters such as temperature, pressure, force and etc.,

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	3	2	-	2	-	-	-	-	-	1	1	-	-
CO-2	1	2	1	2	1	-	-	1	-	1	-	-	-	-
CO-3	2	2	2	1	-	-	1	-	-	-	-	-	-	-
CO-4	2	1	-	-	1	-	-	-	-	1	1	1	-	-
CO-5	1	-	2	1	1	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: STANDARDS OF MEASUREMENT	**9**
Definition and Objectives of metrology, Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, Slip gauges, Wringing phenomena, Indian Standards , Numerical problems on building of slip gauges. Comparators: Introduction to Comparator, mechanical comparators - Johnson Mikrokator, Sigma Comparator, dial indicator, Optical Comparators -principles, Zeiss ultra optimeter, Electric and Electronic Comparators -principles, LVDT, Pneumatic Comparators - Principles, Solex Comparator. ***Suggested Reading:*** Characteristics and classification of comparators	**CO-1** **BTL-3**
MODULE 2: SYSTEM OF LIMITS, FITS, TOLERANCES AND GAUSING	**9**
Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963), geometrical tolerances, positional tolerances, hole basis system, shaft basis system, classification of gauges, brief concept of design of gauges -Taylor's principles, Design of 'Go' and 'No Go' gauges, Wear allowance on gauges. ***Suggested Reading:*** Types of gauges -plain plug gauge, ring gauge, snap gauge, limit gauge, gauge materials.	**CO-2** **BTL-3**
MODULE 3: ANGULAR MEASUREMENTS	**9**

Bevel Protractor, Sine Principle and use of Sine bar, Sine center, use of angle gauges, numericals on building of angles. Screw thread & gear measurement Terminology of screw threads, measurement of major diameter, minor diameter pitch, angle. Measurement of effective diameter by 2-wire and 3-wire methods, Best size wire. Toolmakers microscope, gear terminology, use of gear tooth Vernier caliper ***Suggested Reading:*** Principles of Interferometry: Interferometer, autocollimator, Optical flats	**CO-3** **BTL-3**
MODULE 4: MEASUREMENTS AND MEASUREMENT SYSTEM	**9**
Definition, Significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-times delay. Transducers, Intermediate modifying and terminating devices: Transfer efficiency, Primary and Secondary transducers, electrical, Mechanical, electronic transducers, advantages of each type transducers. Mechanical systems, inherent problems, Electrical intermediate modifying devices. Terminating devices, Mechanical Oscillographs, X-Y Plotters. ***Suggested Reading****:* Errors in Measurements, Classification of Errors.	**CO-4** **BTL-3**
MODULE 5: MEASUREMENT OF FORCE, TORQUE, PRESSURE AND TEMPERTURE	**9**
Principle, platform balance, proving ring, Torque measurement, Prony brake, hydraulic dynamometers. Pressure Measurements Principle, use of elastic members, McLeod gauge, Pirani Gauge. Bridgeman gauge. Temperature and strain measurement: Resistance thermometers, thermo-couple, laws of thermocouple materials used for construction, pyrometer, Optical Pyrometer. Strain Measurements- Strain gauge, gauge factor. ***Suggested Reading:*** Methods of strain measurement	**CO-5** **BTL-3**

TEXT BOOKS	
1	Beckwith Marangoni and Lienhard, (2006), “Mechanical measurements”, Pearson Education, 6 th Edition.
2	N. V. Raghavendra, (2013), “Engineering Metrology and Measurements” Oxford University Press,.
REFERENCE BOOKS	
1	I. C. Gupta, “Engineering Metrology”, Dhanpat Rai Publications, Delhi.
2	Ernen O Dobeblein , Measurements Systems, Applications & Design, 5th edition.
3	R. S. Shrohi & H. C. Radhakrishna, Mechanical Measurements, New Age Intl. Pvt Ltd., 3rd Edition.
E BOOKS	
1	https://global.oup.com/academic/product/engineering-metrology-and-measurements-9780198085492?cc=in&lang=en& N.V Raghavendra, Oxford University Press, 2013.
MOOC	
1	https://onlinecourses.nptel.ac.in/noc18_me62/preview

2	https://www.qimtonline.com/course/index.php?categoryid=84
3	http://www.npl.co.uk/commercial-services/products-and-services/training/e-learning/introduction-to-metrology/

COURSE TITLE	FUNDAMENTALS OF COMPUTER INTEGRATED MANUFACTURING			CREDITS	3
COURSE CODE	MED4382	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	To impart knowledge on how computers are integrated at various levels of planning and manufacturing.				
Course Objective	1. To introduce the flexible manufacturing system and 2. To handle the product data and various software used for manufacturing 3. To understand Computer Aided Process Planning.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the fundamentals of CIM 2. Describe concepts of group technology and computer aided process planning. 3. Differentiate Shop floor controls and components of FMS. 4. Develop the CIM architecture 5. Develop the knowledge in CIM databases.				
Prerequisites: Nil					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	1	2	1	-	-	-	-	-	-	1	-	-	-
CO-2	1	2	1	-	1	-	-	-	-	1	-	-	-	-
CO-3	1	-	1	1	-	-	1	-	-	-	-	-	-	-
CO-4	2	1	-	-	1	-	-	-	-	1	1	1	-	-
CO-5	1	-	2	-	1	-	2	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION 8

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - Islands of automation and software-Dedicated and open systems-Manufacturing automation protocol - Product related activities of a company-Marketing engineering. *Suggested Reading: Manufacturing Technology*	**CO-1** **BTL-3**
MODULE 2: GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING	**10**
History of group technology- Role of G.T. in CAD/CAM integration - Part families - Classification and coding - DCLASS and MICLASS and OPITZ coding systems-Facility design using G.T. -benefits of G.T. - Cellular manufacturing *Suggested Reading: Industrial process planning types*	**CO-2** **BTL-3**
MODULE 3: SHOP FLOOR CONTROL AND INTRODUCTION OF FMS	**9**
Shop floor control-phases - Factory data collection system -Automatic identification methods - Bar code technology-Automated data collection system. FMS-components of FMS - types -FMS workstation -Material handling and storage systems *Suggested Reading: Types of production process*	**CO-3** **BTL-3**
MODULE 4: CIM IMPLEMENTATION AND DATA COMMUNICATION	**10**
CIM and company strategy - System modelling tools -IDEF models - Activity cycle diagram - CIM open system architecture (CIMOSA)- Manufacturing enterprise wheel-CIM architecture - Product data management-CIM implementation software. *Suggested Reading: lifecycle management of products*	**CO-4** **BTL-3**
MODULE 5: OPEN SYSTEM AND DATABASE FOR CIM	**8**
Open systems-Open system inter connection - Manufacturing automations protocol and technical office protocol (MAP /TOP) - Development of databases -Database terminology *Suggested Reading: Application of CIM database in various industries*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Mikell.P.Groover, (2008), "Automation, Production Systems and computer integrated manufacturing" , Pearson Education, New Delhi.
2	V.D. Hunt, (2012), "Computer-Integrated Manufacturing Handbook", Springer Science & Business Media.
3	Kiyoji Asai, Gunduz Ulusoy, (2012), "Computer Integrated Manufacturing: Current Status and Challenges", Springer Science & Business Media.
REFERENCE BOOKS	
1	V. Sandoval," (2016), Computer Integrated Manufacturing (CIM) in Japan", Elsevier.
2	Chris Fill, Graham Hughes, (2013), "CIM Course book Marketing Communications", Routledge,
E BOOKS	
1	https://books.google.co.in/books?isbn=1506302920- Jeffrey K. Pinto
2	https://books.google.co.in/books?isbn=1483163415- Alan Weatherall
3	https://books.google.co.in/books?isbn=3642789889- Wilhelm Scheer
4	https://books.google.co.in/books?isbn=3642790348- Klaus H. Ecker
MOOC	

1	https://www.mooc-list.com/categories/CIM management
2	https://nptel.ac.in/courses/112102101/
3	https://nptel.ac.in/courses/112103174/
4	https://nptel.ac.in/courses/112104031/
5	https://nptel.ac.in/courses/112102011/
6	https://swayam.gov.in/

COURSE TITLE	FUNDAMENTALS OF ENGINEERING DESIGN			CREDITS	3
COURSE CODE	MED4383	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	To impart knowledge on the various design procedures involved in engineering				
Course Objective	1. To impart the importance of design in today's context of global competition, environmental awareness and customer oriented market. 2. To impart the basic concepts and various aspects of design using simple examples and case studies.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the aspects of need for design, design process, materials and processes used for designing various components. 2. Design creative components and legal, human and marketing factors during the design of products. 3. Handle tools for improving quality, reliability and performance of a product. 4. Self-assured of the technique to promote innovative and successful designs. 5. Calculate the reliability factor for their designed products.				
Prerequisites: Nil					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	2	3	-	2	-	1	2	-	2	2	-	2	-	-
CO-2	1	-	2	1	3	1	1	-	1	-	1	-	-	-
CO-3	1	-	-	1	-	2	1	-	1	1	2	-	-	-
CO-4	2	3	1	2	-	-	-	-	-	1	-	1	-	-

CO-5	**1**	**2**	**-**	**1**	**3**	**2**	**1**	**-**	**1**	**2**	**1**	**-**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DESIGN FUNDAMENTALS	**9**
Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering – Designing to codes and standards – Concurrent Engineering	**CO-1** **BTL-3**
MODULE 2: CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS	**9**
Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics. Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts	**CO-2** **BTL-3**
MODULE3: DESIGN METHODS	**8**
Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving (TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods, Embodiment Design-Product Architecture-Configuration Design- Parametric Design	**CO-3** **BTL-3**
MODULE 4: MATERIAL SELECTION PROCESSING AND DESIGN	**9**
Material Selection Process – Economics – Cost Vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly –Designing for castings	**CO-4** **BTL-3**
MODULE 5: PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY	**9**
Probability – Distributions – Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability	**CO-5** **BTL-3**

TEXT BOOKS	
1	Dieter, George E.,(2000), "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore.
REFERENCE BOOKS	
1	Pahl, G, Beitz, W, Feldhusen, J, Grote, K.-H, (2007), " Engineering Design- A systematic approach", Springer – Verlag, NY..
2	Karl T. Ulrich and Steven D. Eppinger, (2008), "Product Design and Development" McGraw Hill Edition. ED7153 EN
E BOOKS	
1	https://books.google.co.in/books/about/Engineering_Design.html?id=wUgqAQAAMAAJ
2	https://books.google.co.in/books?isbn=8177588214
MOOC	
1	https://onlinecourses.nptel.ac.in/noc17_me16/preview
2	https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1

COURSE TITLE	BASIC REFRIGERATION AND AIR CONDITIONING			CREDITS	3
COURSE CODE	MED4384	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To impart knowledge on the various aspects of refrigeration and air-conditioning in mechanical engineering.
Course Objective	1. To understand the underlying principles of operation in different Refrigeration & Air conditioning systems and components. 2. To provide knowledge on design aspects of Refrigeration & Air conditioning systems
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate different Refrigeration and air conditioning systems. 2. Differentiate types of Refrigeration systems 3. Describe the properties of different refrigerants and their impact. 4. Design Heating ventilating and air conditioning systems 5. Describe different air conditioning systems and their impact on environment.

Prerequisites: Knowledge of thermodynamics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	-	2	-	2	2	-	1	2	-	1	-	-
CO-2	-	1	-	2	3	1	2	-	1	-	1	-	-	-
CO-3	1	-	-	1	-	1	1	-	1	1	1	-	-	-
CO-4	1	2	-	3	-	-	-	-	-	1	-	1	-	-
CO-5	1	2	-	1	3	2	1	-	1	2	1	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	9
Introduction to Refrigeration – Units of Refrigeration C.O.P.- Ideal cycles- refrigerants- desirable properties –classification- Nomenclature – ODP &GWP ***Suggested Reading:*** *Reading books on thermodynamics*	**CO-1** **BTL-3**
MODULE 2. VAPOUR COMPRESSION SYSTEM.	**9**

Vapor compression cycle : p-h and T-s diagrams - deviations from theoretical cycle - subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators. ***Suggested Reading:*** *Vapour cycles, compresssors*	**CO-2** **BTL-3**
MODULE3: OTHER REFRIGERATION SYSTEMS	**8**
Working principles of Vapour absorption systems and adsorption cooling systems - Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems. ***Suggested Reading:*** *refrigerants systems, vortex and principles*	**CO-3** **BTL-3**
MODULE 4: PSYCHROMETRIC PROPERTIES AND PROCESSES	**9**
Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air stream ***Suggested Reading****: psychometric charts. Reading of the charts*	**CO-4** **BTL-3**
MODULE 5: AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION	**9**
Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load. ***Suggested Reading:*** *Heat transfer and calculating heat transfer.*	**CO-5** **BTL-3**

TEXT BOOKS	
1	Arora, C.P., (2010), Refrigeration and Air Conditioning, McGraw Hill, New Delhi, 3rd edition
REFERENCE BOOKS	
1	Roy J. Dossat, (2009), Principles of Refrigeration, Pearson Education Asia, 4th edition.
2	ASHRAE (2010), Fundamentals of Refrigeration and Air Conditioning ,Hand book
3	Jones W.P., (2001), Air conditioning engineering, Elsevier Butterworth-Heinemann, 5th edition.
E BOOKS	
1	https://drive.google.com/open?id=0B7JWdKw_4Q07VWNrLVNkRXpyUmM-TROTT, WELCH.
2	https://drive.google.com/open?id=0B7JWdKw_4Q07Q3VwSlBxMFd0Vjg- REX MILLER.
MOOC	
1	http://www.nptelvideos.in/2012/12/refrigeration-and-airconditioning.html
2	http://nptel.ac.in/courses/112105128/

COURSE TITLE	**3D PRINTING IN MODERN MANUFACTURING**			**CREDITS**	**2**
COURSE CODE	**MED4385**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course is designed to provide information on the tools and an understanding necessary to materialize the design ideas into physical products for manufacturing through 3D printing.
Course Objective	1. To Introduce Computer Aided Design (CAD) for Additive Manufacturing 2. To Introduce Fusion Deposition Modeling (FDM) and other 3D Printers and subsequent operations 3. To Practice component design for additive manufacturing 4. To Review the operations of 3D Printer 5. To provide hands-on practice for Fabrication of component
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the 3D printing and different parametric equations 2. Develop digital 3D model and able to slice using software 3. Describe the 3D printer, including how it works and obtain digital designs remix that they can turn into 3D printed objects. 4. Demonstrate the revolutionary advantages of 3D printing and the exciting future of this technology 5. Examine several real-world application

Prerequisites: None

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	1	1	-	3	-	-	-	1	-	-	-	-	-
CO-3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-5	2	-	1	-	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
3D Printing Insights, History of 3D Printing; Parametric equation of Line, Triangle, Circle, Square, Cone, Cylinder, Sphere, frustum of a cone, Pyramid. **Suggested Readings:** Evolution of 3D Printing	**CO-1** **BTL-2**
MODULE 2: 3D DESIGN	**(9)**

3D Design; Design considerations – Material, Size, Resolution, Process; Modelling and viewing - 3D; 3D Scanning- Reverse Engineering; Model preparation – Digital; Slicing; Software; File formats ***Suggested Activity*:** Learn commercially available slicing Software	**CO-2** **BTL-3**
MODULE 3: 3D PRINTING FACT AND CONCEPT	**(9)**
Working principle of 3D Printing; SLA or Stereo Lithography; SLS or Selective Laser Sintering; Fused Deposition Modeling; 3D Printing Demonstration; Post-Processing; 3D Printing vs Additive Manufacturing; 3D Printing Ecosystem ***Suggested Activity:*** Do remixing exercise, using online Thingiverse and print the customized design using 3D Printer	**CO-3** **BTL-4**
MODULE 4: 3D PRINTING – A REVOLUTION	**(9)**
3D Printing Changing Business; Future 3D Printing; Case study of various Revolutionary technologies. ***Suggested Activity****:* Listen to an interview with the successful business man in 3D Printing	**CO-4** **BTL-4**
MODULE 5: APPLICATIONS	**(9)**
Application in Medical, Biomedical, Dental, Bio-printing, Prosthetic Development, Tissue Engineering & Organ Printing, Aerospace Application, Automatic Application, Architectural Modeling and many others Case studies. **Suggested Readings:** Next-generation 3D Printing Technologies	**CO-5** **BTL-4**

TEXT BOOKS	
1	John Hornick, (2015), 3D Printing Will Rock the World, Create Space Independent Publishing Platform; 1 edition
2	Kalani Kirk, Hausman and Richard Horne, (2014), 3D Printing for Dummies, Wiley Publishing.
3	Christopher Barnatt, (2013), 3D Printing Next Industrial Revolution, Create space Independent Publishing Platform.
REFERENCE BOOKS	
1	Ian Gibson, David Rosen and Brent Stucker, (2015), "Additive Manufacturing Technologies 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Springer, Second edition.
E BOOKS	
1	Cutting-Edge Technology: All About 3D Printing, Apps, Coding, Drones, Robots and More Audiobook – Unabridged Various (Author), Lauren McCullough (Narrator), & 1 More, Dreamscape Media, LLC
2	https://amzn.in/dLDp0Ff
3	https://amzn.in/7NVnaMJ
MOOC	
1	3D Printing Software (Coursera)
2	The 3D Printing Revolution (Coursera)
3	Bioprinting: 3D Printing Body Parts (FutureLearn)

SEMESTER –VI

COURSE TITLE	FUNDAMENTALS OF POWER PLANT TECHNOLOGY			CREDITS	3
COURSE CODE	MED4391	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To impart knowledge on the various components, operations and applications of different types of power plants.
Course Objective	1. To understand the present power scenario in India and the various types of Boilers 2. To understand the arrangement and various components involved in Thermal power plant 3. To understand the arrangement and various components involved in Nuclear and hydel power plant 4. To understand the arrangement and various components involved in Diesel and Gas turbine power plant 5. To understand the principles of operation of unconventional power plants and concepts of power plant economics
Course Outcome	Upon completion of this course, the students will be able to 1. Classify the various types of boilers and identify their application area 2. Demonstrate the arrangements of steam power plant and the components involved in it 3. Demonstrate the working principles of nuclear and hydel power plants 4. Describe the construction of Diesel and Gas Turbine Power plants 5. Classify and interpret the power plant economics

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	-	2	-	2	2	-	1	2	-	2	-	-
CO-2	-	1	-	3	3	2	2	-	1	1	1	-	-	-
CO-3	1	2	-	-	-	1	2	-	1	2	-	2	-	-
CO-4	2	2	-	3	-	-	-	-	-	1	-	2	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: INTRODUCTION TO POWER PLANTS AND BOILERS 9	
Conventional and unconventional power plants, Present power scenario in India, Installed capacity of various power plants in India. Steam boilers – Low pressure, High pressure, Super Critical Boilers – Fluidized Bed Boilers	**CO-1 BTL-3**
MODULE 2: STEAM POWER PLANT	**9**
Layout of Steam Power Plants, Fuel and ash handling, Combustion Equipment for burning coal, Pulveriser, Electrostatic Precipitator, Draught- Different Types, Surface condenser and cooling Towers	**CO-2 BTL-3**
MODULE 3: NUCLEAR AND HYDEL POWER PLANTS	**9**
Layout of Nuclear Power Plant, Nuclear Energy-Fission, Fusion Reaction, Types of Reactors, Pressurized water reactor, Boiling water reactor, Layout of Hydroelectric Power Plants, Essential elements, governing of Turbines- Micro hydel developments	**CO-3 BTL-3**
MODULE 4: DIESEL AND GAS TURBINE POWER PLANT	**9**
Layout of Diesel Power Plant, Types of diesel plants, components , applications. Layout of Gas turbine Power Plants, Fuels, open and closed cycles- reheating – Regeneration and intercooling.	**CO-4 BTL-3**
MODULE 5: UNCONVENTIONAL POWER PLANTS AND ECONOMICS OF POWER PLANTS	**9**
MHD, Geo thermal - OTEC- Tidel- Pumped storage –Solar central receiver system, Cost of electric Energy - Load duration Curves, Fixed and operating costs - Energy rates - Types tariffs.	**CO-5 BTL-3**

TEXT BOOKS	
1	Nag P.K , (2007), Power Plant Engineering, Tata McGraw- Hill , Third edition,
2	Rajput R. K, (2008), A Text Book of Power Plant Engineering, Laxmi publications, Fourth edition.
REFERENCE BOOKS	
1	Arora S.C and Domkundwar S, (2001), A Course in Power Plant Engineering, Dhanpat Rai,
E BOOKS	
1	https://drive.google.com/open?id=0B7JWdKw_4Q07VWNrLVNkRXpyUmM- TROTT, WELCH.
2	https://drive.google.com/open?id=0B7JWdKw_4Q07Q3VwSlBxMFd0Vjg- REX MILLER.
3	https://drive.google.com/open?id=0B9bpsTYXP4ceTC0ycVVMX3RxSGs
MOOC	
1	http://nptel.ac.in/courses/112105128/

COURSE TITLE	**INDUSTRIAL AUTOMATION**			**CREDITS**	**3**
COURSE CODE	**MED4392**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to all kinds of automation in the industrial sector.
Course Objective	1. To introduce the basic concepts of automation in production systems. 2. To make the student familiar with the various material handling systems 3. To familiarize students in inspection and control technologies in Automation
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of automation process. 2. Design a material handling and identification system for specific applications 3. Demonstrate the various automated systems used in the industries. 4. Employ suitable inspection technology depending on the applications 5. Explore the various Control systems used in the automated systems

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO -5	PO-6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	1	1	2	1	-	2	2	-	1	2	-	-	-	-
CO-2	2	-	-	1	3	1	2	-	1	2	-	1	-	-
CO-3	1	2	1	2	1	1	2	-	1	-	-	-	-	-
CO-4	2	-	-	3	-	-	1	-	-	2	1	-	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	1	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION&AUTOMATIC DATA CAPTURE	**9**
Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Overview of Automatic Identification Methods, Barcode Technologies, and other ADC Technologies	**CO-1 BTL-3**
MODULE 2: MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES	**9**
Overview of Material Handling Systems, Principles and Design Consideration, Industrial Trucks, Automated Guided Vehicles, Conveyor Systems, Storage Systems Performance, Automated Storage Systems Carousel Storage Systems.	**CO-2 BTL-3**
MODULE 3 AUTOMATED MANUFACTURING SYSTEMS	**9**
Components, Classification and Overview of Manufacturing Systems, GT and Cellular Manufacturing – Part Families, Parts Classification and Coding, Production Flow Analysis, Cellular Manufacturing, Application Consideration in GT, FMS – FMS Components, FMS	**CO-3 BTL-3**

Application and Benefits FMS Planning and Implementation issues.	
MODULE 4: INSPECTION TECHNOLOGIES FOR AUTOMATION	**9**
Inspection Metrology, Contact vs. Non contact inspectionTechnologies, Coordinate Measuring Machines Technologies, Machine Vision, Optical Inspection Techniques and Non-contact Non-optical Inspection Technologies.	**CO-4 BTL-3**
MODULE 5: CONTROL TECHNOLOGIES IN AUTOMATION	**9**
Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Systems & RTU	**CO-5 BTL-3**

TEXT BOOKS	
1	M.P.Groover, (2008), Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education,.
2	Krishna Kant, (2010), Computer Based Industrial Control, EEE-PHI, (2010-01-30) ISBN 10:8120339886.
REFERENCE BOOKS	
1	Tiess Chiu Chang & Richard A.Wysk, (2000), An Introduction to Automated Process Planning Systems,
E BOOKS	
1	https://www.automation.com/en-us/resources-list-pages/advancing-automation-ebooks
2	https://plc4me.com/pdf-industrial-automation-hands-on-by-frank-lamb-ebook-free/
MOOC	
1	https://nielit.gov.in/calicut/content/online-course-industrial-automation-plc-scada
2	https://onlinecourses.nptel.ac.in/noc20_me39/preview

COURSE TITLE	**MECHATRONICS SYSTEM DESIGN**			**CREDITS**	**3**
COURSE CODE	**MED4393**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To expose the students to an integrated approach to the design of complex engineering systems involving Electrical, Mechanical and Computer Engineering.				

Course Objective	1. To introduce the Mechatronics system. 2. To learn real time interfacing. 3. To understand case studies on Data Acquisition and control. 4. To learn about advanced applications in Mechatronics.
Course Outcome	Upon completion of this course, the students will be able to 1. Differentiate between traditional and mechatronics system. 2. Make the real time interfacing. 3. Solve case studies on data acquisition and control. 4. Develop advanced applications in mechatronics. 5. Describe the application of artificial Intelligence in mechanical field.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO-6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	2	1	-	2	2	-	1	2	-	-	-	-
CO-2	2	-	-	1	3	1	2	-	1	2	-	1	-	-
CO-3	1	2	1	2	1	1	2	-	1	-	-	-	-	-
CO-4	2	-	-	3	-	-	1	-	-	2	1	-	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	1	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO MECHATRONICS SYSTEM DESIGN	**9**
Introduction to Mechatronics system – Key elements – Mechatronics Design process – Types of Design – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Man machine interface, industrial design and ergonomics, safety.	**CO-1 BTL-3**
MODULE 2: INTERFACING AND DATA ACQUISITION	**9**
Real-time interfacing – Introduction - Elements of data acquisition and control - Overview of I/O process, Analog signals, discrete signals, and Frequency signals – Overframing	**CO-2 BTL-3**
MODULE 3 CASE STUDIES – FORCE AND DISPLACEMENT	**9**
Case studies on Data Acquisition: Introduction – Cantilever Beam Force Measurement system–Testing of Transportation bridge surface materials – Transducer calibration system for Automotive applications – Strain gauge weighing system – Solenoid Force-Displacement calibration system – Rotary optical encoder – Controlling temperature of a hot/cold reservoir – pick and place robot.	**CO-3 BTL-3**
MODULE 4: CASE STUDIES – TEMPERATURE AND MOTION	**9**
Case studies on Data Acquisition and control: Introduction – Thermal cycle fatigue of a ceramic plate – pH control system – Dc-Icing Temperature Control system – Skip control of a CD Player – Autofocus Camera, exposure control. Case studies of design of mechatronic products – Motion control using D.C.Motor & Solenoids – Car engine management systems.	**CO-4 BTL-3**

MODULE 5: ARTIFICIAL INTELLIGENCE		9
Advanced applications in Mechatronics: Sensors for condition Monitoring – Mechatronic Control in Automated Manufacturing – Artificial intelligence in Mechatronics – Fuzzy Logic Applications in Mechatronics – Microsensors in Mechatronics		CO-5 BTL-3
TEXT BOOKS		
1	Devadas shetty, Richard A. Kolk, (2001), Mechatronics System Design, Thomson Learning, Publishing Company, Vikas publishing house,	
REFERENCE BOOKS		
1	Bolton, (1999), -Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-, Addison Wesley Longman Ltd., 2nd Edition.	
E BOOKS		
1	https://engineeringstudymaterial.net/ebook/essentials-of-mechatronics-by-john/ - John Billingsley	
2	https://engineeringstudymaterial.net/ebook/mechatronics-introduction-by-robert/ - Robert H. Bishop	
MOOC		
1	http://nptel.ac.in/courses/112105047/	
2	http://nptel.ac.in/courses/112102011/	

COURSE TITLE	VIRTUAL INSTRUMENTATION			CREDITS	3
COURSE CODE	MED4394	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	The objective is to give an extensive information and application of virtual instrumentation for all types of measurement systems and analysis.				
Course Objective	1. To learn about the basics of the Virtual instrumentation 2. To learn about the architecture of LABVIEW 3. To learn about programming in LABVIEW				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basics of the Virtual instrumentation 2. Describe the basic functions and architecture of LABVIEW 3. Develop a program for various measurements in LABVIEW 4. Acquire data from various environmental conditions 5. Apply the advanced features like motion control in the application				

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO-6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	2	3	-	2	2	-	1	2	-	1	-	-
CO-2	2	1	-	3	3	2	2	-	1	-	-	1	-	-
CO-3	1	-	1	2	1	1	2	-	1	2	-	-	-	-
CO-4	2	2	-	3	-	-	-	-	-	2	1	-	-	-
CO-5	1	2	-	2	3	2	1	-	1	2	1	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**9**
Historical perspective and traditional bench-top instruments - General functional description of a digital instrument- Block diagram of a Virtual Instrument – Physical quantities and analog interfaces- Hardware and Software – User Interfaces –Advantages of Virtual Instruments over conventional instruments – Architecture of a Virtual Instruments and its relation to the operating system.	**CO-1 BTL-3**
MODULE 2: BASIC FUNCTIONS	**9**
LabVIEW – graphical user interfaces- controls and Indicators – 'G' programming –data types –data flow programming –Editing Debugging and Running a Virtual Instrument – Graphical programming palettes and tools – Front panel objects – Function and Libraries	**CO-2 BTL-3**
MODULE 3 LOOPS AND ARRAYS	**9**
FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes-Sequence structures- Arrays and Clusters- Array operations – Bundle, Unbundle – Bundle/Unbundle by name, graphs and charts – string and file I/O – High level and Low level file I/Os – attribute nodes local and global variables.	**CO-3 BTL-3**
MODULE 4: DATA ACQUISITION SYSTEMS	**9**
Basics of DAQ Hardware and Software – Concepts of Data Acquisition and terminology – Installing Hardware, Installing drivers -Configuring the Hardware – addressing the hardware in LabVIEW- Digital and Analog I/O function – Buffered I/O – Real time Data Acquisition.	**CO-4 BTL-3**
MODULE 5: ADVANCED CONCEPTS	**9**
Simple programs in VI- Advanced concepts in LabVIEW- TCP/IP VI's, Synchronization – other elements of Virtual Instrumentation – Bus extensions – PXI - Computer based instruments - Image acquisition –Motion Control.	**CO-5 BTL-3**
TEXT BOOKS	

1	Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw-Hill, Edition, 1996
2	Lisa.K.Wills, LabVIEW for Everyone Prentice Hall of India, 1996.
REFERENCE BOOKS	
1	Labview Basics I and II Manual, National Instruments, 2003.
2	Barry Paton, Sensor, Transducers and Lab VIEW, Prentice Hall, 2000
E BOOKS	
1	https://www.elektor.com/pic-cookbook-for-virtual-instrumentation-ebook
2	https://www.worldcat.org/title/virtual-instrumentation-using-labview/oclc/743395421
MOOC	
1	https://www.udemy.com/course/introduction-to-process-control-and-instrumentation/

SEMESTER – VII

COURSE TITLE	**DESIGN OF BUILDING AUTOMATION**			**CREDITS**	**3**
COURSE CODE	**MED4481**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course is intended to expose the students in the design of sophisticated building environment for comfortable living.				
Course Objective	1. To examine various services in high rise buildings. 2. To understand how services integration can translate into an intelligent and energy efficient system which will enable sustainability of the structure.				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the Concepts of Intelligence Architecture and Building Automation 2. Design the mechanical systems such as air conditioning and ventilation 3. Design the efficient electrical systems for buildings 4. Demonstrate the safety and security systems provided in various types of buildings 5. Apply the modern automation concepts in different types of buildings				
Prerequisites: Nil					

CO, PO AND PSO MAPPING														
CO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PSO-**	**PSO-2**

	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	1	
CO-1	**2**	**2**	**1**	**-**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**-**	**-**
CO-2	**2**	**2**	**1**	**1**	**2**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO-3	**2**	**1**	**2**	**2**	**2**	**-**	**-**	**2**	**-**	**2**	**-**	**2**	**-**	**-**
CO-4	**1**	**2**	**1**	**2**	**2**	**-**	**1**	**1**	**-**	**1**	**-**	**1**	**-**	**-**
CO-5	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**1**	**-**	**2**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**9**
Standards of high Rise buildings- Indian Standards and Global Standards on High Rise Buildings; Introduction to various services; their significance with regards to High Rise Buildings; Some examples of Buildings and services used in them A brief on evolution of High Rise Buildings. Aspects and Integration of services- Concepts of Intelligence Architecture and Building Automation	**CO-1 BTL-3**
MODULE 2: MECHANICAL SYSTEMS	**9**
Natural and Mechanical Ventilation systems- Air conditioning systems and load estimation- Planning and design for efficiency-Basic concepts- Automation and Energy Management concepts.	**CO-2 BTL-3**
MODULE 3: HVAC AND ELECTRICAL SYSTEMS	**9**
Natural lighting systems- Energy efficiency in lighting systems- load and distribution- Planning and Design for energy efficiency- Automation- basic concepts, Glass and Glazing system for natural lighting. Types of elevators, systems and services- Lobby design- Escalators- safety principles, Some latest Trends, NBC's recommendations	**CO-3 BTL-3**
MODULE 4: SAFETY AND SECURITY	**9**
Security systems- Access Control and Perimeter Protection- CCTV Intruder alarms- Passive fire safety- Fire Detection and Fire Alarm Systems- Planning and Design- NBC Some latest Trends	**CO-4 BTL-3**
MODULE 5: CASE STUDIES	**9**
Case Studies of High Rise buildings and skyscrapers through appropriate examples- Norman Foster; Ove Arup; Ken Yeang, etc.	**CO-5 BTL-3**

TEXT BOOKS	
1	William J. Mcguinness, Benjamin Stein and John S. Reynolds, (2001), Mechanical and Electrical Equipment for Buildings, John Wiley & Sons, Inc.. .
REFERENCE BOOKS	
1	A K Mittal, Electrical and Mechanical Services in High Rise Buildings Design and EstimationManual, 2001.
2	Yahya Mohamad Yatim, Fire Safety Issues in High-Rise Residential Buildings: escape routesdesign and specification, Lambert Academic Publishing, 2011
3	Johann Eisele and Ellen Kloft, High-Rise Manual, Birkhäuser-Publishers for Architecture, 2003

E BOOKS	
1	Building Automation System A Complete Guide - 2020 Edition
2	Intelligent Buildings and Building Automation - Shengwei Wang
MOOC	
1	https://www.smeclabs.com/automation-plc-scada-training-online-course-tutorials-certification/?utm_source=slga-Auto&utm_medium=adwords&gclid=CjwKCAjw4qCKBhAVEiwAk TYsPGRBbCnkJApJr4falzA26WMVUO1HCVwq7r2-sIJPKFvEuk60vPZEsBoCMdcQAvD_BwE
2	https://www.coursera.org/lecture/industrial-iot-markets-security/segment-3-building-automation-9PMxA

COURSE TITLE	INDUSTRIAL SAFETY AND MAINTENANCE ENGINEERING			CREDITS	3
COURSE CODE	MED4482	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course is intended to provide the knowledge about safety in manufacturing industries in the engineering field especially with the new technologies and advancements				
Course Objective	1. To understand about the fundamentals of industrial safety and management 2. To understand the prevention and protective equipment in the industry 3. To understand the Basics safety acts 4. To understand the principles and practices of maintenance planning. 5. To understand the Maintenance policies and preventive maintenance.				
Course Outcome	Upon completion of this course, the students will be able to 1. Describe about the fundamentals of industrial safety and management 2. Demonstrate an understanding on the prevention and protective equipment in the industry 3. Describe information on various basics of safety acts 4. Apply the principles and practices of maintenance planning 5. Demonstrate ability to frame maintenance policies and schedule preventive maintenance.				
Prerequisites: Nil					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	1	-	-	-	2	2	2	1	1	1	-	-	-	-

CO-2	**1**	**1**	**1**	**1**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO-3	**3**	**1**	**-**	**-**	**2**	**2**	**2**	**-**	**1**	**1**	**1**	**1**	**-**	**-**
CO-4	**1**	**-**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-5	**3**	**1**	**-**	**-**	**-**	**2**	**2**	**-**	**1**	**1**	**1**	**1**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO THE DEVELOPMENT OF INDUSTRIAL SAFETY AND MANAGMENT 9	
Implementation of factories act, Formation of various councils, Safety and productivity, Safety organizations. Safety committees, safety committee structure, Roll of management and roll of Govt. in industrial safety, Safety analysis ***Suggested Reading: Industry Management, mandatory requirements on safety***	**CO-1** **BTL-3**
MODULE 2: ACCIDENT PREVENTIONS, PROTECTIVE EQUIPEMTS AND THE ACTS 9	
Personal protective equipment, Survey the plant for locations and hazards, Part of body to be protected. Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Firefighting equipment. Accident reporting, Investigations, Industrial psychology in accident prevention, Safety trials. ***Suggested Reading:*** PPE for various process, Case study on industrial accidents	**CO-2** **BTL-3**
MODULE 3: SAFETY ACTS 9	
Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act. Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases. Stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment. Control of industrial noise and protection against it, Code and regulations for worker safety and health. ***Suggested Reading:*** Role of Pollution Control Board and Inspector of Factories	**CO-3** **BTL-3**
MODULE 4: PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING 9	
Basic Principles of maintenance planning, Objectives and principles of planned maintenance activity. Importance and benefits of sound Maintenance systems, Reliability and machine availability, Equipment Life cycle. Measures for Maintenance Performance: Equipments breakdowns, Mean Time between Failures, Mean Time To Repair, Factors of availability, Maintenance organization, Maintenance economics ***Suggested Reading****: Principles of Maintenance Management.*	**CO-4** **BTL-3**
MODULE 5: MAINTENANCE POLICIES AND PREVENTIVE MAINTENACNE 9	
Maintenance categories, Comparative merits of each category, Preventive maintenance. Maintenance schedules: Repair cycle, Principles and methods of lubrication, Fault Tree Analysis. Total Productive Maintenance: Methodology and Implementation ***Suggested Reading:*** concepts of tribology, case study on fault analysis	**CO-5** **BTL-3**
TEXT BOOKS	

1	L M Deshmukh, (2017), "*Industrial safety Management* ", Mcgraw Hill, Second edition.
2	Willie Hammer "Occupational Safety Management and Engineering" Prentice Hall
3	R.C Mishra, K K.Pathak " Maintenance Engineering and Management" Prentice Hall
REFERENCE BOOKS	
1	Amit gupta, (2006) " industrial Safety and environment" Firewall Media,
2	Higgins, L.R., "Maintenance Engineering Hand book", 5th Edition, McGraw Hill.
3	B.S Dhilon (2002)" Engineering Maintenance – A modern approach" CRC press,
E BOOKS	
1	https://www.osha.gov/pls/publications/publication.athruz?pType=Types&pID=10412
2	https://www.kopykitab.com/Industrial-Safety-And-Environment-by-Er-A-K-Gupta
3	https://www.amazon.com/Plant-Equipment-Maintenance-Engineering-Handbook-ebook/
4	https://www.worldcat.org/title/industrial-safety-management-21st-century-perspectives-of-asia/oclc/1009175845
MOOC	
1	https://www.iti.com/safety
2	https://swayam.gov.in/courses/4817-july-2018-industrial-safety-engineering
3	https://www.oshatrain.org/
4	https://www.tpctraining.com/collections/mechanical-maintenance-training
5	https://www.iti.com/maintenance
6	https://www.lifetime-reliability.com/cms/training/online-training-courses/

COURSE TITLE	**QUALITY CONTROL AND RELIABLITY ENGINEEING**			**CREDITS**	**3**
COURSE CODE	**MED4483**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To expose the students to the concepts of quality, standards followed, sampling techniques to improve reliability				
Course Objective	1. To introduce the concept of SQC 2. To understand process control and acceptance sampling procedure and their application. 3. To learn the concept of reliability.				

Course Outcome	Upon completion of this course, the students will be able to 1. Describe the attributes in process control and basics of quality 2. Demonstrate the basics of control charts on attributes 3. Demonstrate the sampling plans 4. Demonstrate the basics of reliability 5. Illustrate the independent judgment in quality and reliability problems.

Prerequisites: Applied Mathematics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO -5	PO -6	PO -7	PO -8	PO -9	PO - 10	PO -11	PO-12	PSO-1	PSO-2
CO-1	1	1	-	3	-	2	1	-	1	2	-	-	-	-
CO-2	2	1	-	3	-	2	2	-	1	-	-	-	-	-
CO-3	-	-	-	2	-	1	2	-	-	2	-	-	-	-
CO-4	1	2	-	3	-	-	-	-	-	2	-	-	-	-
CO-5	1	2	-	2	3	-	1	-	1	2	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:INTRODUCTION AND PROCESS CONTROL FOR VARIABLES	**9**
Introduction, definition of quality, basic concept of quality, definition of SQC, , Quality assurance, Quality cost-Variation in process- factors - process capability- process capability studies and simple problems - Theory of control chart- uses of control chart -Control chart for variables - X bar chart, R chart and S chart. ***Suggested Reading:*** benefits and limitation of SQC and SPC	**CO-1 BTL-3**
MODULE 2:PROCESS CONTROL OF ATTRIBUTES	**9**
Control chart for attributes -control chart for proportion or fraction defectives - p chart and np chart control chart for defects - C and U charts, State of control and process out of control identification in charts. ***Suggested Reading: c****ontrol and process Attributes of Quality and Reliability*	**CO-2 BTL-3**
MODULE 3: ACCEPTANCE SAMPLING	**9**
Lot by lot sampling - types - probability of acceptance in single, double, multiple sampling techniques - O.C. curves - producer's Risk and Consumer's Risk. AQL, LTPD, AOQL concepts- standard sampling plans for AQL and LTPD- uses of standard sampling plans. ***Suggested Reading:*** *Acceptance sampling types and probability of acceptance*	**CO-3 BTL-3**
MODULE 4: LIFE TESTING-RELIABILITY	**9**

Life testing - Objective - failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration - simple problems. Maintainability and availability - simple problems. Acceptance sampling based on reliability test - O.C Curves. ***Suggested Reading**: Failure data analysis*	**CO-4 BTL-3**
MODULE 5: QUALITY AND RELIABILITY	**9**
Reliability improvements - techniques- use of Pareto analysis - design for reliability - redundancy unit and standby redundancy - Optimization in reliability - Product design - Product analysis - Product development - Product life cycles. ***Suggested Reading:** Study the recent trends of quality and reliability system*	**CO-5 BTL-3**

TEXT BOOKS	
1	Grant, Eugene .L,(2006), Statistical Quality Control, McGraw-Hill, 7th Edition.
2	L .S. Srinath,(2009), Reliability Engineering, Affiliated East west press, 4th Edition.
REFERENCE BOOKS	
1	Monohar Mahajan, (2001),Statistical Quality Control, Dhanpat Rai & Sons.
2	R.C.Gupta, (2003),Statistical Quality control, Khanna Publishers, 6th Edition.
3	Besterfield D.H., (1993),Quality Control, Prentice Hall.
4	Sharma S.C.,(2002),Inspection Quality Control and Reliability, Khanna Publishers.
5	Danny Samson,(1991), Manufacturing & Operations Strategy, Prentice Hall.
E BOOKS	
1	Quality Control Applications (Springer Series in Reliability Engineering) 2013 Edition, Kindle Edition
2	http://www.a-zshiksha.com/forum/viewtopic.php?f=148&t=61562
MOOC	
1	https://learn.org/articles/Online_Courses_in_Quality_Control_Answers_to_Your_Questions.html
2	https://www.udemy.com/statistical-quality-control-sqc/
3	https://ocw.mit.edu/courses/nuclear-engineering/22-38-probability-and-its-applications-to-reliability-quality-control-and-risk-assessment-fall-2005/download-course-materials/

COURSE TITLE	**APPLIED HYDRAULICS & PNEUMATICS**			**CREDITS**	**3**
COURSE CODE	**MED4484**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course describes the fundamentals of fluid power systems. The Designing of hydraulic system and pneumatic system circuits were demonstrated. The importance of low cost automation is also explained neatly.				

Course Objective	1. To understand the fundamentals, components and designing of hydraulic systems. 2. To understand the fundamentals, components and designing of pneumatic systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the fluid power system and fundamentals. Physics of Pascal's law, laminar and turbulent flow, Reynolds number and Darcy's equation. 2. Illustrate the concept of hydraulics system and various components of hydraulics system like pumping theory, cylinders and Actuators. 3. Design a hydraulic circuits and understanding the concept of hydraulic valves and accumulators and its type. 4. Demonstrate pneumatics systems like compressor, valves, filter regulator and lubricant units and able to design a pneumatic and hydraulic circuit and understand a symbols and standard. 5. Design a pneumatic circuit system with servo motor and understanding the logic circuit and ladder diagram and PLC units.

Prerequisites: Fluid Mechanics and Machinery, Mechatronics and Pneumatic

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	-	-	2	2	2	1	1	1	-	-	-	-
CO-2	3	2	1	1	2	-	-	-	1	1	-	-	-	-
CO-3	3	2	-	-	2	2	2	-	1	1	-	-	-	-
CO-4	-	-	1	1	2	2	2	-	-	-	-	-	-	-
CO-5	3	2	1	1	2	2	2	-	1	1	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FLUID POWER SYSTEMS AND FUNDAMENTALS	**9**
Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids - General types of fluids - Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law- Laminar and Turbulent flow - Reynolds number - Darcy's equation - Losses in pipe, valves and fittings. Suggested Reading: Fluid power Industry in India, Comparison of Properties.	**CO-1 BTL-3**
MODULE 2: HYDRAULIC SYSTEM & COMPONENTS	**9**
Sources of Hydraulic Power: Pumping theory - Pump classification - Gear pump, Vane Pump, Piston pump, construction and working of pumps - pump performance - Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders - Single acting, Double acting, special cylinders like Tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators - Fluid motors, Gear, Vane and Piston motors.	**CO-2 BTL-3**

Suggested Reading: Hydrodynamic and hydrostatic pumps, Screw Pump, Cylinder Mounting Configurations, Cylinder Cushioning.	
MODULE 3: DESIGN OF HYDRAULIC CIRCUITS	**9**
Construction of Control Components : Direction control valve - 3/2 way valve - 4/2 way valve - Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve, Flow control valve - Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers : Types of accumulators - Accumulators circuits, sizing of accumulators, intensifier Applications of Intensifier - Intensifier circuit. Suggested Reading: Unloading Valve, Counterbalance Valve, Proportional Valves, Regenerative Circuits, Design of Safety Circuits in Simulink software.	**CO-3** **BTL-3**
MODULE 4: PNEUMATIC SYSTEMS AND COMPONENTS	**9**
Pneumatic Components: Properties of air - Compressors - Filter, Regulator, Lubricator Unit - Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumatic and Hydraulic circuit, Sequential circuit design for simple applications using cascade method. Suggested Reading: Mufflers, Sizing of Compressors, Air Motors, Vacuum Suction Cup.	**CO-4** **BTL-3**
MODULE 5: DESIGN OF PNEUMATIC CIRCUITS	**9**
Servo systems - Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics - Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting. Suggested Reading: Hydro-pneumatic Systems, Installation and Maintenance of Hydraulic Systems, Design a pneumatic system for sorting of components using MATLAB© software.	**CO-5** **BTL-3**

TEXT BOOKS

1	Anthony Esposito, (2014),Fluid Power with Applications, Pearson Education, 7th Edition.
2	Majumdar S.R., (2015),Oil Hydraulics, Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS

1	Majumdar S.R., (2013),Pneumatic systems - Principles and maintenance, Tata McGraw Hill, New Delhi.
2	Srinivasan.R,(2006), “Hydraulic and Pneumatic controls”, Vijay Nicole.
3	James R. Daines, (2012), Fluid Power: Hydraulics and Pneumatics, Goodheart-Willcox Publisher, Second Edition.

E BOOKS

1	https://docs.zoho.com/file/2bvxi8191d4a73d1d4f05941a1f132f86ae1a - Fluid power with Applications – Anthony Esposito
2	http://pages.hydraulicspneumatics.com/fluid-power-basics?code=UM_NX7UMB3 – Fluid Power Basics
3	http://controlmanuals.com/files/Automation/Fluid-Power/TSM-363-Fluid-Power-Systems~ppt908.html
4	https://www.pdfdrive.net/industrial-fluid-power-e3104018.html
MOOC	
1	https://www.mooc-list.com/course/hydraulics-%E6%B0%B4%E5%8A%9B%E5%AD%A6-edx
2	https://www.mooc-list.com/course/fundamentals-fluid-power-coursera

COURSE TITLE	**NON DESTRUCTIVE TESTING METHODS**			**CREDITS**	**3**
COURSE CODE	**MED4485**	**COURSE CATEGORY**	**NE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To impart knowledge on Non Destructive Testing procedures				
Course Objective	1. To understand principle behind various NDT techniques and study about NDT Equipments and accessories. 2. To learn working procedures of various NDT techniques 3. To learn materials that could be inspected – codes, standards, specifications				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic principles of various NDT techniques and optical aids used for visual inspection. 2. Describe procedure for surface testing using PI. 3. Illustrate the basics of ECT and AE 4. Apply Ultrasonic testing and various methods. 5. Compare the various NDT methods and learn about Radiography.				
Prerequisites: Science Fundamentals					

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	-	1	2	2	2		1	1	-	-	-	-

CO-2	**1**	**3**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-3	**3**	**-**	**2**	**1**	**2**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**
CO-4	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-5	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: NON-DESTRUCTIVE TESTING: AN INTRODUCTION	**9**
Introduction to various non destructive methods- comparison of destructive and non destructive tests, visual inspection, optical aids used for visual inspection, applications. ***Suggested Reading:*** *Monitoring surface roughness on a fast moving cable and Magnifying systems such as A tool makers' Microscope.*	**CO-1** **BTL-3**
MODULE 2: LIQUID PENETRANT TESTING, MAGNETIC PARTICLE TESTING	**9**
Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods, - water washable, post- Emulsifiable methods, Applications. Principle of MPT, procedure used for testing a component, Equipment used for MPT, Applications. ***Suggested Reading:*** *Inspection and Evaluation, inspection tools.*	**CO-2** **BTL-3**
MODULE3: EDDY CURRENT TESTING, ACOUSTICEMISSION	**9**
Principles, Instrumentation for ECT, Absolute-differential probes, Techniques- High sensititvity techniques, Applications. Principle of AET, Instrumentation, Applications- testing of metal pressure vessels, Fatigue crack detection in aerospace structures. ***Suggested Reading:*** *Quality control of Non ferromagnetic Heat exchanger Tube sheet Rolled Joints, Probes for inspecting Ferro-magnetic Heat Exchanger Tubes.*	**CO-3** **BTL-3**
MODULE 4: ULTRASONIC TESTING	**9**
Principle, Ultrasonic transducers, inspection methods, normal inscudent pulse-Echo Inspection, Through- transmission testing, angle beam pulse-Echo testing, Techniques for Normal Beam Inspection, Ultrasonic Flaw detection equipment, Modes of display A-Scan, B-Scan, C-Scan, Applications. ***Suggested Reading****: Ultrasonic Examination Nuclear waste containers to decorrosion.*	**CO-4** **BTL-3**
MODULE 5: RADIOGRAPHY, COMPARISON AND SELECTION OF NDT METHODS	**9**
Basic principle, effect of radiation on film, radiographic imaging, inspection techniques- single wall single image, double wall penetration, multiwall penetration technique. Comparison and selection of various NDT techniques. ***Suggested Reading:*** *Three view, Nine shot inspection of a large cast CF-8M stainless steel impeller.*	**CO-5** **BTL-3**
TEXT BOOKS	

1	Baldev raj, T Jeyakumar, M. Thavasimuthu (2012),*Practical Non Destructive Testing* Narosa publishing house, New Delhi.
2	ASM Handbook, "*Non destructive Evaluation and Quality Control*", Vol. 17, ASM International.
3	Mohammed Omar,(2012), "Nondestructive testing methods and new applications", Intech, Croatia, First edition.
REFERENCE BOOKS	
1	Chrales Hellier,(2012), "*Handbook of Nondestructive Evaluation*", McGraw-Hill company, New Delhi.
2	Peter J. Shull (2013),*Non Destructive Evaluation: Theory, Techniques and Application* Marcel Dekker, Inc., New York.
3	Birchan.B,(2015), *Non-Destructive Testing*, Oxford, London.
4	Baldev Raj and B.Venkataraman, (2014),*Practical Radiology*, Narosa Publishing House.
5	Krautkramer. J., (2011),*Ultra Sonic Testing of Materials*, Springer Verlag Publication, New York, First Edition.
E BOOKS	
1	https://www.nde-ed.org
2	https://www.asnt.org
MOOC	
1	https://nptel.ac.in/course.php
2	https://onlinecourses.nptel.ac.in/noc18_mm04/