Sri Krishna College of Engineering and Technology

An Autonomous Institution, Affiliated to Anna University

Coimbatore – 641 008

REGULATION 2020

CURRICULUM AND SYLLABI

B.E. MECHANICAL ENGINEERING

[BATCH: 2021 – 2025]

DEPARTMENT OF MECHANICAL ENGINEERING

SRI KRISHNA COLLEGE OF ENGNEERING AND TECHNOLOGY

An Autonomous Institution Affiliated to Anna University
Kuniamuthur,
Coimbatore - 641 008

VISION AND MISSION OF THE DEPARTMENT

Vision

The department aspires to produce experts in Mechanical Engineering with moral values and desires to set up centers of excellence in innovative design and testing, composite materials, automation, automotive technology and green fuels.

Mission

To produce world class mechanical engineering graduates by promoting core technical competency blended with advanced computing skills, creative thinking and desire to upgrade continuously, so as to empower them to the expectation of the industries in our country and abroad and also to impart the interpersonal skills and make them realize the values of life.

Programme Outcomes (POs):-

At the time of their graduation students of Mechanical Engineering Programme should be in possession of the following Programme Outcomes

a.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b.	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c.	**Design/development of solutions:** Design solutions for complex 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.
d.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e.	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
f.	**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 professional engineering practice.
g.	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i.	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
j.	**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.

k.	**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.
l.	**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.

Programme Educational Objectives (PEOs):-

The following Programme Educational Objectives are designed based on the department mission

PEO 1: Provide strong foundation in the science and engineering fundamentals necessary to formulate, solve and analyze real time mechanical engineering problems.

PEO 2: Develop the ability to synthesize data and technical concepts for making decisions in an ethical manner considering the socio-economic scenario.

PEO 3: Enable to work as part of teams on multidisciplinary projects with good communication and interpersonal skills in the emerging areas like automation, composite materials, automotive technology, green fuels etc.,

PEO 4: Prepare for successful careers in industry that meet the needs of Indian and multinational companies and to inculcate the qualities of continuous learning and entrepreneurial skills.

Programme Specific Outcomes (PSO's):-

At the end of the Programme, Graduate shall have

PSO 1	Design, develop and analyse the engineering components using advanced design softwares.
PSO 2	Ability to fabricate real time mechanical systems and test its worthiness.
PSO 3	Ability to apply the advancements in mechanical engineering to promote automation.

Mapping of PO's and PSO's to PEO's

Programme Educational Objectives	Programme Outcomes												Programme Specific Outcomes		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
PEO 1	3	3	3	3		1					2		3	3	2
PEO 2	3	3	3	3		3	3	3					3	3	2
PEO 3	2	2	2	1	3	3	3		3	3	3	1	3	3	3
PEO 4	3	3	2	2	2		1	2	1	3	2	3	3	3	3

3	Strongly agreed	**2**	Moderately agreed	**1**	Reasonably agreed

B.E. MECHANICAL ENGINEERING
REGULATION 2020 (Batch 2021-2025)
CHOICE BASED CREDIT SYSTEM
I – VIII SEMESTER CURRICULUM AND SYLLABI

SEMESTER I								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY CUM PRACTICAL								
1.	21MA101	Engineering Mathematics I	2/1/2	5	4	-	50/50	BSC
2.	21CH101	Engineering Chemistry	3/0/3	6	4.5	-	50/50	BSC
3.	21EN101	Technical Communication Skills	2/0/2	4	3	-	50/50	HSMC
4.	21CS111	Problem Solving using C Programming	3/0/2	5	4	-	50/50	ESC
5.	21ME101	Engineering Drawing	1/0/3	4	2.5	-	50/50	ESC
6.	21EE111	Basics of Electrical and Electronics Engineering	3/0/2	5	4	-	50/50	ESC
MANDATORY COURSE								
7.	21MC101	Induction Programme	3 WEEKS		0	-	0/100	MC
		Total	**14/1/14**	**29**	**22**	**-**	**700**	

SEMESTER II								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY								
1.	21ME201	Engineering Mechanics	3/1/0	4	4	-	60/40	ESC
2.	21ME202	Manufacturing Technology I	3/0/0	3	3	-	60/40	ESC
3.	21GE201	Universal Human Values	3/0/0	3	3	-	60/40	HSMC
THEORY CUM PRACTICAL								
4.	21MA201	Engineering Mathematics II	2/1/2	5	4	-	50/50	BSC
5.	21PH201	Applied Physics	3/0/3	6	4.5	-	50/50	BSC
PRACTICAL								
6.	21ME103	Engineering Practices Laboratory	0/0/3	3	1.5	-	40/60	ESC
7.	21CS211	Python for Engineers Laboratory	1/0/3	4	2.5	-	40/60	ESC
MANDATORY COURSE								
8.	21MC102	Environmental Sciences	2/0/0	2	0	-	0/100	MC
		Total	**17/2/11**	**30**	**22.5**	**-**	**800**	

SEMESTER III								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY								
1.	21ME301	Solid Mechanics	3/1/0	4	4	-	60/40	PCC
2.	21ME302	Engineering Thermodynamics	3/0/0	3	3	-	60/40	PCC
3.	21ME303	Fluid Mechanics and Machinery	3/0/0	3	3	-	60/40	PCC
4.	21ME304	Industrial Metallurgy	3/0/0	3	3	-	60/40	ESC
5.	21MA301	Engineering Mathematics III	3/1/0	4	4	-	60/40	BSC
THEORY CUM PRACTICAL								
6.	21ME305	Manufacturing Technology- II (with Lab)	3/0/2	5	4	-	50/50	PCC
PRACTICAL								
7.	21ME306	Fluid Mechanics and Strength of Materials Laboratory	0/0/3	3	1.5	-	40/60	PCC
MANDATORY COURSE								
8.	21MCZZZ	Mandatory Course-III	2/0/0	2	0	-	0/100	MC
		Total	**20/2/5**	**27**	**22.5**	**-**	**800**	

SEMESTER IV								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY								
1.	21ME401	Automobile Engineering	3/0/0	3	3	-	60/40	PCC
2.	21ME402	Mechanics of Machines	3/1/0	4	4	-	60/40	PCC
3.	21ME403	Metrology and Instrumentation	3/0/0	3	3	-	60/40	PCC
4.	21ME404	Thermal Engineering	3/0/0	3	3	-	60/40	PCC
5.	21MA401	Probability and Numerical Methods	3/1/0	4	4	-	60/40	BSC
6.	21XXZZZ	Open Elective – I	3/0/0	3	3	-	60/40	OEC
PRACTICAL								
7.	21ME405	Computer Aided Machine Drawing	0/0/3	3	1.5	-	40/60	PCC
8.	21ME406	Metrology and Dynamics Laboratory	0/0/3	3	1.5	-	40/60	PCC
9.	21ME407	Thermal Engineering Laboratory	0/0/2	2	1	-	40/60	PCC
		Total	**18/2/8**	**28**	**24**	**-**	**900**	

SEMESTER V								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY								
1.	21ME501	Design of Machine Elements	4/0/0	4	4	-	60/40	PCC
2.	21ME502	Applied Hydraulics and Pneumatics	3/0/0	3	3	-	60/40	PCC
3.	21ME013	Industry 4.0	3/0/0	3	3	-	60/40	EC
4.	21ME503	Heat and Mass Transfer	3/0/0	3	3	-	60/40	PCC
5.	21ME9ZZ	Professional Elective-I	3/0/0	3	3	-	60/40	PEC
6.	21XXZZZ	Open Elective – II	3/0/0	3	3	-	60/40	OEC
PRACTICAL								
7.	21ME504	CAD/CAM Laboratory	0/0/3	3	1.5	-	40/60	PCC
8.	21ME505	Heat Transfer Laboratory	0/0/2	2	1	-	40/60	PCC
MANDATORY COURSE								
9.	21MCZZZ	Mandatory Course-IV	2/0/0	2	0	-	0/100	MC
		Total	**21/0/5**	**26**	**21.5**	**-**	**900**	

SEMESTER VI								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY								
1.	21ME601	Design of Transmission Systems	3/0/0	3	3	-	60/40	PCC
2.	21ME602	Computational Mechanics	3/0/0	3	3	-	60/40	PCC
3.	21ME9ZZ	Professional Elective-II	3/0/0	3	3	-	60/40	PEC
4.	21ME9ZZ	Professional Elective-III	3/0/0	3	3	-	60/40	PEC
5.	21ME9ZZ	Professional Elective-IV	3/0/0	3	3	-	60/40	PEC
6.	21MEZZZ	Emerging Elective- I	3/0/0	3	3	-	60/40	EEC
PRACTICAL								
7.	21ME603	Simulation and Analysis Laboratory	0/0/3	3	1.5	-	40/60	PCC
PROJECT WORK								
8.	21ME604	Design Thinking and Mini Project	0/0/3	3	1.5	-	40/60	PROJ
MANDATORY COURSE								
9.	21MCZZZ	Mandatory Course-V	2/0/0	2	0	-	0/100	MC
		Total	**20/0/6**	**26**	**21**	**-**	**900**	

SEMESTER VII								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
THEORY								
1.	21ME701	Industrial Engineering and Operations Management	3/0/0	3	3	-	60/40	HSMC
2.	21ME702	Mechatronics	3/0/0	3	3	-	60/40	ESC
3.	21MEZZZ	Emerging Elective – II	3/0/0	3	3	-	60/40	EEC
4.	21ME9ZZ	Professional Elective-V	3/0/0	3	3	-	60/40	PEC
5.	21ME9ZZ	Professional Elective-VI	3/0/0	3	3	-	60/40	PEC
PRACTICAL								
6.	21ME703	Mechatronics Laboratory	0/0/3	3	1.5	-	40/60	ESC
PROJECT WORK								
7.	21ME704	Phase I – Project Work	0/0/2	2	1	-	40/60	PROJ
		Total	**15/0/5**	**20**	**17.5**	**-**	**700**	

SEMESTER VIII								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
PROJECT WORK								
1.	21ME801	Phase II – Project Work	0/0/24	24	12	-	40/60	PROJ
		Total	**0/0/24**	**24**	**12**	**-**	**100**	

EMPLOYABILITY ENHANCEMENT SKILLS								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Ext./Int.**	**Cat.**
1.	21MEE01	Industrial Practice (21 Days) / Publication in Journals (National/International) / IPR	-	-	2	-	-	EES
		Total	**-**	**-**	**2**	**-**	**-**	

SCHEME OF CREDIT DISTRIBUTION – SUMMARY

SL. No.	Stream	Credits/Semester									C	%
		I	II	III	IV	V	VI	VII	VIII			
1	Humanities & Social Sciences Including Management (HSMC)	3	3	-	-	-	-	3	-		9	5.45
2	Basic Sciences (BSC)	8.5	8.5	4	4	-	-	-	-		25	15.15
3	Engineering Sciences (ESC)	10.5	11	3	-	-	-	4.5	-		29	17.58
4	Professional Core (PCC)	-	-	15.5	17	12.5	7.5	-	-		52.5	31.82
5	Professional Electives (PEC)	-	-	-	-	3	9	6	-		18	10.91
6	Open Electives (OEC) / Emerging Courses (EC)/ Emerging Elective Courses (EEC)	-	-	-	3	6	3	3	-		15	9.09
7	Project Work (PROJ)	-	-	-	-	-	1.5	1	12		14.5	8.79
8.	Employability Enhancement Skills (EES)	-	-	-	-	-	-	-	-	2	2	1.21
9.	Mandatory Course (MC)	-	-	-	-	-	-	-	-		0	0
Total		**22**	**22.5**	**22.5**	**24**	**21.5**	**21**	**17.5**	**12**	**2**	**165**	**100**

STRUCTURE FOR UNDERGRADUATE ENGINEERING PROGRAM

S. No.	Course Work - Subject Area	AICTE Suggested Credits	AICTE model curriculum credits	SKCET Credits (165)
1.	Humanities and Social Sciences (HS), including Management;	12*	6	**9**
2.	Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology;	25*	30	**25**
3.	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation;	24*	27	**29**
4.	Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required ;)	48*	50.5	**52.5**
5.	Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch;	18*	18	**18**
6.	Open Subjects- Electives (OE), from other technical and/or emerging subject areas;	18*	12	**15**
7.	Project Work, Seminar and/or Internship in Industry or elsewhere.	15*	15	**14.5**
8.	Employability Enhancement Skills	Non-credit		**2**
9.	Mandatory Courses (MC);	Non-credit		
Total		160*	158.5	**165**
**Minor Variations is allowed as per need of the respective disciplines*				

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT (9 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21EN101	Technical Communication Skills	2/0/2	4	3	HSMC
2.	21GE201	Universal Human Values	3/0/0	3	3	HSMC
3.	21ME701	Industrial Engineering and Operations Management	3/0/0	3	3	HSMC

BASIC SCIENCE COURSES (25 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21MA101	Engineering Mathematics I	2/1/2	5	4	BSC
2.	21CH101	Engineering Chemistry	3/0/3	6	4.5	BSC
3.	21MA201	Engineering Mathematics II	2/1/2	5	4	BSC
4.	21PH201	Applied Physics	3/0/3	6	4.5	BSC
5.	21MA301	Engineering Mathematics III	3/1/0	4	4	BSC
6.	21MA401	Probability and Numerical Methods	3/1/0	4	4	BSC

ENGINEERING SCIENCE COURSES (29 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21CS111	Problem Solving using C Programming	3/0/2	5	4	ESC
2.	21ME101	Engineering Drawing	1/0/3	4	2.5	ESC
3.	21EE111	Basics of Electrical and Electronics Engineering	3/0/2	5	4	ESC
4.	21ME201	Engineering Mechanics	3/1/0	4	4	ESC
5.	21ME202	Manufacturing Technology I	3/0/0	3	3	ESC
6.	21ME103	Engineering Practices Laboratory	0/0/3	3	1.5	ESC
7.	21CS211	Python for Engineers Laboratory	1/0/3	4	2.5	ESC
8.	21ME304	Industrial Metallurgy	3/0/0	3	3	ESC
9.	21ME702	Mechatronics	3/0/0	3	3	ESC
10.	21ME703	Mechatronics Laboratory	0/0/3	3	1.5	ESC

PROFESSIONAL CORE COURSES (52.5 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21ME301	Solid Mechanics	3/1/0	4	4	PCC
2.	21ME302	Engineering Thermodynamics	3/0/0	3	3	PCC
3.	21ME303	Fluid Mechanics and Machinery	3/0/0	3	3	PCC
4.	21ME305	Manufacturing Technology- II (with Lab)	3/0/2	5	4	PCC
5.	21ME306	Fluid Mechanics and Strength of Materials Laboratory	0/0/3	3	1.5	PCC
6.	21ME401	Automobile Engineering	3/0/0	3	3	PCC

7.	21ME402	Mechanics of Machines	3/1/0	4	4	PCC
8.	21ME403	Metrology and Instrumentation	3/0/0	3	3	PCC
9.	21ME404	Thermal Engineering	3/0/0	3	3	PCC
10.	21ME405	Computer Aided Machine Drawing	0/0/3	3	1.5	PCC
11	21ME406	Metrology and Dynamics Laboratory	0/0/3	3	1.5	PCC
12.	21ME407	Thermal Engineering Laboratory	0/0/2	2	1	PCC
13.	21ME501	Design of Machine Elements	4/0/0	4	4	PCC
14.	21ME502	Applied Hydraulics and Pneumatics	3/0/0	3	3	PCC
15.	21ME503	Heat and Mass Transfer	3/0/0	3	3	PCC
16.	21ME504	CAD/CAM Laboratory	0/0/3	3	1.5	PCC
17.	21ME505	Heat Transfer Laboratory	0/0/2	2	1	PCC
18.	21ME601	Design of Transmission Systems	3/0/0	3	3	PCC
19.	21ME602	Computational Mechanics	3/0/0	3	3	PCC
20.	21ME603	Simulation and Analysis Laboratory	0/0/3	3	1.5	PCC

PROFESSIONAL ELECTIVE COURSES (18 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
ELECTIVE STREAM I – ENGINEERING DESIGN						
1.	21ME901	Product Design and Development	3/0/0	3	3	PEC
2.	21ME902	Tool and Die Design	3/0/0	3	3	PEC
3.	21ME903	Fundamentals of Fracture Mechanics	3/0/0	3	3	PEC
4.	21ME904	Design for Manufacturing and Assembly	3/0/0	3	3	PEC
5.	21ME905	Optimization Techniques in Engineering Design	3/0/0	3	3	PEC
6.	21ME906	Industrial Robotics	3/0/0	3	3	PEC
7.	21ME907	Engineering Failure Analysis	3/0/0	3	3	PEC
8.	21ME908	MEMS/NEMS	3/0/0	3	3	PEC
9.	21ME909	Surface Engineering	3/0/0	3	3	PEC
ELECTIVE STREAM II - THERMAL ENGINEERING						
1.	21ME910	Non-Conventional Energy Sources	3/0/0	3	3	PEC
2.	21ME911	Refrigeration and Air Conditioning	3/0/0	3	3	PEC
3.	21ME912	Alternate Fuels and E-Vehicle Technology	3/0/0	3	3	PEC
4.	21ME913	Turbo Machines	3/0/0	3	3	PEC
5.	21ME914	Gas Dynamics and Jet Propulsion	3/0/0	3	3	PEC
6.	21ME915	Power Plant Engineering	3/0/0	3	3	PEC
7.	21ME916	Energy Conservation and Management	3/0/0	3	3	PEC
8.	21ME917	Internal Combustion Engines	3/0/0	3	3	PEC
9.	21ME918	Cryogenic Engineering	3/0/0	3	3	PEC

ELECTIVE STREAM III - MANUFACTURING /INDUSTRIAL ENGINEERING						
1.	21ME919	Composite Materials, Processing and Applications	3/0/0	3	3	PEC
2.	21ME920	Industrial Layout, Ergonomics and Safety Engineering	3/0/0	3	3	PEC
3.	21ME921	Additive Manufacturing	3/0/0	3	3	PEC
4.	21ME922	Lean Six Sigma	3/0/0	3	3	PEC
5.	21ME923	Theory of Metal Cutting	3/0/0	3	3	PEC
6.	21ME924	Entrepreneurship Development and Managerial Skills	3/0/0	3	3	PEC
7.	21ME925	Special Manufacturing Processes	3/0/0	3	3	PEC
8.	21ME926	Engineering Management and Financial Accounting	3/0/0	3	3	PEC
9.	21ME927	Advanced Casting and Welding Processes	3/0/0	3	3	PEC

OPEN ELECTIVE COURSES
(Offered to Other Branches)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21ME001	Industrial Safety	3/0/0	3	3	OEC
2.	21ME002	Fundamentals of MEMS/NEMS	3/0/0	3	3	OEC
3.	21ME003	Total Quality Management	3/0/0	3	3	OEC
4.	21ME004	Product Development	3/0/0	3	3	OEC
5.	21ME005	Fundamentals of Additive Manufacturing	3/0/0	3	3	OEC
6.	21ME006	Technology Management	3/0/0	3	3	OEC

EMERGING ELECTIVE COURSES

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21ME007	Applied Soft Computing Techniques	3/0/0	3	3	EEC
2.	21ME008	Internet of Things for Mechanical Engineers	3/0/0	3	3	EEC
3.	21ME009	Data Analytics for Mechanical Engineers	3/0/0	3	3	EEC
4.	21ME010	Expert System and Machine Learning	3/0/0	3	3	EEC
5.	21ME011	Fuel Cells	3/0/0	3	3	EEC
6.	21ME012	Product Life Cycle Management	3/0/0	3	3	EEC

PROJECT WORK (14.5 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21ME604	Design Thinking and Mini Project	0/0/3	3	1.5	PROJ
2.	21ME704	Phase I – Project Work	0/0/2	2	1	PROJ
3.	21ME801	Phase II – Project Work	0/0/24	24	12	PROJ

EMPLOYABILITY ENHANCEMENT SKILLS (2 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21MEE01	Industrial Practice (21 Days) and Publication in Journals (National/International) / IPR	-	-	2	EES

MANDATORY COURSES (Non Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	21MC101	Induction Program	3 WEEKS		0	MC
2.	21MC102	Environmental Sciences	2/0/0	2	0	MC
3.	21MC103	Soft Skills	2/0/0	2	0	MC
4.	21MC104	Management Organizational Behavior	2/0/0	2	0	MC
5.	21MC105	General Aptitude	2/0/0	2	0	MC
6.	21MC106	Life Skills and Ethics	2/0/0	2	0	MC
7.	21MC107	Stress Management	2/0/0	2	0	MC
8.	21MC108	Constitution of India	2/0/0	2	0	MC
9.	21MC109	Essence of Indian Traditional Knowledge	2/0/0	2	0	MC
10.	21MC110	Biology	2/0/0	2	0	MC

* Courses conducted either by internal faculty or through MOOCs

ONE CREDIT COURSES (Additional Credits) / VALUE ADDED COURSES

S.No	Course Code	Course Title	Credits
1.	21VA500	Certification in Creo, ANSYS, CFD, LabVIEW, CATIA, NDT etc.,	1
2.	21VA501	Any other certification from MNCs/OEMs, Texas Instruments, Bosch, Rexroth, SAE Skill India etc.,	1
3.	21VA502	NSS	1
4.	21VA503	Spoken Hindi / Foreign Language	1
5.	21VA504	Massive Open Online Courses (MOOC) / NPTEL	1
6.	21VA505	Geometric Dimensioning and Tolerancing	1
7.	21VA506	Automotive Interior/Exterior Plastic Parts Design	1
8.	21VA507	Project Management Process	1
9.	21VA508	Heating, Ventilation and Air Conditioning – HVAC	1

SERVICE SUBJECTS

SL. No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	21ME103	Engineering Practices Laboratory	0/0/3	3	1.5	40/60	ES
2	21ME111	Engineering Graphics	1/0/3	4	2.5	40/60	ES

SEMESTER WISE CREDIT DISTRIBUTION: -

Semester	I	II	III	IV	V	VI	VII	VIII	EES	Total
Credits	22	22.5	22.5	24	21.5	21	17.5	12	2	165

Total Credits: 165

L: Lecture **T:** Tutorial **P:** Practical **C:** Credit **O:** Outside Class hours **Cat.:** Category

HSMC : Humanities and Social Sciences including Management
BSC : Basic Science Courses
ESC : Engineering Science Courses
PCC : Professional Core Courses
PEC : Professional Elective Courses
OEC : Open Elective Courses
EEC : Emerging Elective Courses
EC : Emerging Courses
PROJ : Project Work
EES : Employability Enhancement Skills
MC : Mandatory Course

Definition of Credit:

L – Lecture	1 Hr. Lecture (L) per week	1 credit
T – Tutorial	1 Hr. Tutorial (T) per week	1 credit
P - Practical/Practice (Project and Industry based Courses)	1 Hr. Practical (P) per week	0.5 credit

Semester – 01

21MA101	ENGINEERING MATHEMATICS I (COMMON TO MECH, MCT, CIVIL, ECE, EEE, CSE, IT, AIDS)	2/1/2/4

Nature of Course	J (Problem analytical)
Pre-Requisites	Concept of Differentiation and Matrices

Course Objectives:

1	To develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
2	To know about system of linear equations and its solution set and how to write down the coefficient matrix and augmented matrix of a linear system
3	To familiarize with functions of several variables applicable in many branches of engineering.
4	To find the solution of ordinary differential equations as most of the engineering problems are characterized in this form.

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Recall the concepts of matrices, ordinary and partial derivatives.	[R]
C101.2	Express square matrix in the diagonal form.	[U]
C101.3	Solve systems of linear equations numerically and to find inverse matrices.	[AP]
C101.4	Apply numerical techniques effectively to analyse and visualize data to solve basic engineering-related problems.	[AP]
C101.5	Find the extreme values of the given functions to solve the engineering problems.	[AP]
C101.6	Find the solution of second and higher order differential equations connected with electric circuits and simple harmonic motion.	[AP]

Course Contents:

MATRICES

Definition – Types of matrices – Characteristic equation – Eigenvalues and eigenvectors of a real matrices and their properties (statement only) – Cayley-Hamilton theorem (statement only) –Verification and application to find inverse and powers of real matrices – Orthogonal transformation of a real symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by Orthogonal transformation. (14)

SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

Newton-Raphson method – Fixed point iteration method– Gauss-Elimination method – Gauss-Jordan method –Iterative methods of Gauss-Jacobi and Gauss-Seidel – Matrix Inversion by Gauss-Jordan method – Eigenvalue of a matrix by Power method and Jacobi method. (16)

CALCULUS

Concepts of limits and continuity –Functions of several variables – Total derivatives – Differentiation of implicit functions – Jacobians – Taylor series expansion – Maxima and Minima – Method of Lagrangian multipliers – Ordinary differential equations –Higher order linear differential equations with constant coefficients –Euler Cauchy's equations – Applications of ODE: Solving electrical circuits and simple harmonic motion. (18)

Lab Component

S.No	List of Experiments	RBT
1	Entering row vector, column vector, accessing blocks of elements in MATLAB.	[U]
2	Entering matrices, to locate matrix elements and Correcting any entry through indexing in MATLAB.	[U]
3	Eigenvalues and eigenvectors of a matrix using MATLAB.	[AP]

4	Sum, product, transpose, inverse, determinant and rank of a matrices using MATLAB.	[AP]
5	System of linear equations in MATLAB using Gaussian elimination.	[AP]
6	System of linear equations in MATLAB using matrix inverse method	[AP]
7	System of linear equations in MATLAB using linsolve.	[AP]
8	First and second derivative of single variable functions using MATLAB.	[AP]
9	Maxima and Minima of a function using MATLAB.	[AP]
10	Higher Order Equations of constant coefficients using MATLAB.	[AP]
	Total Hours: (48+12)	**60**

Text Books:	
1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 14th Edition,Pearson, Reprint,2018
2	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2018.
3	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2018.
Reference Books:	
1	Veerarajan. T, "Engineering Mathematics I", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2	Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012.
3	N.P.Bali and Dr.ManishGoyal,"A Text book of Engineering Mathematics" 9th edition, Laxmi publications ltd, 2014.
Web References:	
1	http://www.nptel.ac.in/courses/111105035
2	http://www.nptel.ac.in/courses/122104017
3	http://nptel.ac.in/courses/122102009
4	http://nptel.ac.in/courses/111107063
Online Resources:	
1	https://www.coursera.org/learn/linearalgebra2
2	https://www.coursera.org/learn/differentiation-calculus
3	https://www.coursera.org/learn/single-variable-calculus
4	https://alison.com/courses/Algebra-Functions-Expressions-and-Equations

Summative assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (10 Marks)			**CA 2 (10 Marks)**			**Practical Exam (30 Marks)**		**Theory Examination (50 Marks)**
SA 1 (6 Marks)	**FA 1**		**SA 2 (6 marks)**	**FA 2**		**FA (22 marks)**	**SA (8 Marks)**	
	Component -I (2 marks)	**Component -II (2 marks)**		**Component -III (2 marks)**	**Component -IV (2 marks)**			

Assessment Methods & Levels (based on Blooms'Taxonomy) - Theory				
Formative assessment based on Capstone Model (8%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C101.1	Remember	Component - I	Quiz	2
C101.2	Understand	Component - II	Assignment	2
C101.3	Apply	Component - III	Tutorial	2
C101.4	Apply	Component - IV	Group activity	2
C101.5	Apply			
C101.6	Apply			

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	20	20
Understand	30	30
Apply	50	50
Analyse	-	-
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C101.1	3	3	3	3	1								3		
C101.2	3	3	2	2	3								1		
C101.3	3	3	3	3	3								3		
C101.4	3	3	3	3	3								3		
C101.5	3	3	3	3	3								3		
C101.6	3	3	3	3	3								3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21CH101	ENGINEERING CHEMISTRY (COMMON TO ALL I YEAR B.E. / B.TECH)	3/0/3/4.5
Nature of Course	E (Theory skill based)	
Pre-Requisites	NIL	

Course Objectives:

1	To make the students conversant with water treatment, boiler feed water techniques.
2	To learn the effect of corrosion in materials and the methods for prevention of corrosion.
3	To understand the principles and applications of electrochemistry and to learn electroanalytical methods.
4	To understand the basic concepts, synthesis, and applications of nanomaterials.
5	To explore the synthesis and properties of important engineering plastics, energy sources and drug molecules.
6	To understand the concepts of photophysical and photochemical processes in spectroscopy.

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Recall the requirements of water treatment procedures and boiler feed water for industries.	[R]
C101.2	Apply the various corrosion control techniques in real time industrial environments.	[AP]
C101.3	Understand the principle and working of reference electrodes and conductivity meters as an analyzer.	[U]
C101.4	Understand the basic concepts and applications of Nanochemistry.	[U]
C101.5	Use the knowledge of polymers, various energy sources and storage devices in engineering field.	[AP]
C101.6	Understand the principle and working of certain analytical techniques, and synthesis of some common drug molecules.	[U]

Course Contents:

Water chemistry and Corrosion: Water treatment-characteristics of water-hardness-types and estimation of hardness by EDTA method with numerical problems. Boiler feed water–requirements-disadvantages of hard water. Domestic water treatment-disinfection methods (chlorination, Ozonation, UV treatment)-demineralization process–desalination-reverse osmosis. Corrosion-types–mechanism of dry and wet corrosion-galvanic corrosion-differential aeration corrosion-protective coatings-electroplating of gold-electroless plating of nickel.

Electrochemistry and Energy sources: Electrochemical cells-electrolytic cell-reversible and irreversible cells - Free energy and emf, cell potentials, Nernst equation and applications. Oxidation and reduction potentials-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Nanochemistry-Basics-Comparison of molecules, nanomaterials and bulk materials; Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: Electrochemical deposition and electro spinning. Applications of nanomaterials in medicine. Energy Sources-Fuel cells (H_2-O_2). Storage Devices-Batteries- Alkaline-Lead acid, Nickel cadmium and Lithium-ion batteries.

Polymer chemistry, Spectroscopic techniques and Synthesis of drug molecules: Introduction-monomers and polymers-classification of polymers-Polymerization-types. Mechanism of addition polymerization (free radical mechanism). Plastics-classification-

preparation, properties and uses of Nylon 6,6, Nylon 6, PVC, Bakelite and PET. Moulding methods- moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays (Compression moulding) and PET bottles (Blow moulding). Spectroscopy-Beer Lambert's law, principle, instrumentation, and applications of Electronic spectroscopy (UV-visible), Vibrational and rotational spectroscopy (IR) and Flame emission spectroscopy (FES). Synthesis of a commonly used drug molecule-Asprin, p-nitroaniline from acetanilide.

Field work:

Industrial visit- Water treatment plant / Sewage treatment plant / Reverse osmosis plant

Lab Components

S.No	List of Experiments	RBT
1	Estimation of hardness of water by EDTA method	[E]
2	Estimation of alkalinity of water sample	[E]
3	Determination of chloride content in bleaching powder	[E]
4	Estimation of dissolved oxygen in water	[E]
5	Potentiometry- determination of redox potentials and emf's	[E]
6	Conductometric titration-mixture of acids vs NaOH	[E]
7	Determination of strength of strong acid by pH metry	[E]
8	Corrosion rate of mild steel in acid medium	[E]
9	Electroplating of nickel over copper	[E]
10	Spectrophotometry-Estimation of iron in water	[E]
11	Separation of mixture of amino acids by thin layer chromatography	[E]
12	Synthesis of Nylon 66	[E]
	Total Hours:	**75**

Understanding the concepts by simple Demonstrations/Experiments:	
1	To observe the hardness of given water sample by soap solution test
2	To view the colour of the different medium of given water sample using litmus paper test
3	To detect the chlorine content in tap water using simple chemical method
4	To know the presence of dissolved oxygen in given water sample using glucose by redox principle
5	To illustrate the rate of corrosion in steel nails using acid medium

Text Books:	
1	Dara S.S, Umare S.S, "Engineering Chemistry", First revised Edition by S. Chand & Company Ltd., New Delhi 2015.
2	Jain P. C. & Monica Jain., "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
3	Fundamentals of Molecular Spectroscopy, 4th Edition by C. N. Banwell Publishing McGraw-Hill Book Company (P) Ltd, England, 1994.
4	Physical Chemistry, 11th Edition by P. W. Atkins Publishing Oxford University Press (P) Ltd, United Kingdom, 2018.
5	Nanochemistry, 2nd Edition by K. Klabunde, G. Sergeev Springer Publisher, 2013.
6	N.Krishna Murthy, Vallinayagam D.,"Engineering Chemistry" 3rd Edition by PHI Learning Pvt Ltd.,2014.

7	Sunita Rattan, A Text Book of Engineering Chemistry, Student Edition by SK Kataria Publishers, 2013.
8	R.V.Gadag, A.Nithyananda Shetty “Engineering Chemistry” 3rd Edition PHI Learning Pvt Ltd., 2014.
Reference Books:	
1	Shikha Agarwal., “Engineering Chemistry and Applications”, Cambridge University press, 2016.
2	Liliya.,Bazylak.I.,Gennady.E.,Zaikov.,Haghvi.A.K.,”Polymers and Polymeric Composites” CRC Press,2014.
3	Lefrou.,Christine.,Fabry.,Pierre.,Poignet.,Jean-claude.,”Electrochemistry - The Basics, with examples” 2012 ., Springer.
4	Zaki Ahmad, Digby Macdonald, “Principles of Corrosion Engineering and Corrosion Control”, Elsevier Science, 2nd Edition 2012.
5	Perez, Nestor,”Electrochemistry and Corrosion Science”, Springer, 2016.
6	Introduction to Nano: basics to Nanoscience and Nanotechnology, by Sengupta, Amretashis, Sarkar, Chandan Kumar, Springer Publisher, 2015.
7	Ghazi A.Karim. “Fuels, Energy and the Environment”, CRC Press, Taylor and Francis group, 2012.
Web References:	
1	http://www.analyticalinstruments.in/home/index.html
2	www.springer.com › Home › Chemistry › Electrochemistry
3	https://www.kth.se/.../electrochem/welcome-to-the-division-of-applied-electrochemistry
4	https://www.ntnu.edu/studies/courses
5	www.corrosionsource.com/
Online Resources:	
1	nptel.ac.in/courses/105104102/hardness.htm
2	https://ocw.mit.edu/courses/chemistry
3	nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf https://alison.com - Spectroscopic technique, Colorimetry
4	https://ocw.mit.edu/courses/chemistry
5	nptel.ac.in/courses/113108051
6	nptel.ac.in/courses/105104102/hardness.htm

Summative assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (10 Marks)			**CA 2 (10 Marks)**			**Practical Exam (30 Marks)**		**Theory Examination (50 Marks)**
SA 1 (6 Marks)	**FA 1**		**SA 2 (6 marks)**	**FA 2**		**FA (22 marks)**	**SA (8 Marks)**	
	Component -I (2 marks)	**Component -II (2 marks)**		**Component -III (2 marks)**	**Component -IV (2 marks)**			

Assessment Methods & Levels (based on Blooms'Taxonomy) - Theory				
Formative assessment based on Capstone Model (8%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C101.1	Remember	Component - I	Quiz	2
C101.2	Apply	Component - II	Assignment	2
C101.3	Understand	Component - III	Seminar	2
C101.4	Understand			
C101.5	Apply	Component - IV	Group activity	2
C101.6	Understand			

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	30	30	20
Understand	50	40	50
Apply	20	30	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	10	10
Understand	20	20
Apply	40	40
Analyse	30	30
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

Cos	**Pos**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**K**	**l**	**1**	**2**	**3**
C101.1	3			3			2								
C101.2	3			2			3								
C101.3	2		2				3								
C101.4	3		2				3								
C101.5	3						3								
C101.6	3		2	3			2								

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21EN101	TECHNICAL COMMUNICATION SKILLS (MECH/MCT/IT/CIVIL/CSE)	2/0/2/3

Nature of Course	E (Theory skill based)
Pre-Requisites	Basics of English Language

Course Objectives:

1	To enhance learners' LSRW skills.
2	To develop effective communication skills.
3	To facilitate learners to acquire effective technical writing skills.
4	To prepare learners for placement and competitive exams.
5	To facilitate effective language skills for academic purposes and real-life situations

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Remember language skills for technical communication.	[U]
C101.2	Apply communication skills in corporate environment.	[AP]
C101.3	Understand and communicate effectively in personal and professional situation.	[AP]
C101.4	Understand and analyse a variety of reading strategies to foster comprehension and to construct meaningful and relevant connections to the text.	[U]
C101.5	Apply technical writing skills to write letters, emails and prepare technical documents.	[AP]
C101.6	Apply language skills with ease in academic and real-life situations.	[AP]

Course Contents:

Listening and Speaking **17 Hours**

Introduction to Effective Communication- Basics of English Language - Importance of LSRW Skills - Self Introduction - Introducing Others - **Listening** to Short Conversations or Monologues - Listening to Speeches / Talks - Listening and Responding -- Longer Listening Tasks - Recognise Functions **Speaking**- Speaking about Giving Directions / Instruction - Talk about Preferences-Agree and Disagree - Giving Opinions - Speaking Practices by Giving Examples, Reasons and Extra Information- Short Talk on Business Topics- Non Verbal Communication- Presentation using Digital Tools- Power of Narrative- Leadership, Conflict and Persuasion.

Reading **13 Hours**

Reading Short Texts - Skimming and Scanning - Comparing Facts and Figures - Reading and Understanding Specific Information in a Text - Cloze Reading - Identifying Reasons and Consequences Through Reading Practices - Comprehension - Collocations.

Writing and Grammar **15 Hours**

Writing Formal Letters (Accepting and Declining Invitations) - Writing Business Letters (Placing an Order and Complaint Letter) - Email Writing – Memo - Circular - Agenda and Minutes of the Meeting - Job Application Letter - Resume Writing - Paragraph Writing – Proof Reading and Editing--Technical Instructions and Recommendations- Jumbled Sentences - Technical Definitions - Report Phrases - Report Writing - Technical Proposal - Transcoding (Bar Chart, Flow Chart).

Parts of Speech- Tenses – Subject Verb Agreement - Sentence Structures - Connectives - Modal Verbs - Question Formation - If Conditionals- Active and Passive - Impersonal Passive

Voice - Vocabulary Building - Business Vocabulary -- Synonyms, Antonyms – British and American Words - One Word Substitution- Identifying Common Errors.

Lab Components

S.No	List of Experiments	RBT
1	Listening Comprehension	[E]
2	Pronunciation, Intonation, Stress and Rhythm	[E]
3	Common Everyday Situations: Conversations and Dialogues.	[E]
4	Formal Presentation	[E]
5	Group Discussion	[E]
6	Interview Skills	[E]

Total Hours:	**60**

Text Books:	
1	Practical English Usage. Michael Swan. OUP. 1995.
2	Remedial English Grammar. F.T. Wood. Macmillan.2007
3	On Writing Well. William Zinsser. Harper Resource Book. 2001
4	Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.
Reference Books:	
1	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
3	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
Web References:	
1	http://www.academiccourses.com/Courses/English/Business-English
2	https://steptest.in
Online Resources:	
1	https://www.coursera.org/specializations/business-english
2	http://www.academiccourses.com/Courses/English/Business-English
3	https://scoop.eduncle.com/one-word-substitution-list

Summative assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (10 Marks)			**CA 2 (10 Marks)**			**Practical Exam (30 Marks)**		**Theory Examination (50 Marks)**
SA 1 (6 Marks)	**FA 1**		**SA 2 (6 marks)**	**FA 2**		**FA (22 marks)**	**SA (8 Marks)**	
	Component -I (2 marks)	**Component -II (2 marks)**		**Component -III (2 marks)**	**Component -IV (2 marks)**			

Assessment Methods & Levels (based on Blooms'Taxonomy) - Theory				
Formative assessment based on Capstone Model (8%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C101.1	Understand	Component - I	Quiz	2
C101.2	Apply			
C101.3	Apply	Component - II	Impromptu speaking	2
C101.4	Understand			
C101.5	Apply	Component - III	Reading comprehension	2
C101.6	Apply	Component - IV	Group assignment	2

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	20	20
Understand	40	40
Apply	40	40
Analyse	-	-
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**Pos**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**K**	**l**	**1**	**2**	**3**
C101.1									2	3		2			
C101.2									2	3		2			
C101.3									2	3		2			
C101.4										3		2			
C101.5									2	3					
C101.6									2	3		2			

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed	

21CS111	PROBLEM SOLVING USING C PROGRAMMING	3/0/2/4
Nature of Course	F (Theory Programming)	
Pre Requisites	Nil	

Course Objectives:

1	To understand problem solving using structured programming language
2	To gain knowledge about the control structures in C.
3	To develop logics and write C programs using arrays
4	To gain familiarity in inbuilt functions, structures and unions in C.
5	Apply concept and techniques for implementation in respective domain

Course Outcomes:
Upon completion of the course, students shall have ability to

C111.1	Apply problem solving techniques to solve real world problems	[AP]
C111.2	Understand C fundamental constructs and control structures	[U]
C111.3	Use the concept of pointers and arrays in designing programs	[AP]
C111.4	Design C programs using the concepts of strings and functions	[C]
C111.5	Develop programs using structures and Unions in C	[AP]
C111.6	Apply the suitable programming concept for the given computational problem	[AP]

Course Contents:

Problem Solving Techniques and C Fundamentals **15 Hours**

Problem Solving Techniques: Algorithm, Pseudo-code and Flowchart. Creative Thinking and Problem solving skills in everyday life. Understanding Compiler and interpreter. Program Development Life Cycle. C Fundamentals: Structure of C program, Character Set – Identifiers and Keywords – Data Types – Constants - Variables and Arrays – Declarations - Operators and Expressions –Precedence of operators and associativity. Data input and output - Preparing and running a Complete C Program

Control Structures, Arrays, Strings **15 Hours**

Control Structures: Branching: if-else- Looping – while - do while – for - Nested control structures –switch – break – continue – comma - goto. Arrays - Defining an array - Processing an array - Multi dimensional arrays - Strings: Defining a string - Null character -initialization of strings – reading and writing a string - processing the string

Pointers, Functions, Structures and Unions: **15 Hours**

Pointers: fundamentals – Pointer Declaration & Usage – Dynamic Memory Allocation. Functions: Defining a Function – Accessing a function – Function Prototype Functions - Pointer to Function - Functions Returning Pointers. - Pointers and Strings - Passing arguments to a function – Recursion. Structures and Unions: The Type Definition (type def) – Enumerated types – Structure - Type Definition – Initialization – Accessing Structures - Unions.

Lab Components

S.No	List of Experiments	RBT
1	Formulate simple algorithm and flowchart using Raptor Tool for simple and complex problem	[AP]
2	Program to process data types, format input and output and to evaluate an expression	[AP]
3	Program using decision making statements	[AP]
4	Program using looping statements	[AP]
5	Program using single- and two-dimensional arrays	[AP]

6	Program with Strings	[AP]
7	Program using Pointers.	[AP]
8	Program using Recursion	[AP]
9	Program using structures	[AP]
10	Branch specific application program	[AP]
	Total Hours:	**30**

Text Books:	
1	Sprankle M, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2013
2	Yashavant Kanetkar, "Let Us C", 16th Edition, BPB Publication, 2017.
3	Byron, S. Gottfreid, "Programming with C", McGraw Hill, Schaum's outlines, 4th Edition, 2018.
4	Reema Thareja Computer Fundamentals and Programming in C, 2nd edition, OXFORD publications, 2016
5	Brian W. Kernighan, Dennis Ritchie, " The C Programming Language", 2nd Edition Pearson Publications, 2015
Reference Books:	
1	Yashavant Kanetkar, "101 Challenges in C Programming" Edition, BPB Publication, 2017
2	Herbert Schildt, "The Complete Reference C", 4th Edition , McGraw Hill , 2015
3	Venugopal K R and Sudeep R.Prasad , "Mastering C", 2nd Edition, McGraw Hill, 2017
4	Jeri.RHanly, and Elliot B Koffman, "Problem solving and programming Design in C",8th Edition, Pearson 2016
Web References:	
1	http://raptor.martincarlisle.com/
Online Resources:	
1	https://nptel.ac.in/courses/106/104/106104128/
2	https://nptel.ac.in/courses/106/105/106105171/
3	https://www.coursera.org/specializations/c-programming

Summative assessment based on Continuous and End Semester Examination							
Continuous Assessment (50%)							**End Semester Examination (50%)**
CA 1 (10 Marks)			**CA 2 (10 Marks)**		**Practical Exam (30 Marks)**		**Theory Examination (50 Marks)**
SA 1 (6 Marks)	**FA 1**		**SA 2 (6 marks)**	**FA 2**	**FA (22 marks)**	**SA (8 Marks)**	
	Component -I (2 marks)	**Component -II (2 marks)**		**Component -III (4 marks)**			

Assessment Methods & Levels (based on Blooms'Taxonomy) - Theory				
Formative assessment based on Capstone Model (8%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C111.1	Apply	Component - I	Quiz	2
C111.2	Understand	Component - II	Assignment	2
C111.3	Apply			
C111.4	Create	Component - III	Mini project	4
C111.5	Apply			
C111.6	Apply			

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	30	20	20
Understand	50	30	40
Apply	20	50	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	20	20
Understand	20	20
Apply	60	60
Analyse	-	-
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C111.1	3	3	3						2	1		2	2		
C111.2	3	3	3						2	1		2	2		
C111.3	3	3	3						2	1		2	2		
C111.4	3	3	3						2	1		2	2		
C111.5	3	3	3						2	1		2	2		
C111.6	3	3	3						2	1		2	2	1	1

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME101	ENGINEERING DRAWING	1/0/3/2.5

Nature of Course	1. Practical Application
Pre Requisites	General Drawing skill

Course Objectives:

1	2. To develop skills for communication of concepts, ideas and design of engineering products.
2	To expose them to existing national standards related to technical drawings.
3	Ability to create basic geometries using the modelling software.

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Interpret and sketch the basic and intermediate geometries.	[Ap]
C101.2	Visualize and sketch the 3D diagram from 2D diagrams.	[Ap]
C101.3	Imagine the parametric features of new products.	[C]
C101.4	Sketch the geometries using the drafting software.	[Ap]
C101.5	Interpret the isometric to orthographic projection (Vice versa)	[A]

Course Contents:

Concepts and conventions: Drafting instruments, BIS conventions, drawing sheets, general principles of projection in quadrants: First angle projection – Layout of views. **(Not for examination)**

Manual drafting of the following using mini-drafter
General Plane Curves: Conic curves: ellipse, parabola and hyperbola by eccentricity method. Drawing normal and tangents to these curves, Involutes- Circle, Square, Simple Cycloid.
Orthographic projection- Conversion of isometric/pictorial in to orthographic views.

Projection of lines and planes- Object has inclination to any one planes: HP or VP. **Projection of solids-** Basic concepts using a simple Prisms/Pyramids in vertical position and axis inclined to one of the principle planes.

Sectioning of solids- Basic concepts using a simple prism/pyramid in vertical position. **Development of lateral surfaces of solids-** Development of lateral surfaces of Simple Prisms/Pyramids and Truncated Prisms only. **Isometric drawing** of solids – Simple Prisms/ Pyramids and Composite solids. **Perspective projection –** Introduction to Visual ray method and vanishing point method.

Lab Components

S.No	List of Experiments	CO Mapping	RBT
1	Study the Basics of 2D and 3D modeling	C101.4	[R]
2	Drafting of title block, Co-ordinate system	C101.4	[U]
3	Drafting of simple geometrics: Line, planes and simple 2D drawings- Three exercises	C101.4	[A]

Total Hours: 60

Text Books:

1	K. V. Natarajan, “A Text Book of Engineering Graphics", Dhanalakshmi Publishers, 2018.
2	Varghese P. I., “Engineering Drawing”, McGraw Hill Education Pvt. Ltd., 2015.
3	Shah M.B. and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2010.
4	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2010.

Reference Books:	
1	Bhatt N.D and Panchal, “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2014.
2	Venugopal K. and Prabhu Raja V, “Engineering Graphics”, New Age Int. (P) Limited, 2011.

Web References:	
1	http://nptel.ac.in/courses/112103019/Engineering drawing
2	http://pioneer.netserv.chula.ac.th/~kjirapon/self-practice.html

Summative assessment based on Continuous and End Semester Examination

Continuous Assessment (50%)							End Semester Examination (50%)
CA 1 (10 Marks)			CA 2 (10 Marks)		Practical Exam (30 Marks)		Theory Examination (50 Marks)
SA 1 (6 Marks)	FA 1		SA 2 (6 marks)	FA 2	FA (22 marks)	SA (8 Marks)	
	Component -I (2 marks)	Component -II (2 marks)		Component -III (4 marks)			

Assessment Methods & Levels (based on Blooms’Taxonomy) - Theory

Formative assessment based on Capstone Model (8%)

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)		Marks
C101.1	Apply	Component - I	Assignment	2
C101.2	Apply			
C101.3	Create	Component - III	Model making	4
C101.4	Apply			
C101.5	Analyse	Component - II	Assignment	2

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment (12%)		End Semester Examination (50%) [50 Marks]
	CIA1 [6 Marks]	CIA2 [6 Marks]	
Remember	10	-	10
Understand	20	10	10
Apply	40	40	40
Analyse	30	40	40
Evaluate	-	10	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical

Bloom’s Level	Continuous Assessment (30%)	
	FA (22 Marks)	SA (8 Marks)
Remember	20	20
Understand	30	30
Apply	50	50
Analyse	-	-
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C101.1	3			1						3			2		
C101.2	3			1						3			3	1	
C101.3	3		1							3			2		
C101.4	3		1		1					3			3	1	
C101.5	3									3			2		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21EE111	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING (COMMON TO CSE, MECH, CIVIL AND IT)	3/0/2/4

Nature of Course	G (Theory analytical)
Course Pre-requisites	Nil

Course Objectives:

1	To equip students with a basic understanding of Electrical circuits
2	To learn the working principle of transformers
3	To understand the DC and AC Machine working principles and to have a knowledge on selection of machine for specific types of applications.
4	To give a comprehensive exposure to electrical installations.
5	To equip students with an ability to understand basics of analog and digital electronics.

Course Outcomes:
Upon completion of the course, students shall have ability to

C111.1	Analyze the concepts in AC circuit and DC circuits.	[A]
C111.2	Understand the working principle of single phase and three phase transformers.	[U]
C111.3	Understand the working principle of DC and AC machines.	[U]
C111.4	Utilize the basic components for electrical installations.	[AP]
C111.5	Understand the basic concepts of Analog and Digital Electronics.	[U]

Course Contents:

Course Contents:

Module 1: DC Circuits and AC Circuits **20 Hrs**

DC Circuits - Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage law, analysis of simple circuits with dc excitation, Mesh, Nodal Analysis Superposition, Thevenin's Theorem, Maximum power transfer theorem and Norton's Theorem. **AC Circuits** - Representation of sinusoidal waveforms, peak and rms values, Phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, voltage and current relations in star and delta connections.

Module 2: Electrical Machines and Installations **15 Hrs**

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections (Qualitative only). Construction and working principle of DC motor. Construction and working principle of Synchronous motor and three phase Induction motor. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption.

Module 3: Basics of Analog and Digital Electronics **10 Hrs**

Semiconductor, PN junction diode, Zener diode, rectifier- Half wave, full wave and Bridge rectifier, Introduction to Number system, basic Boolean laws, reduction of Boolean expressions and implementation with logic gates.

Lab Component

S.No	List of Experiments	CO Mapping	BT

1	Familiarization of Electrical Elements, Sources, Measuring Devices and Verification of ohm's law	C111.1	[U]
2	Estimation of voltage and current by KVL and KCL in Electric Circuits	C111.1	[AP]
3	Determination of mesh current and node voltage by Mesh and Nodal Analysis	C111.2	[AP]
4	Application of Superposition theorems, thevenin's and maximum power transfer theorem in electrical circuits	C111.2	[AP]
5	Determination of three phase power	C111.2	[AP]
6	Demonstration of cut-out sections of machines: dc machine (Commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winding - slip ring arrangement) and single-phase induction machine	C111.2	[U]
7	Load test on DC shunt motor.	C111.3	[AP]
8	Demonstration of components of LT Switch Gears	C111.4	[AP]
9	Construction of bridge rectifier with and without filters	C111.5	[AP]
10	Verification of logic gates.	C111.5	[A]
		Total Hours	**75**
Text Books:			
1	Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 6th edition 2015.		
2	Vincent. Del. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 2nd edition, 2015.		
3	E. Hughes, "Electrical and Electronics Technology", Pearson, 10th edition, 2011		
4	Donald .A. Neamen, Electronic Circuit Analysis and Design, 2nd Edition reprint, Tata Mc GrawHill, 2013.		
5	M. Morris Mano, 'Digital Logic and Computer Design', Prentice Hall of India, 6th edition, 2017		
Reference Books:			
1	Charles A.Gross, Thaddeus A.Roppel, "Fundamentals of Electrical Engineering", CRC press, 2012.		
2	D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 5th edition 2012,		
3	Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, 'Electronic Devices and Circuits', Pearson Education, 6th edition, 2019.		
4	Charles A.Gross, Thaddeus A.Roppel, "Fundamentals of Electrical Engineering", CRC press, 2012.		
Web References:			
1	http://nptel.ac.in/course.php?disciplineId=108		
2	https://ocw.mit.edu/courses/find-bytopic/#cat=engineering&subcat=electricalengineering&spec=electricpower		
3	https://nptel.ac.in/video.php?subjectId=117103063		
4	https://onionesquereality.wordpress.com/.../more-video- lectures-iit-open		
5	https://nptel.iitg.ernet.in/Elec_Comm_Engg/.../Video-ECE.pdf		
Online Resources:			
1	https://www.edx.org/course/electricity-magnetism-part-1-ricex-phys102-1x-1		

2	https://www.mooc-list.com/course/fundamentals-electrical-engineering-coursera
3	https://nptel.ac.in/course.php

Summative assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (10 Marks)			**CA 2 (10 Marks)**			**Practical Exam (30 Marks)**		**Theory Examination (50 Marks)**
SA 1 (6 Marks)	**FA 1**		**SA 2 (6 Marks)**	**FA 2**		**FA (22 Marks)**	**SA (8 Marks)**	
	Component -I (2 Marks)	**Component -II (2 Marks)**		**Component -I (2 Marks)**	**Component -II (2 Marks)**			

	Assessment Methods & Levels (based on Blooms' Taxonomy) - Theory		
	Formative assessment based on Capstone Model (8%)		
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C111.1	Analyze	Component - I – Assignment	2
C111.2	Understand	Component - II – Tutorial	2
C111.3	Understand	Component - III – Quiz	2
C111.4	Apply	Component - IV – Simulation	2
C111.5	Understand		

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	10	10	10
Understand	10	30	30
Apply	40	50	30
Analyse	40	10	30
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	10	10
Understand	30	30
Apply	20	20
Analyse	40	40
Evaluate	-	-
Create	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
30	20	50	100

No. of the CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C111.1	2	1			2							2	3	3	
C111.2	3	3	2	2	2							2	3	3	
C111.3	3	2	1	1	2							2	3	3	
C111.4	3	3	2	2	2							2	3	3	
C111.5	2	1			2							2	3	3	
1	Reasonably Agreed				2	Moderately Agreed					3	Strongly Agreed			

Semester – 02

21ME201	ENGINEERING MECHANICS	3/1/0/4
Nature of Course	Concepts and Analytical	
Pre Requisites	Fundamentals of basic mathematics and physics	

Course Objectives:

1	To make the students understand the vector and scalar representation of forces and moments and the static equilibrium of particles and rigid bodies.
2	To understand the effect of friction on equilibrium, laws of motion, kinematics of motion and their interrelationship.
3	To make the students understand the properties of surfaces and solids, prediction of behaviour of particles and rigid bodies under motion.

Course Outcomes:
Upon completion of the course, students shall have ability to

C201.1	Define and illustrate the basic concepts of force system	[U]
C201.2	Calculate the resultant force, moment and geometrical properties of 2D, 3D objects	[Ap]
C201.3	Analyse the resistance force of particles and objects for Impending Motion	[A]
C201.4	Determine the displacement, velocity and acceleration of particles and objects.	[Ap]
C201.5	Determine the Dynamic forces exerted in various mechanisms of planar motion	[Ap]

Course Contents:

Equilibrium of Particles and Rigid Bodies: Force Systems – Basic concepts, System of Forces, Coplanar Concurrent Forces, Resolution and addition of forces, resultant of several concurrent forces, Forces in space, Particle equilibrium in 2D and 3D. Moment of Forces and its Application; Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems - Equations of equilibrium of rigid bodies in 2D and 3D. Beams and frames - types of supports, loads and reactions.

Centre of Gravity, Moment of Inertia and Friction: Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere.
Friction: Types of friction, Limiting friction, Laws of friction – Static and Dynamic Friction; simple contact friction, ladder friction – wedge friction.

Dynamics of Particles and rigid bodies: Kinematics of Particles: Basic terms, general principles in dynamics; Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates); Relative motion.
Kinetics of Particles: Newton's 2nd law (rectangular, path, and polar coordinates). D'Alembert's principle and its applications; Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.
Kinetics of rigid bodies: rigid body translation, rotation and general plane motion.

Total Hours:	**60**

Text Books:	
1	Beer F.P, and Johnston ER, Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill Education, New Delhi, 2015.
2	Dhiman A.K, Dhiman P, Kulshreshtha D.C, Engineering Mechanics-Statics and Dynamics, McGraw Hill Education, 2015.
Reference Books:	
1	Kottiswaran N, Engineering Mechanics - Statics and Dynamics, Sri Balaji Publications- 2013.
2	Rajasekaran S and Sankarasubramanian G, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2009.
3	Meriam JL and Craige, "Engineering Mechanics statics and dynamics", John Willey and Son's publication, 8th edition.2011
4	Kumar DS, "Engineering Mechanics", S.K.Kataria& Sons Publications-2012.
5	Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2011.
6	Timoshenko.S, "Engineering Mechanics", McGraw Hill Education, 2008.
Web References:	
1	http://nptel.ac.in/courses/122104015/
2	http://nptel.ac.in/courses/112103109/
Online Resources:	
1	https://ocw.mit.edu/courses

Summative assessment based on Continuous and End Semester Examination

Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA 2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -III (4 marks)**	**Component -IV (4 marks)**	

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (16%)

Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C201.1	Understand	Component - I	Objective type Quiz	4
C201.2	Apply	Component - II	Assignment	4
C201.3	Analyze	Component - III	Assignment	4
C201.4	Apply	Component - IV	Tutorial	4
C201.5				

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	10	10	10
Understand	10	20	20
Apply	40	40	40
Analyse	40	30	30
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C201.1	3		1										2		
C201.2	3	2	2										3	1	
C201.3	3	3	3										3		
C201.4	3	2	3										3	1	
C201.5	3	2	2										3	1	
	3 Strongly agreed | 2 Moderately agreed | 1 Reasonably agreed														

21ME202	MANUFACTURING TECHNOLOGY – I	3/0/0/3
Nature of Course	Theory concepts	
Pre Requisites	Fundamentals of Physics and Chemistry	

Course Objectives:

1	3. To describe the various manufacturing processes used to produce the desired components.
2	To impart the methodologies to be followed in casting, metal joining and forming of engineering materials.
3	To enable the students to select a suitable manufacturing process for the required product based on its process characteristics.

Course Outcomes:
Upon completion of the course, students shall have ability to

C202.1	Describe the concepts of basic manufacturing processes like casting, plastic moulding, welding and forming processes	[U]
C202.2	Develop appropriate casting techniques for various materials and components	[Ap]
C202.3	Select the suitable welding process for an application	[Ap]
C202.4	Apply a suitable metal forming processes and other manufacturing process for making an industrial usable component	[Ap]
C202.5	Explore the possible defects and its causes in various manufacturing processes.	[U]

Course Contents:

METAL CASTING AND PLASTIC MOULDING PROCESSES: Metal casting: Sand casting – Sand moulding - Pattern – materials, types and allowances - Types of Molding sand – Properties and testing - Cores and its types – CO_2 process for core hardening –Classification and methods of moulding-Moulding Machines – Induction furnace for melting – Fettling and cleaning of castings - Casting defects - Special casting techniques - shell moulding, Investment casting, pressure die casting processes, centrifugal casting, continuous casting, ceramic mould casting, stir casting and squeeze casting – Plastic moulding: Plastic types and properties – plastic moulding techniques – injection moulding, blow moulding, rotational moulding, extrusion process, thermoforming and film blowing, compression moulding, transfer moulding.

METAL JOINING PROCESSES: Welding – classification- Gas welding processes – equipments and flame characteristics – Arc welding processes – use of bare and coated electrode – shielded metal arc welding, TIG welding, MIG welding - Submerged arc welding, plasma arc welding, atomic hydrogen welding, electro slag welding, thermit welding, Resistance welding – working principle of spot, seam and projection welding –diffusion and explosive welding - friction welding and friction stir welding-Electron beam welding , Laser beam welding– common welding defects and inspection of weldments- Soldering and brazing – other joining processes – mechanical joining and adhesive bonding.

METAL FORMING PROCESSES: Hot and cold working processes – Open and closed die forging– Types of forging hammers – forging operations – forging defects – Rolling – types of rolling mills – flat and shape rolling - Thread and ring rolling – Defects in rolled parts - Extrusion types – Wire, rod and tube drawing. **SHEET METAL WORKING:** Sheet metal characteristics – Shearing, drawing, bending and metal spinning operations – Stretch forming operations – Formability of sheet metal, Formability limit diagram –special forming processes- hydro forming, Electro hydraulic forming, Rubber pad forming, Explosive forming, Electromagnetic forming, Peen forming. **SPECIAL MANUFACURING TECHNIQUES:** Introduction to powder metallurgy and additive manufacturing- FDM.

Total Hours:	**45**

Text Books:	
1	Serope Kalpajian, Steven R.Schmid, Manufacturing Engineering and Technology, Pearson Education, Seventh edition, 2018.
2	P. N. Rao, “Manufacturing Technology”, Vol.1, McGraw-Hill Education, 2013.
Reference Books:	
1	Hajra Choudhury, “Elements of Workshop Technology”, Vol. I & II, Media Promotors Pvt Ltd., 2014
2	P.C. Sharma, “A Text Book of Production Engineering”, S. Chand and Co. Ltd, Eighth Revised edition, 2014.
3	Radhakrishnan, “Manufacturing Technology I”, Scitech Publications Pvt Ltd, 2010
Web References:	
1	www.nptel.ac.in
2	www.sme.org
3	https://www.coursera.org/learn/3d-printing-revolution
Online Resources:	
1	https://ocw.mit.edu/courses

Summative assessment based on Continuous and End Semester Examination					
Continuous Assessment (40%)					**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA 2 (20 Marks)**		
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		**Theory Examination (60 Marks)**
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -III (4 marks)**	**Component -IV (4 marks)**	

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (16%)

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C202.1 C202.5	Understand	Component - I	Quiz	4
C202.2	Apply	Component - II	Assignment Presentation	4
C202.3	Apply	Component - III	Group Assignment	4
C202.4	Apply	Component - IV	Seminar	4

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C202.1	3	3	2											3	
C202.2	3	3	2											3	
C202.3	3	3	2											3	
C202.4	3	3	2											3	
C202.5	3	3	2											3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21GE201	UNIVERSAL HUMAN VALUES (All Branches)	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre-Requisites	Interpersonal Communication and Value Sciences	

Course Objectives:

1	Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
3	Strengthening of self-reflection.
4	Development of commitment and courage to act.
5	Helping the students to appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings
6	Highlighting plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature

Course Outcomes:
Upon completion of the course, students shall have ability to

C201.1	Understand about themselves and their surroundings (family, society, nature).	[U]
C201.2	Understand and take responsibilities in life and handle problems to attain sustainable solutions while keeping human relationships and human nature in mind.	[U]
C201.3	Apply responsibilities towards their commitments (human values, human relationship and human society).	[AP]
C201.4	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.	[AP]
C201.5	Analyse ethical and unethical practices, and formulate strategies to actualize a harmonious environment wherever they work.	[A]
C201.6	Understand the harmony in nature and existence, and work out mutually on fulfilling participation in the nature.	[U]

Course Contents:

Introduction - Need, Basic Guidelines, Content and Process for Value Education, Understanding Harmony in the Human Being - Harmony in Myself! - Purpose and motivation for the course. Self-Exploration–Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Understanding human being as a co-existence of the sentient 'I' and the 'Material Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical Facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of 'I' with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail-Programs to ensure Sanyam and Health.

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship, Understanding Harmony in the Nature and Existence - Whole existence as Coexistence - Understanding values in human-human relationship; meaning of Justice (nine

universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and Competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all- pervasive space. Holistic perception of harmony at all levels of existence.

Implications of the above Holistic Understanding of Harmony on Professional Ethics - Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for the above production systems. Case studies of typical holistic technologies, management models and eco-friendly production systems. Strategy for transition from the present state to Universal Human Order: a. Individual level: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations. Sum up.

Total Hours:	**45**

Text Books:	
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, 2010
2	Rajni Setia, Priyanka Sharma, " Human Values", Genius Publication", Jaipur,2019.
Reference Books:	
1	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
2	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
3	India Wins Freedom - Maulana Abdul Kalam Azad.
Web References:	
1	https://examupdates.in/professional-ethics-and-human-values/
2	http://hvpe1.blogspot.com/2016/06/notes-human-values-and-professional.html
3	https://www.yourmorals.org/schwartz.2006.basic%20human%20values.pdf
Online Resources:	
1	https://nptel.ac.in/courses/109/104/109104068/
2	https://medium.com/the-mission/the-12-important-life-skills-i-wish-id-learned-in-school-f4593b49445b
3	https://www.thebalancecareers.com/life-skills-list-and-examples-4147222

Summative assessment based on Continuous and End Semester Examination															
Continuous Assessment (40%)														End Semester Examination (60 %)	
CA 1 (20 Marks)						CA 2 (20 Marks)								Theory Examination (60 Marks)	
SA 1 (12 Marks)	FA 1					SA 2 (12 marks)	FA 2								
	Component -I (4 marks)		Component –II (4 marks)				Component -III (4 marks)		Component -IV (4 marks)						

Assessment Methods & Levels (based on Blooms'Taxonomy)				
Formative assessment based on Capstone Model (16%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C201.1	Understand	Component - I	Group Discussion	4
C201.2	Understand	Component - II	Book Review	4
C201.3, C201.4	Apply	Component - III	Role Play	4
C201.5, C201.6	Apply	Component - IV	Formal Presentation	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	Pos												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C201.1						3	3	3	2				1		
C201.2						3	3	3	2				1		
C201.3						3	3	3	2				1		
C201.4						2	1	3	1				1		
C201.5						3	3	3	2				1		
C201.6						3	3	3	2				1		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21MA201	ENGINEERING MATHEMATICS II (COMMON TO MECH, MCT, CIVIL, ECE, EEE, CSE, IT, AIDS)	2/1/2/4
Nature of Course	J (Problem analytical)	
Pre Requisites	Concepts of Differentiation and Integration	

Course Objectives:

1	To gain knowledge in integrals, which are needed in engineering applications.
2	To develop logical thinking and analytical skills in evaluating multiple integrals.
3	To acquaint with the concepts of vector calculus needed for problems in all engineering disciplines.
4	To impart the knowledge of Laplace transform, to find solutions of initial value problems for linear ordinary differential equations.

Course Outcomes:
Upon completion of the course, students shall have ability to

C201.1	Determine the area and volume by applying the techniques of double and triple integrals.	[R]
C201.2	Finding the values of integrals through different numerical methods.	[U]
C201.3	Differentiate and integrate a vector-valued functions to solve real world applications.	[AP]
C201.4	Calculate grad, div, curl and use Gauss, Stokes and Greens theorem to simplify the calculations of integrals.	[AP]
C201.5	Apply Laplace transform techniques in system modelling, digital signal processing, process control, solving boundary value problems.	[AP]
C201.6	Apply Laplace transform methods for solving linear differential equations.	[AP]

Course Contents:

Integral Calculus

Definite integrals: Evaluation of definite integrals using Bernoulli's formula –Multiple Integrals: Double integration in Cartesian coordinates –Area as double integral –Change of order of Integration – Triple integration in Cartesian co-ordinates –Volume as triple integral –Beta and Gamma functions – Relation between Beta and Gamma Functions – Evaluation of Integrals using Beta and Gamma Functions –Numerical integration: Trapezoidal rule and Simpson's rule for single and double integrals. (18)

Vector Calculus

Vector differential operator – Gradient of a scalar point function - Directional derivatives – Divergence and Curl of a vector point function – Irrotational and solenoidal vector fields –Simple problems – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (theorems statements only)– Simple applications involving cubes and rectangular parallelepipeds. (14)

Laplace Transform

Convergence of Laplace transform – Transform of some standard functions –Unit step function – Unit Impulse function – Properties – Initial and final value theorem – Inverse Laplace transform – Partial fraction method – Convolution theorem – Application of Laplace transform for solving second order ordinary differential equation. (16)

Lab Components

S.No	List of Experiments	RBT
1	Double integrals evaluation in cartesian coordinates using MATLAB.	[AP]

2	Triple integral calculations using MATLAB in cartesian and cylindrical coordinates.	[AP]
3	Double integral evaluation in MATLAB by Trapezoidal rule.	[AP]
4	Evaluation of gradient, curl and divergence in MATLAB.	[AP]
5	Line integral over a vector field using MATLAB	[AP]
6	Applying Green's theorem to solve integrals in MATLAB.	[AP]
7	Relation between Laplace transform of function and its derivative using MATLAB.	[AP]
8	Laplace transform of Dirac delta and Heaviside functions in MATLAB.	[AP]
9	Solving Differential Equations in MATLAB using Laplace Transform.	[AP]
10	Inverse Laplace Transform of symbolic expressions using MATLAB.	[AP]
	Total Hours:	**60**

Text Books:	
1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 14th Edition, Pearson, Reprint, 2018.
2	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore, 2018.
3	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2014.
Reference Books:	
1	Veerarajan. T, "Engineering Mathematics II",Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012.
3	N.P.Bali and Dr.ManishGoyal, "A Text book of Engineering Mathematics", 9th edition, Laxmi publications ltd, 2014.
Web References:	
1	http://nptel.ac.in/video.php?subjectId=122107037
2	http://nptel.ac.in/courses/122107036/
3	http://nptel.ac.in/video.php?subjectId=117102060
Online Resources:	
1	https://www.coursera.org/learn/pre-calculus
2	https://www.coursera.org/learn/linearalgebra1
3	https://alison.com/courses/Advanced-Mathematics-1
4	https://www.edx.org/course/algebra-lineal-mexicox-acf-0903-1x.

Summative assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (10 Marks)			**CA 2 (10 Marks)**			**Practical Exam (30 Marks)**		**Theory Examination (50 Marks)**
SA 1 (6 Marks)	**FA 1**		**SA 2 (6 marks)**	**FA 2**		**FA (22 marks)**	**SA (8 Marks)**	
	Component -I (2 marks)	**Component -II (2 marks)**		**Component -III (2 marks)**	**Component -IV (2 marks)**			

Assessment Methods & Levels (based on Blooms' Taxonomy) - Theory				
Formative assessment based on Capstone Model (8%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C201.1	Remember	Component - I	Quiz	2
C201.2	Understand	Component - II	Assignment	2
C201.3	Apply	Component - III	Tutorial	2
C201.4	Apply	Component - IV	Group activity	2
C201.5	Apply			
C201.6	Apply			

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	20	20
Understand	30	30
Apply	50	50
Analyse	-	-
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**Pos**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**H**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C201.1	2	2	2	1	2	1							1		
C201.2	2	2	2	2	2	2							2		
C201.3	3	3	3	3	3	3							3		
C201.4	3	3	3	3	3	3							3		
C201.5	3	3	3	3	3	3							3		
C201.6	3	3	3	3	3	3							3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21PH201	APPLIED PHYSICS (COMMON TO MECH, MCT AND CIVIL)	3/0/3/4.5
Nature of Course	E (Theory skill based)	
Prerequisites	Nil	

Course Objectives:

1	To learn the basic concepts of physics needed for all branches of engineering.
2	To enable the students to understand the basics of properties of matter, harmonic oscillator, quantum mechanics and crystallography.
3	To familiarize the principles of various instruments and laser.

Course Outcomes:
Upon completion of the course, students shall have the ability to

C201.1	Describe the bending behavior beams, analyze the expression for young's modulus and working of torsional pendulum.	[U]
C201.2	Identify the various parameters that are measurable in different instruments.	[U]
C201.3	Discuss the physical characteristics of oscillation and the basic principle of laser.	[U]
C201.4	Understand the central concepts and principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation.	[U]
C201.5	Estimate the Atomic packing and acquire the basic knowledge about Crystal Lattice, Unit cell, Crystal defects and classify the solids based on band theory.	[Ap]
C201.6	Apply the gained knowledge to solve the problems related to their field of study.	[Ap]

Course Contents:

Properties of matter and Instrumentations: 15 hours

Properties of matter: elasticity –Plasticity – Types of stress and strain –Hooke's law, stress-strain diagram - Poisson's ratio – Types of moduli of elasticity, relation between three moduli of elasticity –Factors affecting elasticity – Bending moment of a body: neutral surface and neutral plane, derivation of expression for bending moment of a beam with circular and rectangular cross section, cantilever, I- beam – Derivation of expression for Young's modulus –Torsion of cylinder: expression for couple per unit twist of a solid cylinder (derivation), torsional pendulum, expression for period of oscillation. **Instrumentations:** dial gauge – Piezo electric strain gauge – Load cell: pneumatic load cell and hydraulic load cell – Pirani gauge – Optical microscope: Scanning electron microscope (SEM), transmission electron microscope (TEM) – Types of errors: gross error, systematic error and random error.

Harmonic oscillations and Laser 15 hours

Harmonic oscillations: periodic motion– Simple harmonic motion: characteristics of simple harmonic motion –Simple spring-mass system – Resonance – Damped harmonic oscillator, energy decay in a damped harmonic oscillator. **Laser:** characteristics of laser – Principle of spontaneous emission and stimulated emission – Einstein's theory of matter radiation interaction and A and B coefficients (derivation) – Population inversion – Pumping –Different types of lasers: Neodymium laser, CO_2 and semiconductor laser (heterojunction) – Thermal effect –Qualitative industrial applications of lasers: welding, drilling and cutting.

Quantum mechanics and Crystallography: 15 hours

Quantum mechanics: Planck's quantum theory (derivation)– Matter waves, de-Broglie wavelength –Heisenberg's uncertainty principle – Schrödinger's wave equation: time independent and time dependent– Physical significances of wave function – Particle in a one dimensional potential box. **Crystallography:** crystal system – lattice –Bravais lattice, calculation of atomic packing factor for simple cubic, body centered cubic, face centered cubic

and hexagonal close packed lattice–Miller indices – Crystal imperfections: point, line burger vector – Basic concepts of band theory and classification of materials into conductor, semi-conductor and insulator.		
Lab Components		
S.No	**List of Experiments**	**RBT**
1	Young's modulus of the material - Non-Uniform bending method.	[U]
2	Moment of Inertia of disc and rigidity modulus of a wire – Torsional pendulum.	[U]
3	Projectile motion – Simulation lab.	[U]
4	Frequency of transverse and longitudinal wave modes –Melde's experiment.	[U]
5	Simple harmonic motion- Simulation lab.	[U]
6	Determination of laser and optical fiber parameters.	[U]
7	Determination of Planck's Constant.	[U]
8	Determination of Stefan's Constant.	[U]
9	Determination of lattice constant of cubic crystal structure.	[U]
10	Determination of band gap of semiconductor.	[U]
	Life Skills Experiments	
1	How does a fuel (gas/liquid) pump nozzle shut off?	
2	How does a circuit breaker work?	
3	How to Check Earthing at Home?	
	Total Hours:	**75**
Text Books:		
1	David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics", Wileyplus, 2018	
2	Rajendran. V, "Engineering Physics", Mc Graw Hill Publications ltd, New Delhi, 2016.	
Reference Books:		
1	Avadhanulu M. N., Kshirshagar P. G., Arun Murthy TVS, "A Text Book of Engineering Physics", S. Chand & Co Ltd, 2018.	
2	Sawhney A. K., Puneet Sawhney "A Course In Mechanical Measurements And Instrumentation & Control", Dhanpat Rai & Co, 2013.	
3	Richard P. Feynman. Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics Vol. I": The New Millennium Edition, 2015.	
Web References/ Online Resources:		
1	https://faraday.physics.utoronto.ca/IYearLab/Elastic-properties-of-solids-manual.pdf	
2	https://www.physik.uzh.ch/~matthias/espace-assistant/manuals/en/anleitung_102-tb_e.pdf	
3	https://ir.nctu.edu.tw/bitstream/11536/1680/1/A1995TF11100052.pdf	
4	http://www2.optics.rochester.edu/workgroups/cml/whole-enchilada-SPR05.pdf	
5	https://nptel.ac.in/courses/122/103/122103010/	
6	https://nptel.ac.in/courses/115/106/115106119/	
7	https://www.eatm.in/upload/srit__unit_i_laser.pdf	
8	https://nptel.ac.in/courses/115/101/115101107/	
9	https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecture-notes/	
10	http://nptel.ac.in/courses/113106032/4%20-%20Crystal%20structure.pdf	

Summative assessment based on Continuous and End Semester Examination									
Continuous Assessment (50%)									End Semester Examination (50%)
CA 1 (10 Marks)			CA 2 (10 Marks)			Practical Exam (30 Marks)		Theory Examination (50 Marks)	
SA 1 (6 Marks)	FA 1		SA 2 (6 marks)	FA 2		FA (22 marks)	SA (8 Marks)		
	Component -I (2 marks)	Component -II (2 marks)		Component -III (2 marks)	Component -IV (2 marks)				

Assessment Methods & Levels (based on Blooms'Taxonomy) - Theory				
Formative assessment based on Capstone Model (8%)				
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**		**Marks**
C201.1	Understand	Component - I	Quiz	2
C201.2	Understand	Component - II	Assignment	2
C201.3	Understand	Component - III	Seminar	2
C201.4	Understand			
C201.5	Apply	Component - IV	Tutorial	2
C201.6	Apply			

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (12%)**		**End Semester Examination (50%) [50 Marks]**
	CIA1 [6 Marks]	**CIA2 [6 Marks]**	
Remember	30	30	20
Understand	50	40	50
Apply	20	30	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative assessment based on Continuous and End Semester Examination - Practical		
Bloom's Level	**Continuous Assessment (30%)**	
	FA (22 Marks)	**SA (8 Marks)**
Remember	20	20
Understand	30	30
Apply	50	50
Analyse	-	-
Evaluate	-	-
Create	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C201.1	3	1		1					1				1		
C201.2	3	1		1					1				1		
C201.3	3	1		1					1				1		
C201.4	3	1		1					1				1		
C201.5	3	2		2					2				2		
C201.6	3	2		2					3				2		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME103	ENGINEERING PRACTICES LABORATORY	0/0/3/1.5

Nature of Course	Practical application
Pre Requisites	Nil

Course Objectives:

1	To learn the use of basic hand tools and to know the need for safety in work place and to gain hands on experience in Carpentry, Sheet metal, Plumbing, Welding and Foundry.
2	To learn about basic electrical devices, meters and electronics devices and to gain knowledge about the fundamentals of various electrical and electronic gadgets their working and trouble shooting.

Course Outcomes:
Upon completion of the course, students shall have ability to

C103.1	Identify and solve the basic engineering problems at home and in workplace.	[Ap]
C103.2	Develop the surfaces and make simple components like tray and funnel.	[Ap]
C103.3	Make simple metal joints using welding equipment and wooden joints using carpentry tools.	[Ap]
C103.4	Prepare pipe connections and sand moulds.	[Ap]
C103.5	Describe the fundamentals of hot forging and injection moulding	[U]
C103.6	Examine and troubleshoot electrical and electronic circuits	[A]

Course Contents:

GROUP A (CIVIL & MECHANICAL)

Manufacturing Methods –Sheet metal operations - Welding - arc welding, gas welding,Study of TIG & MIG welding. Study of foundry, Demonstration of Smithy and Injection moulding - Carpentry work using power tools - Plumbing components and pipelines

List of Experiments:

S.No	List of Experiments	CO Mapping	RBT
1	Preparation of butt joints and lap joints using arc welding	C103.3	[Ap]
2	Sheet metal Forming and Bending, Model making – Trays and funnels.	C103.2	[Ap]
3	Preparation of wooden joints by sawing, planning and cutting.	C103.3	[Ap]
4	Making basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings.	C103.4	[Ap]
5	Demonstration of foundry operations like mould preparation for solid and split piece pattern.	C103.4	[U]
6	Demonstration of Smithy operations	C103.5	[Ap]
7	Demonstration of assembly of pump / Demonstration of Injection moulding	C103.1	[Ap]

GROUP B (ELECTRICAL AND ELECTRONICS ENGINEERING)

List of Experiments:

Basic Circuit Elements: Resistor, inductor, capacitor. Introduction to measuring equipments: Moving iron meter, moving coil meter, Wattmeter, Energy meter, CRO, Multi-meter. Digital logic circuits, PCB design, fuse, relay, circuit breaker, wire, Earthing, fan, fluorescent lamp, iron box, mixer grinder, study of FM radio and mobile phone.

S.No	List of Experiments	CO Mapping	RBT
1	Study and identification of electronic components with specification.	C103.6	[U]
2	Testing of CRO and Electronic components using Multimeter.	C103.6	[A]

3	Generation and measurement of signals using CRO.	C103.6	[A]
4	Familiarisation of digital basic gate IC's.	C103.6	[AP]
5	Soldering practice-components devices and circuits- using general purpose PCB.	C103.6	[AP]
6	Demonstration of meters and electrical components.	C103.6	[AP]
7	Safety precautions with electrical components.	C103.6	[AP]
8	Residential house wiring.	C103.6	[A]
9	Measurement of power and energy.	C103.6	[A]
10	Trouble shooting of electrical equipments.	C103.6	[A]
		Total Hours:	**45**

Reference Books:	
1	Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson Education, Inc. 2009 (Second Indian Reprint).
2	Hajra Choudhury, "Elements of Workshop Technology", Vol. I & II, Media Promotors Pvt Ltd., 2014.
3	Suyambazhagan S, 'Engineering practices' PHI Learning private limited, New Delhi, 2012.
4	D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
5	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
Web References:	
1	www.nptel.ac.in
2	www.sme.org
3	http://www.allaboutcircuits.com/education/

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (60%)**		**End Semester Examination (40%)**
	FA (45 Marks)	**SA (15 Marks)**	**Practical Examination (40 Marks)**
Remember	10	10	10
Understand	10	10	10
Apply	40	40	40
Analyse	40	40	40
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C103.1	3														
C103.2	3	1													
C103.3	3													3	
C103.4	3	1												3	
C103.5	3	1												3	
C103.6	3														

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21CS211	PYTHON FOR ENGINEERS LABORATORY	1/0/3/2.5
Nature of Course	F (Theory Programming)	
Pre Requisites	NIL	

Course Objectives:

1	Interpret the use of procedural statements like assignments, conditional statements, loops and function calls.
2	Infer the supported data structures like lists, dictionaries and tuples in Python.
3	Improve problem solving skills using strings, and functions
4	Describe the need for Object-oriented programming concepts in Python.

Course Outcomes:
Upon completion of the course, students shall have ability to

C211.1	Structure simple Python programs for solving problems.	[U]
C211.2	Describe the Python language syntax including control statements, loops and functions to write programs for a wide variety problem in mathematics, science, and games.	[U]
C211.3	Examine the core data structures like lists, dictionaries, tuples and sets in Python to store, process and sort the data.	[AP]
C211.4	Interpret the concepts of Object-oriented programming as used in Python using encapsulation, polymorphism and inheritance.	[AP]
C211.5	Identify the external modules for creating and writing data to excel files and inspect the file operations to navigate the file systems.	[AP]

Course Contents:

Introduction to Python: Interpreter and Interactive Mode; Values and Data Types, Variables, Expressions, Statements, Operators. **Conditionals:** Boolean Values and Operators, Conditional (If), Alternative (If-Else), Chained Conditional (If-Elif-Else). **Iteration:** While, For, Break, Continue, Pass. **Functions:** Function Definition, parameters and arguments, Recursion. **Strings:** String Slices, String Functions and Methods. **Lists:** List Operations, List Slices, List Methods, List Loop**. Tuples:** Tuple Assignment and Methods **Dictionaries:** Operations and Methods, Set in Python**. Files:** Text Files, Reading and Writing Files, Command Line Arguments.

Lab Components

S.No	List of Experiments	RBT
Write Python programs for the following:		
1	Commands in interactive mode	[U]
2	Programs using operators	[AP]
3	Programs using I/O Operations	[AP]
4	Programs using control structures	[AP]
5	Programs using break, continue and pass statements	[AP]
6	Programs using loops	[AP]
7	Programs using functions	[AP]
8	Programs using recursive functions	[AP]
9	Programs using Strings	[AP]
10	Programs using Lists	[AP]
11	Programs using Tuples	[AP]
12	Programs using Dictionary	[AP]
13	Programs using Sets	[AP]

14	Programs using Files	[AP]
15	Programs using Command line arguments	[AP]
	Total Hours:	**60**

Text Books:	
1	John V. Guttag., Introduction to computation and programming using python: with applications to understanding data, PHI Publisher, 2016
2	Beginning Python: From Novice to Professional, Magnus Lie Hetland. Edition, 2005
3	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
4	Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python" – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
Reference Books:	
1	Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
2	Timothy A. Budd, "Exploring Pythonll", Mc-Graw Hill Education (India) Private Ltd., 2015.
3	John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press, 2013.
Web References:	
1	https://www.wileyindia.com/introduction-to-computer-science-using-python.html
2	https://www.programiz.com/python-programming
3	https://www.fullstackpython.com/best-python-resources
4	https://www.tutorialspoint.com/python/
5	https://www.geeksforgeeks.org/python-programming-language/
Online Resources:	
1	http://nptel.ac.in/courses/106106145/
2	https://www.codecademy.com/learn/learn-python

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment (60%)**		**End Semester Examination (40%)**
	FA (45 Marks)	**SA (15 Marks)**	**Practical Examination (40 Marks)**
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C211.1	3	3	3	2	1								2	1	1
C211.2	3	3	3	2	1								2		
C211.3	3	3	3	2	1								2		
C211.4	3	3	3	2	1								2		
C211.5	3	3	3	2	1								2	1	1
	3 Strongly agreed 2 Moderately agreed 1 Reasonably agreed														

21MC102	ENVIRONMENTAL SCIENCES	2/0/0/0
Nature of Course	C (Theory Concept)	
Pre Requisites	Basics in Environmental Studies	

Course Objectives:

1	To learn the integrated themes on various natural resources.
2	To gain knowledge on the type of pollution and its control methods.
3	To have an awareness about the current environmental issues and the social problems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C102.1	Recall and play an important role in transferring a healthy environment for future generation.	[R]
C102.2	Understand the importance of natural resources and conservation of biodiversity.	[U]
C102.3	Understand and analyze the impact of engineering solutions in a global and societal context.	[U]
C102.4	Apply the gained knowledge to overcome pollution problems.	[AP]
C102.5	Apply the gained knowledge in various environmental issues and sustainable development.	[AP]

Course Contents:

Natural Resources:

Introduction-Forest resources: Use and abuse, case study-Major activities in forest-Water resources-over utilization of water, dams-benefits and problems. Mineral resources-Use and exploitation, environmental effects of mining- case study–Food resources- World food problems, case study. Energy resources -Renewable and non-renewable energy sources Land resources- Soil erosion and desertification – Role of an individual in conservation of natural resources.

Environmental Pollutions:

Definition – causes, effects and control measures of: a. Air pollution-Acid rain - Greenhouse effect-Global warming- Ozone layer depletion – case study- Bhopal gas tragedy. Water pollution c. Solid waste management-Recycling of plastics-Pyrolysis method- causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazards-case study-Chernobyl nuclear disaster-Role of an individual in prevention of pollution.

Social issues and the Environment:

Sustainable development-water conservation, rain water harvesting, E-Waste Management – Environmental ethics: 12 Principles of green chemistry-Scheme of labelling of environmental friendly products (Eco mark) – Emission standards – ISO 14001 standard. HIV AIDS.

Total Hours:	**30**

Text Books:

1	Anubha Kaushik and C P Kaushik “Perspectives in Environmental Studies”, 4th Edition, New age International (P) Limited, Publisher Reprint 2014. New Delhi.
2	Rajagopalan, R, “Environmental Studies-From Crisis to Cure”, Oxford University Press 2015.

Reference Books:	
1	Tyler Miller, Jr., “Environmental Science”, Brooks/Cole a part of Cengage Learning, 2014.
2	William Cunningham and Mary Cunningham, “Environmental Science”, 13th Edition, McGraw Hill, 2015.
3	Gilbert M. Masters, “Introduction to Environmental Engineering and Science”, Third Edition, Pearson Education, 2014.

Web References:	
1	http://nptel.ac.in/courses/104103020/20
2	http://nptel.ac.in/courses/120108002
3	http://nptel.ac.in/courses/122106030
4	http://nptel.ac.in/courses/120108004/
5	http://nptel.ac.in/courses/122102006/20

Online Resources:	
1	https://www.edx.org/course/subject/environmental-studies
2	www.environmentalscience.org

Tentative Assessment Methods & Levels (based on Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C102.1	Remember	Quiz	5
C102.2	Understand	Mini project based on environmental aspect	15
C102.3	Understand	Class Presentation	10
C102.4, C102.5	Apply	Group Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			Term End Assessment [60 marks]
	CIA-I [0 marks]	CIA-II [0 marks]	CIA-III [0 marks]	
Remember	-	-	-	30
Understand	-	-	-	40
Apply	-	-	-	30
Analyze	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C102.1	3	2	2			3	2	1				1	1		
C102.2	3	2				3	3	1				1			
C102.3	2	2	2			3	3	1				1	1		
C102.4	3	2	2			3	3	1				1	1		
C102.5	3	2	2			3	3	1				1	1		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Semester – 03

21ME301	SOLID MECHANICS	3/1/0/4
Nature of Course	Theory Analytical	
Pre Requisites	Engineering Mechanics	

Course Objectives:

1	To learn the fundamental concepts of strength of materials
2	To understand and analyze the stress induced in various structural members
3	To evaluate the stability of columns and beams.
4	To understand the two dimensional stresses.

Course Outcomes:
Upon completion of the course, students shall have ability to

C301.1	Discuss the strength of various structural elements subjected to axial loading.	[U]
C301.2	Interpret the principle stress and strain energy	[U]
C301.3	Compute graphically the shear force and bending moment for different types of beams and interpret the effect of transverse loading on beams	[Ap]
C301.4	Inspect the slope and deflection of beams.	[Ap]
C301.5	Examine the stresses in shafts and columns	[A]
C301.6	Analyze the stresses involved in thin & thick cylinders.	[A]

Course Contents:

Simple Stresses and Strain- Introduction, Definition, Hooke's law, Stress-Strain diagrams, factor of safety, Elongation due to self-weight, Compound bars, Thermal stresses, Compound section subjected to thermal stresses. Elastic constants and their relationships. Principal stresses and principal planes- Mohr's circle. Strain Energy- Analysis of strain energy in uniaxial loading.

Introduction to types of beams- supports and loadings. Definition of bending moment and shear force, Sign conventions, Shear force and bending moment diagrams for statically determinate beams subjected various kinds of loads. **Stresses in Beams**- bending equation, section modulus, flexural rigidity. Analysis of bending stress in the circular, rectangular, 'I' sections. **Deflection of Beams -** Double Integration method and Macaulay's method.

Torsion - stresses and deformation in circular and hollow shafts, torsional rigidity and polar modulus, Power transmitted by a uniform shaft, Columns – Buckling load by Euler's and Rankine's equations. Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thin and thick cylinders subjected to internal pressure.

Total Hours:	**60**

Text Books:

1	Ferdinand P. Beer, E. Russell Johnston Jr, John T. DeWolf, David F. Mazurek, Sanjeev Sanghi, ""Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 8th Edition, 2020
2	S.S. Rattan "Strength of Materials", McGraw Hill Education (India) Pvt. Ltd., 3rd Edition, 2017.

Reference Books:

1	Egor.Popov, "Mechanics of Materials" 2nd Edition, Pearson Education India, 2015
2	S. H. Crandall and N. C. Dahl, "Introduction to Mechanics of Solids", 3rd Edition, Tata McGraw Hill, India, 2013.
3	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2018.

Web References:

1	https://lecturenotes.in/subject/260/strength-of-materials-som

Online Resources:

1	https://nptel.ac.in/courses/112107146

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C301.1	Understand	Quiz	20
C301.2			
C301.3	Apply	Individual Assignment	20
C301.4		Group Assignment	20
C301.5	Analyze	Tutorial	20
C301.6			

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C301.1	3	2	2										2		
C301.2	3	3	3										2		
C301.3	3	3	3										2		
C301.4	3	3	2										2		
C301.5	3	3	3										3		
C301.6	3	3	3										2		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME302	ENGINEERING THERMODYNAMICS	3/0/0/3
Nature of Course	Concepts and Analytical	
Pre Requisites	Fundamentals of basic mathematics and physics	

Course Objectives:

1	To understand the thermodynamic laws and their applications.
2	To study the properties of steam and the use of steam tables and Mollier Chart.
3	To develop a clear understanding about thermodynamic relations.

Course Outcomes:
Upon completion of the course, students shall have ability to

C302.1	Discuss about the thermodynamic properties, work, heat and entropy.	[U]
C302.2	Apply laws of thermodynamics to open and closed systems.	[Ap]
C302.3	Examine the properties of pure substances	[A]
C302.4	Analyze and understand the vapor power cycle used in steam power plants.	[A]
C302.5	Derive simple thermodynamic relations of ideal and real gases	[A]
C302.6	Illustrate the working principles of various refrigeration systems and allied components	[Ap]

Course Contents:

Basic Concepts and First Law: Review of basic concepts of thermodynamics- System, Surrounding, Property, State and Equilibrium, Process and Cycle, Work, Temperature, Heat and Other forms of energy, Internal energy, Specific heat capacities, Macroscopic approach and Microscopic approach - Quasi static process, Zeroth law of thermodynamics, First law of thermodynamics, Application of First law to non- flow system, Steady flow energy equation and its application to various thermal equipments, Unsteady flow process-Tank filling and emptying (Descriptive). **Second Law:** Second law of Thermodynamics – Kelvin's and Clausius statements of Second law, Reversibility and Irreversibility, Heat reservoirs - Refrigerator and heat pump, Carnot theorem, Carnot cycle, Reversed Carnot cycle, Efficiency, COP, Thermodynamic temperature scale, Clausius inequality, Concept of entropy, Entropy of ideal gas, and Principle of increase of entropy.

Properties of Pure Substance and Vapour Power Cycle: Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapour phases, Phase rule, P-V, P-T, T-V, T-S, H-S (Mollier chart) diagrams, PVT surfaces, Specific properties of steam - Use of Steam Tables & Mollier chart, Calculations of work done and heat transfer in non-flow and flow processes, Standard Rankine cycle (Analytical), Reheat (Descriptive) and Regenerative cycle (Descriptive).

Gas Mixtures and Thermodynamic Relations: Gas mixtures – Properties of ideal and real gases, Equation state, Vander waal's equation of state, Compressibility factor, Compressibility chart, Dalton's law of partial pressure, Exact differentials, TdS relations, Maxwell's relations, Clausius clapeyron equations, Joule–Thomson coefficient. **Refrigeration:** Refrigeration – definition - terminology used, desirable properties of refrigerant, classification of refrigerants, introduction to eco-friendly refrigerants, selection of refrigerant, types of refrigeration systems, Ideal vapour compression refrigeration cycle (Descriptive), Vapour absorption refrigeration cycle (Descriptive).

Total Hours:	**45**

Text Books:

1	Nag. P.K, "Engineering Thermodynamics", 5th Edition, McGraw Hill Education, New Delhi, 2017.
2	Yunus. N.J, Cengel. A and Michael Boles. A, "Thermodynamics- An Engineering Approach" 8th Edition, McGraw Hill Education, New Delhi, 2016.

Reference Books:	
1	Mahesh M. Rathore, “Thermal Engineering”, Mc Graw Hill Education private limited, Reprint 2016.
2	Michael Moran.J, and Howard Shapiro.N, “Fundamentals of Engineering Thermodynamics”, 4th Edition, John Wiley & Sons, New York, 2017.
Web References:	
1	http://nptel.ac.in/courses/112103016/
2	http://nptel.ac.in/courses/112105128/
Online Resources:	
1	http://booksite.elsevier.com/balmer/thermodynamicresources.php

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C302.1	Understand	Quiz	20
C302.2	Apply	Tutorial	20
C302.3	Analyze	Assignment	40
C302.4			
C302.5			
C302.6	Apply		

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C302.1	3	2	2												
C302.2	3	3	2												
C302.3	3	1	1												
C302.4	3	3	1												
C302.5	3	2													
C302.6	3	2	3										2		
	3 Strongly agreed					2 Moderately agreed						1 Reasonably agreed			

21ME303	FLUID MECHANICS AND MACHINERY	3/0/0/3
Nature of Course:	G (Theory and Practical)	
Pre Requisites:	Basic Mathematics and Engineering Physics	

Course Objectives:

1	To understand the properties of the fluid
2	To analyze and appreciate the complexities involved in solving the fluid flow problems.
3	To study the mathematical techniques and apply them to the solutions of practical flow Problems
4	Learn to apply conservation laws flow through pipes.

Course Outcomes:

Upon completion of the course, students shall have ability to

C303.1	Recognize the basic concepts of fluid properties.	[U]
C303.2	Examine the fluid flow and its behaviour.	[A]
C303.3	Study the behaviour of boundary layer flows.	[U]
C303.4	Examine the dependent and independent dimensionless parameters.	[A]
C303.5	Analyze the performance of hydraulic machines.	[A]

Course Contents:

Basic Concepts and Fluid Properties - density, specific weight, specific volume, specific gravity, viscosity, compressibility, capillary, surface tension and buoyancy - forces on submerged bodies, Measurement of Pressure: Pascal's law and Hydrostatic equation - concept of fluid static pressure, Measurement of Pressure using Manometers.

Fluid Dynamics - Euler's equation - Bernoulli's equation and its applications. Laminar flow – Hagan Poiseuille equation - Turbulent flow – Darcy Weisbach formula - Major and minor losses of flow in circular pipes. Pipes in series and in parallel. Boundary Layer - Boundary layer thickness, boundary layer separation

Dimensional Analysis - Dimension and Units – Buckingham π theorem – similitude – Dimensionless numbers - Model analysis. Centrifugal pumps, reciprocating pump – working principles, Velocity triangles, Work done by impellor, Efficiencies, Cavitation in pumps. Classification of water turbines - Pelton wheel, Francis turbine and Kaplan turbines, working principles - Constructional details, Velocity triangles, Power and efficiency calculations - Specific speed.

Total Hours:	**45**

Text Books:

1	Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw-Hill Education, 2017.
2	Rajput, R.K., "Fluid Mechanics and Hydraulic Machines", S.Chand Publishers, 2016.
3	YunusCengel and John Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi 2010.

Reference Books:

1	Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
2	Bansal, R.K. "Fluid Mechanics and hydraulic Machines", Laxmi Publications (P) Ltd., New Delhi,2018
3	Introduction to Fluid Mechanics, Robert W. Fax, Philip J. Pritchard, Alan T. McDonald. Wiley India Edition. (Wiley Student Edition Seventh 2011).

Web References:	
1	http://www.nptel.ac.in
2	http://www.creativeworld9.com
Online Resources:	
1	https://www.reddit.com/r/fluid_mechanics_online_andor_textbook_resources
2	www.efluids.com

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C303.1	Understand	Quiz	20
C303.3	Understand		
C303.2	Analyse	Individual Assignment	20
C303.4		Group Assignment	20
C303.5	Analyse	Tutorial	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	20	20	30
Apply	20	20	40
Analyse	50	50	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C303.1	3	1	1												
C303.2	3	3	2												
C303.3	3	1	1												
C303.4	3	3	2												
C303.5	3	3	2										3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME304	INDUSTRIAL METALLURGY	3/0/0/3
Nature of Course	Theory concepts	
Pre Requisites	Engineering Physics	
Course Objectives:		
1	To impart knowledge on phase diagrams and use of phase diagrams	
2	To understand the heat treatments processes and apply the same to modify the material properties.	
3	To impart knowledge on various metals and non-metals and its applications	
4	To demonstrate the various material testing methods.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C304.1	Recall the different types of materials, bonding of materials and their properties.	[R]
C304.2	Discuss the crystallization mechanisms	[U]
C304.3	Interpret the phase diagrams and the use of phase diagrams.	[U]
C304.4	Identify and apply the heat treatment processes and coatings to modify the properties of materials.	[Ap]
C304.5	Implement the various testing procedures to study the properties of materials.	[Ap]

Course Contents:

Crystallization, atomic bonding and phase diagrams: Mechanism of Crystallization- Nucleation-Homogeneous and Heterogeneous Nucleation- Growth of crystals- dendritic growth –Classification of solids – characteristics of covalent solids, ionic solids and metallic solids — structure of solid solutions - Phase diagrams- cooling curves- phase rule- lever rule – application of phase rule and lever rule in Cu-Ni phase diagram - Iron and carbon phase diagram – phases and reactions in iron-carbon diagram.

Heat treatment of steel: Definition – purposes – types - annealing, normalizing, hardening and tempering of steel – TTT diagram for eutectoid steel – continuous cooling curve and interpretation of final microstructure – austempering and mar tempering - surface modification - case hardening - carburising, nitriding, carbonitriding, flame, induction, electron beam and laser beam hardening- coating - PVD process using plasma - **Metals and non-metals: Metals:** properties and applications of carbon steel, alloy steel (stainless steel, HSLA steel, Maraging steel) - specification of steels - SAE standard - microstructure, properties and application of different cast iron – properties and applications of nickel, magnesium, copper, titanium and aluminium alloys - precipitation hardening – **Non-metals:** Polymers - Thermoplastics and thermosets, properties and applications (Acrylonitrile butadiene styrene, polyamide, polyphenyleneoxide, polyetheretherketone, urea formaldehyde, phenol formaldehyde and epoxy) –Ceramics - properties and applications of SiC, Al_2O_3 and PSZ – introduction to composites and smart materials (SMA).

Mechanical properties and testing of materials: Mechanical properties of materials - testing methods- metallography – specimen preparation – optical microscope - jominy end quench test – Deformation – slip and twinning - tensile test - stress-strain curve (Engineering and True) – compression test – shear test – torsion test – hardness tests – impact test – fatigue test- S-N curve – creep test- creep curve - fractures – types of fractures – corrosion test- wear test – ASTM for above testing methods – Non destructive testing – liquid penetrant test, ultrasonic test and magnetic particle inspection.

Total Number of Theory Hours	**45**

Text Books:

1	William D. Callister Jr., David G. Rethwisch , 'Material Science and Engineering – An introduction' 10th edition, Wiley India, 2018.

2	Kenneth G Budinski and Michael K Budinski, “Engineering Materials properties and selection”, PHI learning private limited, 9th edition, 2016.
Reference Books:	
1	Sidney.H Avner , “Introduction to Physical Metallurgy”, McGraw Hill Education, 2nd edition, 2017.
2	G. E.Dieter, Mechanical Metallurgy, McGraw Hill, 3rd edition, 2017.
3	V. Raghavan “Materials Science and Engineering”, PHI Learning Pvt. Ltd., 6th edition, 2015.
Web References:	
1	nptel.iitm.ac.in./courses/113105028/
2	www.sciencedaily.com/articles/m/metallurgy.html

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C304.1	Remember	Quiz	20
C304.2	Understand	Assignment	20
C304.3	Understand	Assignment	20
C304.4	Apply	Presentation / seminar	20
C304.5	Apply		

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	40
Apply	50	50	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C304.1	3	1	1												
C304.2	3	1	1												
C304.3	3	1	2										2		
C304.4	3	2	3										2		
C304.5	3	2	3										3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21MA301	ENGINEERING MATHEMATICS III MECH/MCT/CIVIL	3/1/0/4

Nature of Course	B (100% analytical)
Pre requisites	-

Course Objectives:

1	To understand the different possible forms of Fourier series and the frequently needed practical harmonic analysis that an engineer may have to make from discrete data.
2	To acquaint the student with transform techniques which are used in variety of engineering fields.
3	To study the concept of mathematical formulation of certain practical problems in terms of partial differential equations and solving for physical interpretation.
4	To find the numerical solution for partial differential equations.

Course Outcomes:
Upon completion of the course, students shall have ability to

C301.1	Recall the basic integration concepts and partial derivatives	[R]
C301.2	Interpret Fourier series solutions to the engineering problems	[U]
C301.3	Apply continuous transforms techniques to evaluate definite integrals	[AP]
C301.4	Apply the Z transform techniques in discrete sequences	[AP]
C301.5	Apply analytical methods to solve the partial differential equations	[AP]
C301.6	Apply numerical methods to solve wave and heat equation with boundary conditions	[AP]

Course Contents:

MODULE I - FOURIER SERIES (20 Hrs)

Dirichlet's conditions - General Fourier Series - Odd and Even Functions - Half range sine series and cosine series - Parseval's Identity - Harmonic analysis.

MODULE II - FOURIER TRANSFORM AND Z TRANSFORM (20 Hrs)

Fourier Transform: Complex form of Fourier Transforms – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Self reciprocal - Convolution theorem and Parseval's Identity (Statement only) – Evaluation of integrals using Parseval's Identity. **Z- Transform**: Convergence of Z transform **-** Z-transform of Standard functions **-** Properties – Initial and Final value Theorem **-** Inverse Z- transform - Convolution theorem (Statement only) - Partial fraction method - Formation of difference equations - Solution of difference equations using Z-transform Techniques.

MODULE III - PARTIAL DIFFERENTIAL EQUATIONS (20 Hrs)

Introduction to PDE- Formation of PDE by eliminating arbitrary constants and arbitrary functions – Solving PDE by Lagrange's linear equations - Linear homogeneous partial differential equations of second and higher order with constant coefficients-Classifications - Numerical Solution to Partial differential Equation - Elliptic equations - Laplace equation - Liebmann's Iteration Process -Poisson equation - Parabolic Equation (one dimensional heat equation) - Bender-Schmidt's Difference Scheme – Crank-Nicholson's Difference Scheme - Hyperbolic Equation (one dimensional wave equation).

Total hours:	**60**

Text Books:

1	Erwin E Kreyszig., "Advanced Engineering Mathematics",John Wiley and Sons (Asia) Limited, Hoboken,2020.
2	Grewal. B.S, "Higher Engineering Mathematics", 44th edition, Khanna Publications, Delhi, 2018.
3	Jain M.K. Iyengar, K & Jain R.K., Numerical Methods for Scientific and Engineering

	Computation, New Age International (P) Ltd, Publishers,6th edition, 2016.
Reference Books:	
1	Veerarajan. T, “Transforms and Partial differential equations”, 3rd edition, Tata McGraw-Hill Publishing Company Ltd., reprint, 2016.
2	N.P.Bali ,”A Text book of Engineering Mathematics Sem-III/IV” 13th edition, Laxmi Publications Ltd, 2017.
3	Glyn James, ”Advanced Modern Engineering Mathematics”, Pearson Education, 4th edition, 2016.
4	P. Kandasamy, K. Thilagavathy and K. Gunavathy, “Numerical Methods”,S.Chand Co. Ltd., New Delhi, 2015.
5	Holly Moore, “MATLAB for Engineers” Fifth Edition – Pearson Publications, 2018.
Web References:	
1	https://www.youtube.com/watch?v=jNC0jxb0OxE
2	https://www.youtube.com/watch?v=iRXXmtcocAQ
3	https://www.youtube.com/watch?v=OGT59INHz3Y
Online Resources:	
1	https://nptel.ac.in/courses/111/106/111106111/
2	https://nptel.ac.in/courses/111/107/111107111/
3	https://nptel.ac.in/courses/111/107/111107107/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C301.1	Remember	Quiz	20
C301.2	Understand	Seminar	20
C301.3–C301.6	Apply	Tutorial	20
C301.3–C301.6	Apply	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C301.1	2	2	1										1		
C301.2	2	2	2										2		
C301.3	3	3	3										3		
C301.4	2	2	2										1		
C301.5	2	2	2										2		
C301.6	2	2	2										1		

21ME305	MANUFACTURING TECHNOLOGY – II (WITH LAB)	3/0/2/4
Nature of Course	**Theory concepts and laboratory**	
Pre Requisites	**Manufacturing Technology I**	

Course Objectives:

1	To understand the concepts of metal cutting and measurements.
2	To understand the working of standard machine tools, special purpose machines and allied machining processes.
3	To study the advancements in manufacturing operations.

Course Outcomes:

Upon completion of the course, students shall have ability to

C305.1	Illustrate the basics of metal cutting processes and various machining operations.	[U]
C305.2	Discuss the working principle of special purpose machines and various mechanisms involved.	[U]
C305.3	Categorize the various finishing operations and advanced manufacturing methods.	[Ap]
C305.4	Interpret the working of CNC machine tools and different additive manufacturing techniques.	[U]
C305.5	Make components using various manufacturing processes and analyze their machining time.	[A]

Course Contents:

Theory of Metal Cutting: Introduction, cutting tool: Types, materials and life. Theory of metal cutting: Merchant's circle, cutting force measurements - Chip formation. **Centre Lathe:** Constructional features, various operations, work holding devices and machining time estimation. Capstan and turret lathes – Automats: Single and Multi spindle.

Special Purpose Machines and Abrasive processes: Shaper, Planer, Slotter machines. Milling machines: Types, cutters and various operations. Drilling machines: Types, Operations. Broaching - Gear cutting: forming, generation, shaping, **Grinding Process:** Introduction, types of grinding processes - Finishing processes: Honing, lapping, super finishing, polishing and buffing.

Advanced Manufacturing Methods: Abrasive Jet machining (AJM), Ultrasonic machining (USM), Electro chemical machining (ECM), Electrical discharge machining (EDM), Electron beam machining (EBM) and Laser beam machining (LBM). **Additive Manufacturing processes**: Direct Metal Laser Sintering (DMLS) - Direct Metal Laser Melting (DMLM) - Electron Beam Melting (EBM) - Stereolithography (SLA) **–** Applications**. CNC machines:** Introduction, machine structure and drives, feedback devices, Automatic tool changers and multiple pallet systems, MTConnect, Industrial Internet of CNC Machines, DIY Hardware and Part programming fundamentals.

Total Number of Theory Hours	**45**

Laboratory Components

S.No	List of Experiments	CO Mapping	RBT
1	Taper turning and external thread cutting using lathe	C305.5	[Ap]
2	Measuring various angles involved in a single point cutting tool	C305.5	[Ap]
3	Measurement of cutting forces in Turning / Milling process	C305.5	[Ap]
4	Contour milling and keyway slotting	C305.5	[Ap]
5	Fasten the two different plates using drilling, reaming and tapping processes	C305.5	[Ap]
6	External dovetail and internal dovetail	C305.5	[Ap]

7	Make a spur gear / helical gear using hobbing machine.	C305.5	[Ap]
8	Improve the surface finish of the given component using grinding process	C305.5	[Ap]
9	Perform a machining operation using CNC turning centre.	C305.4	[U]
10	Estimate the cycle timing of the machining operation	C305.5	[A]
11	Every student must undergo minimum of 3 industrial visits during the activity day.	C305.1	[U]

Text Books:	
1	SeropeKalpakjian, “Manufacturing Engineering and Technology”, Pearson India, 7th edition. 2018
2	Rao, P.N. “Manufacturing Technology - Metal Cutting and Machine Tools,” McGraw – Hill Education, New Delhi, 2013.
Reference Books:	
1	Hajra Choudhury, “Elements of Workshop Technology”, Vol. I & II, Media Promotors Pvt Ltd., 2014.
2	HMT - “Production Technology”, McGraw-Hill Education, 2017.
Web References:	
1	https://nptel.ac.in/courses/112105127/
2	www.sme.org

Continuous Assessment									**End Semester Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C305.1	Understand	Quiz	20
C305.2	Understand	Assignment	20
C305.3	Apply	Assignment	20
C305.4	Understand	Presentation / seminar	20
C305.5	Analyse		

Assessment based on Summative and End Semester Examination - Theory			
Bloom’s Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	10	10	10
Understand	40	50	40
Apply	40	30	40
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	20	20	20
Understand	20	20	20
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination							
Continuous Assessment (50%)							**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**	**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)** / **SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**		

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C305.1	3	2												1	
C305.2	3	2												1	
C305.3	3	2												3	
C305.4	3	2												3	
C305.5	3	2												2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME306	FLUID MECHANICS AND STRENGTH OF MATERIALS LABORATORY	0/0/3/1.5
Nature of Course:	Practical	
Pre Requisites:	Fluid Mechanics & Solid Mechanics	
Course Objectives:		
1	Ability to apply knowledge of fluid & solid mechanics in calculating the properties of fluids & solids.	
2	Ability to function on multi-disciplinary teams in the area of fluid & solid materials testing.	
3	Ability to use the techniques, skills and modern engineering tools necessary for engineering.	
4	Ability to communicate effectively the properties of fluids & solid materials	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C306.1	Calculate the coefficient of discharge for Orifice meter and Venturimeter	[Ap]
C306.2	Calibrate the Rotameter	[A]
C306.3	Estimate the friction factor for flow through pipes	[E]
C306.4	Conduct the performance test on pump	[Ap]
C306.5	Evaluate the values of yield stress, breaking stress and ultimate stress of the given specimen under tension test & examine the strain gauge calibration	[A]
C306.6	Evaluate the compression strength of brick/wood and the shear strength of a given specimen.	[A]
C306.7	Evaluate the Rockwell, Brinell hardness values and examine the shear modulus using torsional test for the given specimen.	[A]
C306.8	Evaluate the impact strength of specimen by using charpy and izod tests and examine the modulus of elasticity using deflection test	[A]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Determination of the Coefficient of discharge of given Orifice meter	C306.1	[U]
2	Determination of the Coefficient of discharge of given Venturimeter.	C306.1	[A]
3	Determination of the rate of flow using Rotameter	C306.2	[A]
4	Determination of friction factor for a given set of pipes	C306.3	[Ap]
5	Performance test on characteristics of centrifugal pump / Gear pump / Submersible pimp/ Reciprocating pump	C306.4	[A]
6	Tensile test on metals to determine tensile strength and ductility	C306.5	[A]
7	Study of strain gauge calibration	C306.6	[U]
8	Compression test on wood / bricks to determine compressive strength	C306.6	[A]
9	Hardness test on ferrous and nonferrous metals to Determine hardness value	C306.7	[A]
10	Torsion test on mild steel rod to find shear modulus	C306.7	[A]
11	Impact test on metal specimen to determine the impact strength and toughness using Izod test Charpy test	C306.8	[A]
12	Deflection test on steel and aluminium beam to find modulus of elasticity	C306.8	[A]

Reference Books:	
1	Ferdinand P. Beer , E. Russell Johnston Jr, John T. DeWolf, David F. Mazurek , Sanjeev Sanghi , ""Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 8th Edition , 2020
2	Bansal, R.K. "Fluid Mechanics and hydraulic Machines", Laxmi Publications (P) Ltd., New Delhi, 2018
3	Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw-Hill Education, 2017.
Web References:	
1	https://sm-nitk.vlabs.ac.in/
2	https://fm-nitk.vlabs.ac.in/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	10	10	10
Understand	10	10	10
Apply	30	30	30
Analyse	40	40	40
Evaluate	10	10	10
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	Pos												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C306.1	3												1		
C306.2	3												1		
C306.3	3												1		
C306.4	3												1		
C306.5	3												1		
C306.6	3												1		
C306.7	3	2											1		
C306.8	3	2											3		

	3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Semester – 04

21ME401	AUTOMOBILE ENGINEERING	3/0/0/3
Nature of Course	Theory Technology	
Pre Requisites	Thermodynamics	

Course Objectives:

1	To enable the students to understand the working of various automobile systems.
2	To prepare the students to update their knowledge in upcoming technology related to automobiles.
3	To enable the students to modify various automobile systems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C401.1	Recall the fundamental concepts of automobile engineering	[R]
C401.2	Discuss the various mechanisms involved in automobile systems.	[U]
C401.3	Explore the advanced mechanisms in current vehicles.	[Ap]
C401.4	Survey the various systems of the vehicle.	[A]
C401.5	Design the components of automotive systems.	[C]

Course Contents:

AUTOMOBILE AND ENGINE ARCHITECTURE: Automobile - types, components, subsystems and their positions - Power required for automobile - resistance and force - Chassis, frame and body–Engine- classification, components - An overview of Cooling and Lubrication systems–Petrol and Diesel fuel feed system- drawbacks- Petrol engine fuel injection (MPFI) and diesel engine fuel injection (CRDI) – VVTi engine, GDI technology, BS - VI Engine technology, Turbo engine -supercharging and turbo charging. **AUTOTRONICS:** An overview of basic electrical components and circuits in an automobile - overview of various sensors and other vehicle electronic systems.

EMISSION CONTROL AND ALTERNALE ENERGY SOURCE: An overview of SI and CI Engine emission and its control, Emission norms BS-VI, Non-exhaust and exhaust emission types (description only) – Alternative energy source - Overview - Electricity vehicle, hybrid vehicle, hydrogen fuel cell. **TRANSMISSION LINES AND AXLES: Power train:** Clutch, single plate, diaphragm, multi plate clutch, centrifugal- Gear box, sliding mesh, synchromesh, automatic gearbox, CVT, torque converter, overdrive gear changing mechanism types **Drive Line:** Universal joints and Propeller shaft types, **Rear axle:** types of rear axle, **Final Drive:** Differential unit, Differential Lock, Limited Slip Differential.

VEHICLE CONTROL SYSTEMS: Front axle: Types of front axle **Steering System:** Ackermann principle, manual steering, wheel geometry, rack and pinion, recirculating ball screw steering gear box, Power steering types- **Suspension system**: Types of suspension systems – coil spring, leaf spring, shock absorber, air suspension, hydro assisted suspension. **Brake system**: braking system types – hydraulic drum brake, disc brake, air brake, power assisted brake, ABS - **Wheels and Tyres:** Types of wheels, tyres and tubes. **Self-study:** Introduce to additive manufacturing and its applications in the automobile industry.

Total Hours	**45**

Text Books:

1	Anil chhikara, "Automobile engineering", Vol. 1&2 Tech India Publications, New Delhi,3th edition, 2018.
2	Kirpal Singh, "Automobile Engineering", Vol. 1&2, Standard Publishers, Delhi, 13thedition, 2017.

Reference Books:

1	Crouse and Anglin, "Automotive Mechanics", McGraw Hill Education, 10th edition, 2017.
2	Julian Happian-Smith "Introduction to Modern Vehicle Design", Publisher: Society of Automotive Engineers Inc, 2016.

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C401.1	Remember	Hands on Training/ Industrial Case Study with Poster Presentation	40
C401.2	Understand		
C401.3	Apply	Project work with Poster Presentation / Vehicle fabrication	40
C401.4	Analyze		
C401.5	Create		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	30	30
Understand	40	30	40
Apply	20	30	20
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C401.1	3														
C401.2	3	3													
C401.3	3	3													
C401.4	3	3											1		
C401.5	3	3			3						2			3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME402	MECHANICS OF MACHINES	3/1/0/4
Nature of Course	Theory Analytical	
Pre Requisites	Engineering Mechanics	

Course Objectives:

1	To impart knowledge about forces acting on machine parts.
2	To enable students to understand the fundamental concepts of machines
3	To facilitate students to understand the functions of cams and gears.
4	To make students to get an insight into balancing of rotating and reciprocating masses and the concepts of vibration.

Course Outcomes:
Upon completion of the course, students shall have ability to

C402.1	Relate different mechanisms for designing machines	[Ap]
C402.2	Compute velocity and acceleration of various mechanisms	[A]
C402.3	Relate the principles for analyzing cams, gears and gear trains.	[Ap]
C402.4	Measure and analyze free vibrations of mechanical systems	[A]
C402.5	Examine the balancing of rotating and reciprocating masses.	[A]
C402.6	Examine gyroscopic effects on aero planes & ships	[A]

Course Contents:

Introduction- General concepts, Introduction of Simple mechanisms, Grublers rule, Grashof"s Criterion for mobility. Velocity and accelerations in simple slider crank and four bar mechanisms by relative velocity method, Coriolis component of acceleration. Classification of cam and follower - displacement diagrams - Graphical layouts of cam profiles

Gears - fundamental law of gearing, spur gear contact ratio and interference/undercutting, Epicyclic gear trains – Analysis by tabular method. Basic features of vibratory systems – Single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts.

Balancing - Static and dynamic balancing of revolving & reciprocating masses in single and multi-cylinder engines. Gyroscopes - Basic concepts - gyroscopic law, effect of gyroscopic couple on ships and aircrafts.

Total Hours:	**60**

Text Books:

1	F.B. Sayyad, “Kinematics of Machinery”, MacMillan Publishers Pvt Ltd., Tech-max Educational resources, 2020.
2	Rattan, S.S, “Theory of Machines”, 5th Edition, Tata McGraw-Hill, 2019.
3	Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4th Edition, Oxford University Press, 2014.
4	Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014
5	F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources, 2020.

Reference Books:

1	Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014.
2	Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2020.
3	Khurmi, R.S.,”Theory of Machines”, 14th Edition, S Chand Publications, 2017.

Web References:

1	https://lecturenotes.in/notes/2094-notes-for-kinematics-and-dynamics-of-machines

Online Resources:

1	http://nptel.iitm.ac.in/courses.php, related web and video resources on Kinematics of Machines and Dynamics of Machines.

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C402.1	Apply	Quiz	20
C402.3			
C402.2	Analyze	Individual Assignment	20
C402.4		Group Assignment	20
C402.5		Tutorial	20
C402.6			

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	30	10
Understand	30	30	20
Apply	30	30	50
Analyse	10	10	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C402.1	3	3	2										2		
C402.2	3	3	2										2		
C402.3	3	3	2										2		
C402.4	3	3	2										2		
C402.5	3	3	2										2		
C402.6	3	3	2										2		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME403	METROLOGY AND INSTRUMENTATION	3/0/0/3
Nature of Course	Theory applications	
Pre Requisites	Manufacturing Technology- II (with Lab)	
Course Objectives:		
1	To expose the students in the measurement of linear, angular, surface roughness, threads and gears	
2	To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.	
3	To calibrate the various instruments and measure the dimensions of the components.	
4	To familiarize the students with basic and advanced metrology concepts	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C403.1	Describe the concepts of measurements to apply in various metrological instruments	[U]
C403.2	Outline the principles of linear and angular measurement tools used for industrial applications	[U]
C403.3	Demonstrate the techniques of form measurement used for industrial components	[Ap]
C403.4	Analyse the force, torque and power calculations based on the industrial standards.	[A]
C403.5	Examine the temperature through appropriate electrical instruments.	[A]

Course Contents:

BASICS OF METROLOGY: Introduction to Metrology, Distinction between precision and accuracy. Limits, fits and tolerances, Tolerance grades, Types of fits, Factors considered in selection of instruments, Errors in Measurements – Types. **LINEAR AND ANGULAR MEASUREMENTS:** Linear Measuring Instruments – Evolution – Types – Classification, Limit gauges, Angular measuring instruments – Types, Comparators - Constructional features and operation of mechanical, optical, electrical / electronics and pneumatic comparators, Principle of interferometry, Michelson interferometer, NPL flatness interferometer.

FORM MEASUREMENT: Principles and Methods of straightness – Flatness measurement, Surface Texture Measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications. **ADVANCES IN METROLOGY:** Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications. Special Measuring Equipment - Principles of measurement using Tool Maker's microscope profile projector & 3D coordinate measuring machine. Nano-measurements: Scanning Electron Microscope-Atomic Force Microscopy-Transmission Electron Microscopy.

INDUSTRIAL MEASUREMENTS: Force, torque, power - Mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

Total Hours:	**45**

Text Books:

1	R.K Jain, 'Engineering Metrology', 21st edition, Khanna Publishers, 2018.
2	Gupta I C, "A text book of Engineering Metrology", Dhanpat Rai Publications, New Delhi, 2018.
3	Ernest O. Doebelin, "Measurement Systems", McGraw Hill Education; 6th edition, 2017.

Reference Books:	
1	Alan S Morris, Reza Langari, "Measurement and Instrumentation: Theory and Application", Academic Press, 2012.
2	Venkateshan S P, "Mechanical Measurements", John Wiley & Sons, 2015.
3	Raghavendra, Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013.
4	Eckman Donald PEckman, “Industrial Instrumentation”, Wiley Eastern Limited, 2019.
Web References:	
1	http://www.nplindia.in/research-areas
Online Resources:	
1	https://nptel.ac.in/courses/112106179/
2	http://www.ni.com/en-in/shop/labview/labview-details.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C403.1	Understand	Quiz	20
C403.2	Apply	Assignment	40
C403.3			
C403.4	Analysis	Tutorial/Group assignment	20
C403.5			

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	40	40	40
Apply	30	30	40
Analyse	20	20	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	POs												PSOs		
	a	b	c	d	e	f	g	h	I	j	k	l	1	2	3
C403.1	3												2		
C403.2	3	2											2		
C403.3	3	1											2		
C403.4	3	1											2		
C403.5	3	1											3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME404	THERMAL ENGINEERING	3/0/0/3
Nature of Course	Theory analytical.	
Pre Requisites	Engineering thermodynamics and Mathematics	

Course Objectives:

1	To study the fuel properties and performance of I.C Engines.
2	To understand the performance of air compressors.
3	To impart knowledge of the psychrometric processes and air conditioning systems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C404.1	Identify and describe air standard cycles for air standard efficiencies	[U]
C404.2	Identify basic components of Engines, differentiate and describe the working of different types of Engines.	[A]
C404.3	Analyze the performance of Internal combustion Engines.	[A]
C404.4	Appraise the performance of reciprocating and rotary equipment.	[A]
C404.5	Classify the psychrometry processes and calculate the air conditioning systems performance.	[A]

Course Contents:

IC Engine analysis: Air standard analysis - Carnot cycle - Otto cycle - Diesel cycle, Classification- Principle and working of four stroke and two stroke petrol and diesel engines, Combustion process- Knocking, Detonation, Cetane and Octane numbers, Combustion in SI and CI engines.

Air Compressors: Single stage reciprocating compressor- Working principle, Multistage reciprocating compressors: Working principle. Rotary compressor (Descriptive): Vane compressor, Screw compressor and lobe compressor.

Psychrometry and Air Conditioning: Psychrometry and Psychrometric charts, Psychrometric process Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, Evaporative cooling, Introduction to HVAC (Descriptive) - Air handling and distribution system, Self-cleaning / Electro static precipitation in Air conditioning, Layout of Air conditioner in Automobiles.

Total Hours:	**45**

Text Books:

1	Kothandaraman C.P, Domkundwar S, “A course in Thermal Engineering”, Dhanpat Rai & Co. pvt ltd, 2017.
2	Mahesh M, Rathore, “Thermal Engineering”, Mc Draw Hill Education private limited, Reprint 2016.

Reference Books:

1	Rudramoorthy R, “Thermal Engineering”, Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2016.
2	Ganesan V, Internal Combustion Engine; Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2016.
3	Arora C.P, “Refrigeration and Air Conditioning”, Tata McGraw Hill publishers Co. Ltd, 2017.

Web References:

1	http://nptel.ac.in/courses/112104033/
2	http://nptel.ac.in/courses/112105128/

Online Resources:

1	https://ocw.mit.edu/courses/mechanical-engineering/

2	https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/lecture-notes/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C404.1	Understand	Quiz	20
C404.2	Analyse	Assignment	20
C404.3	Analyse	Assignment	20
C404.4	Analyse	Tutorial	20
C404.5	Analyse		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C404.1	3	2	2	1			1								
C404.2	3	2	2												
C404.3	3	2	2												
C404.4	3	2	2												
C404.5	3	2	2												

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed	

21MA401	PROBABILITY AND NUMERICAL METHODS MECH/MCT/CIVIL	3/1/0/4

Nature of Course	B (100% Analytical)
Pre requisites	-

Course Objectives:

1.	To define the concept of probability and its features
2.	To have a well – founded knowledge of standard distributions which can be used to describe real life phenomena
3.	To learn the concept of testing hypothesis using statistical analysis
4.	To study the concept of fitting a curve of best fit to the given numerical data and to calculate the deviation of the expected value from the observed value

Course Outcomes:
Upon completion of the course, students shall have ability to

C401.1	Recall the concept of probability	[R]
C401.2	Understand to handle situations involving random variables and Standard distributions.	[U]
C401.3	Apply measures of central tendency to Analyze statistical data	[AP]
C401.4	Develop the inferences for engineering problems using testing of hypothesis.	[AP]
C401.5	Apply curve fitting to Fit a polynomial or special function curve for the given data.	[AP]
C401.6	Apply numerical methods to fit the polynomial.	[AP]

Course Contents

MODULE I - PROBABILITY (20 Hrs)

Sample space, Axioms of Probability-Events-independent events-Conditional probability, Total Probability- Baye's Theorem (Statement only) – Simple Problems. One dimensional Random Variable-Probability mass function-Probability density function-Discrete random variable-Continuous Random Variable-Simple problems. Mathematical Expectations-Moments-Moment generating function-Properties-Standard distributions - Discrete distributions: Binomial – Poisson - Geometric – Continuous distribution: Uniform - Normal – Simple Problems.

MODULE II - STATISTICS (20 Hrs)

Definition of Statistics - Applications - Data - Collection of Data: Internal and external data, Primary and secondary Data. Descriptive Statistics: Classification and tabulation of univariate data, Measures of central tendency: Mean Median and Mode. Measures of dispersion – Range, Variance and Standard deviation – Scatter diagram - Correlation (Karl Pearson's) - Rank correlation (Spearman's) - Linear regression. Testing of Hypothesis - Small Samples - Student's t -Test for single mean, difference of mean -F test - Chi square test for goodness of fit and independence of attributes.

MODULE III - NUMERICAL METHODS (20 Hrs)

Curve Fitting-Empirical laws - Linear law - Laws reducible to Linear law- Method of group averages - straight line and parabola - Principle of Least squares - Fitting straight line, parabola and exponential curve - Interpolation - Interpolation with equal intervals –Newton's Forward and Backward difference formula - Interpolation with unequal intervals –Newton's Divided difference formula – Lagrange's interpolation formula. Numerical differentiation - Newton's Forward and Backward differentiation formulas.

Total Hrs	**60 Hrs**

Text Books:

1.	Peebles Jr. P.Z., —Probability Random Variables and Random Signal Principles, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2016
2.	Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & sons, 12th edition , 2020

3.	Grewal B.S., Numerical methods in Engineering and Science. 12th edition, Stylus Publishing, 2018.
Reference Books:	
1.	Ross, S,"A First Course in Probability, Ninth edition", Pearson Education, Delhi, 2018.
2.	Richard A. Johnson, Irwin Miller, John Freund, Miller &Freund's,"Probability and Statistics for Engineers",Ninth edition,2016.
3.	Steven Chapra, "Applied Numerical Methods with MATLAB for engineers and scientists", 4th edition, 2017.
4.	Holly Moore, "MATLAB for Engineers" Fifth Edition – Pearson Publications,2018.
Web References:	
1.	http://nptel.ac.in/courses/111104079/
2.	http://www.nptelvideos.in/2012/12/probability-random-variables.html
3.	http://freevideolectures.com/Course/2311/Digital-Communication/4
Online Resources:	
1.	https://www.coursera.org/learn/probability-intro
2.	https://www.coursera.org/lecture/wharton-introduction-spreadsheets-models/3-1-random-variables-and-probability-distributions-Y3bCF
3.	https://www.codewithc.com/newtons-interpolation-in-matlab/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C401.1	Remember	Quiz	20
C401.2	Understand	Seminar	20
C401.3–C401.6	Apply	Tutorial	20
C401.3–C401.6	Apply	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C401.1	2	1	1	1									1		
C401.2	1	2	2	1									2		
C401.3	2	2	2	3									2		
C401.4	1	1	2	2									2		
C401.5	2	3	2	3									3		
C401.6	2	3	2	3									3		

21ME405	COMPUTER AIDED MACHINE DRAWING	0/0/3/1.5
Nature of Course:	Practical Application	
Pre Requisites:	Engineering Drawing	

Course Objectives:

1	4. To impart the knowledge of drawing practices for common machine components.
2	To enable the students to understand blue prints and assembly drawings.
3	To impart the fundamental knowledge about geometric dimensioning and tolerance.

Course Outcomes:

Upon completion of the course, students shall have ability to

C405.1	Recall the conventional representation of mechanical components and understand the concept of joints	[U]
C405.2	Applying tolerance to mechanical components.	[Ap]
C405.3	Draw the various components/products elements using modelling software.	[Ap]
C405.4	Imagine and draw the assembled views of machine parts using modelling software.	[C]
C405.5	Formulate the detailed drawing of the given component	[C]

Course Contents:

Machine Drawing Conventions - Conventional representation of machine elements. Fits/Tolerances And Geometric Tolerances. Geometric tolerance-uses, types of form and position tolerances, symbols, method of indicating geometric tolerances on part drawings. Introduction to Production drawing.

S.No	List of Exercises [Using Recent Modelling Software]	CO Mapping	RBT
1	Draw hexagonal nut and square nut, hexagonal headed bolt, square headed bolt and washer.	C405. 1 C405. 3	[Ap]
2	Draw single riveted lap joint, double riveted (chain) lap joint, double riveted (zigzag) lap joint.	C405. 1 C405. 3	[Ap]
3	Draw single riveted (single strap) butt joint, single riveted (double straps) butt joint.	C405. 1 C405. 3	[Ap]
4	Draw the assembly of Sleeve & Cotter Joint	C405. 2 C405. 4	[C]
5	Draw the assembly of Socket and Spigot joint	C405. 2 C405. 4	[C]
6	Draw the assembly of Knuckle joint.	C405. 2 C405. 4	[C]
7	Draw the assembly of Foot step bearing/ Plummer block.	C405. 2 C405. 4	[C]
8	Draw the assembly of Flange coupling.	C405. 2 C405. 4	[C]
9	Draw the assembly of Screw Jack.	C405. 2 C405. 4	[C]
		Total Hours:	**45**

Text Books:

1	N. D. Bhatt, V.M. Panchal “Machine Drawing” Charotar Publishing House. 2015.
2	K. R. Gopalakrsihnan, “Machine Drawing”, Subhas Publication, 2014.

Reference Books:	
1	K.L. Narayana, P.Kannaiah, & K.Venkata Reddy, “Machine Drawing-Multi Color Edition”, New Age International Publishers, 2019.
2	Laxminarayan and Mathur, “A Textbook Of Machine Drawing”, “Machine Drawing” , Jain Brothers Publications, 2016.
Web References:	
1	http://www.nptel.ac.in
2	http://www.sigmetrix.com
Online Resources:	
1	1 https://www.universalclass.com/i/crn/8683.htm
2	2 https://www.machinedesignonline.com

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom’s Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	-	-	-
Understand	40	40	40
Apply	30	30	30
Analyse	-	-	-
Evaluate	-	-	-
Create	30	30	30

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C405.1	3				3								3		
C405.2	3		2		3								3		
C405.3	3		3		3								3		
C405.4	3		3		3								3		
C405.5	3		3		3								3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME406	METROLOGY AND DYNAMICS LABORATORY	0/0/3/1.5
Nature of Course	Practical application	
Pre Requisites	Manufacturing Technology II Engineering mechanics Kinematics of Machines	

Course Objectives:

1	To measure the dimensions of mechanical components using various measuring instruments.
2	To develop programs for applications using Lab View software.
3	To enable the students to understand the principles of static force analysis and dynamic force analysis of mechanisms.
4	To provide an insight regarding the undesirable effects of unbalance in rotors and engines.
5	To introduce the concept of vibratory systems and damping methods.

Course Outcomes:
Upon completion of the course, students shall have ability to

C406.1	Perform the experiments to check linear and angular measurements.	[Ap]
C406.2	Develop programs for various applications using Lab View software.	[A]
C406.3	Determine the forces acting on machines and mechanisms such as flywheels, and engines.	[Ap]
C406.4	Determine the gyroscopic couple on motorized gyroscope both experimentally and analytically.	[A]
C406.5	Evaluate the various types of vibrations and to impart knowledge in calculating natural frequency and forces caused due to unbalance in masses.	[E]
C406.6	Perform static and dynamic balancing calculations for rotating parts of machinery.	[A]

Course Contents:

S.No	List of Experiments (Using analysis and simulation softwares)	CO Mapping	RBT
1	Measure the various physical parameters of the given workpiece using linear measuring instruments	C406.1	[Ap]
2	Determine the unknown angle by using angle measuring instruments.	C406.1	[Ap]
3	Non-contact (Optical) measurement using Measuring microscope / Profile projector	C406.1	[Ap]
	Study of Virtual instrumentation for simple applications.		
4	Simulate the basic arithmetic and logic operations using VI.	C406.2	[A]
5	Measure the Real time temperature Using DAQ	C406.2	[A]
6	Determination the moment of inertia of turn table apparatus.	C406.4	[Ap]
7	Determination the moment of inertia using bifilar suspension.	C406.4	[Ap]
8	Determination of gyroscopic couple using motorized gyroscope.	C406.4	[A]
9	Determination of transmissibility ratio using vibrating table.	C406.5	[E]
10	Determination of transverse frequency of beam.	C406.5	[E]
11	Balancing of rotating masses and reciprocating masses.	C406.6	[A]
12	Determination of Natural frequency of Free longitudinal Vibration	C406.5	[A]
13	Determination of Critical speed of Shaft	C406.5	[A]
		Total Hours:	**45**

Reference Books:	
1	R.K Jain, 'Engineering Metrology', 21st edition, Khanna Publishers, 2018.
2	Sanjay Gupta and Joseph john, "Virtual Instrumentation using Labview", Mcgraw Hill Education; 2nd edition, 2017.
3	Rattan S.S., "Theory of Machines", 5th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2019.
4	Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2013.
Web References:	
1	https://nptel.ac.in/courses/112/106/112106180/
2	https://nptel.ac.in/courses/112106179/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	30	30	30
Understand	30	30	30
Apply	20	20	20
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	Pos												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C406.1	3	3	2											2	
C406.2	3	3	2		3								3	2	
C406.3	3	3	3										1		
C406.4	3	3	3										1		
C406.5	3	3	3										2		
C406.6	3	3	3										2		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME407	THERMAL ENGINEERING LABORATORY	0/0/2/1
Nature of Course	Practical application	
Pre Requisites	Nil	

Course Objectives:

1	To study the fuel properties and performance of I.C Engines and understand performance of Air compressors.
2	To impart knowledge on the air conditioning system and refrigerator.

Course Outcomes:
Upon completion of the course, students shall have ability to

C407.1	Identify basic components of Engines, differentiate and describe the working of different types of Engines.	[A]
C407.2	Compare, conduct performance test in Engines and calculate the performance of Engines.	[E]
C407.3	Compare and calculate the performance of reciprocating and rotary equipment.	[A]
C407.4	Estimate the properties of lubricants.	[E]
C407.5	Evaluate the performance of air conditioner and refrigerator.	[E]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Experimental study on valve timing diagram in 4-stroke engine cut model and port timing diagram in 2-stroke engine cut model.	C407.1	[A]
2	Performance and Heat balance test on a twin cylinder diesel engine with electrical dynamometer (Alternator).	C407.2	[E]
3	Performance test on a single cylinder diesel engine with Mechanical dynamometer.	C407.2	[E]
4	Appraise the performance of Two stage Air compressor using test rig.	C407.3	[E]
5	Performance and combustion test on computerized Kirloskar TV1 engine with eddy current dynamometer. (In diesel mode).	C407.2	[E]
6	Performance Analysis of a centrifugal blower test rig.	C407.3	[A]
7	Experimental analysis of performance of air-conditioning system.	C407.5	[A]
8	Determination of flash and fire point by open cup apparatus.	C407.4	[E]
9.	Determination of viscosity using Redwood viscometer.	C407.4	[E]
10.	Experimental analysis of performance of Refrigeration system.	C407.5	[A]

Total Hours: 45

Reference Books:

1	Kothandaraman C.P, Domkundwar S, “A course in Thermal Engineering”, Dhanpat Rai & Co. pvt ltd, 2017.
2	Mahesh M, Rathore, “Thermal Engineering”, Mc Draw Hill Education private limited, Reprint 2016.
3	Arora C.P, “Refrigeration and Air Conditioning”, Tata McGraw Hill publishers Co. Ltd, 2017.

Web References:

1	http://vlabs.iitkgp.ernet.in/rtvlas/#
2	http://nptel.ac.in/courses/112105128/
3.	https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/labs/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	10	10	10
Understand	10	10	10
Apply	10	10	10
Analyse	35	35	35
Evaluate	35	35	35
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C407.1	3	2	2	2										2	
C407.2	3	3	3	3										3	
C407.3	3	3	3	2										2	
C407.4	3	2	2	2										3	
C407.5	3	3	2	3										3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Semester – 05

21ME501	DESIGN OF MACHINE ELEMENTS	4/0/0/4
Nature of Course	Concept and Analytical	
Pre Requisites	Engineering Mechanics, Strength of Materials, Kinematics of Machinery	
Course Objectives:		
1	To familiarize the various steps involved in the design process.	
2	To understand the principles involved in evaluating the shape and dimensions of a component in order to satisfy functional and strength requirements.	
3	To encourage the usage of standard practices and standard data.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C501.1	Discover various processes involved in machine design.	[U]
C501.2	Elucidate the variety of stresses induced in machine components to resolve the design of machine components.	[Ap]
C501.3	Familiarize with standard design data and select the appropriate mechanical components.	[A]
C501.4	Summarize the results of a design assignment by means of drawing and design report.	[E]
C501.5	Design and make a model of the learnt concepts.	[C]

Course Contents:

Steady and Variable Stresses in Machine Elements: Introduction to the Design Process – Direct – Bending and Torsional Stress Equations – Eccentric Loading – Impact and Shock Loading – Calculation of Principle Stresses for Various Load Combinations – Theories of Failure – Design of Curved Beams, Crane Hook – Stress Concentration – Design for Variable Loading, Soderberg, Goodman and Gerber Relations.

Design of Shafts, Couplings and Springs: Design of Solid and Hollow Shafts – Design of Knuckle Joint – Design of Keys and Couplings – Design of Helical and Leaf springs.

Design of Fasteners, Bearings, Seal and Gaskets: – Threaded Fasteners – Design of Welded Joints – Design of riveted joints (Various types of failures alone) –- Adhesively Bonded Joints in Aircraft Structures - Selection of Bearings, Sliding Contact and Rolling Contact bearing, Design of Seal and Gaskets.

Total Hours:	**60**

Text Books:	
1	Shigley J.E and Mischke C. R., “Mechanical Engineering Design”, 10th Edition, McGraw-Hill, 2017.
2	Bhandari V.B, “Design of Machine Elements”, McGraw-Hill Book Co, 2017.
Reference Books:	
1	R.S.Khurmi and J.K.Gupta, “A Text Book of Machine Design", S.Chand Publications, 2019.
2	Orthwein W, “Machine Component Design”, 2nd Jaico Publishing Co, 2016.
3	William Cawthorne Unwin “The elements of machine design” Norderstedt Hanse books GmbH, 2017.
Web References:	
1	https://nptel.ac.in/courses/112105124/5
2	https://www.coursera.org/learn/machine-design1
3	https://ocw.mit.edu/courses/mechanical-engineering/2-75-precision-machine-design-fall-2001/
Online Resources:	
1	https://www.machinedesignonline.com/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C501.1	Understand	Tutorials/Assignments	20
C501.2	Apply	Poster presentation and Case study	20
C501.3	Analyze		
C501.4	Evaluate	Mini Project	40
C501.5	Create		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	20	20	20
Apply	30	30	30
Analyse	20	20	20
Evaluate	20	20	20
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C501.1	3	2	2	2											
C501.2	3	3	3	3									3		
C501.3	3	3	3	3									3		
C501.4	3	3	3	3									3		
C501.5	3	3	3	3							2		3		1

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME502	APPLIED HYDRAULICS AND PNEUMATICS	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	Fluid Mechanics and Machinery	
Course Objectives:		
1	To introduce the working of the fluid power components and their needs.	
2	To enable the students to understand the operation of various fluid power circuits.	
3	To enable the students to understand the concepts like synchronizing and sequencing for automation.	
4	To prepare the students to design electro-pneumatic circuit and ladder diagrams.	
5	To allow students to design and simulate the circuits.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C502.1	Recall the fundamentals of hydraulic and pneumatic systems	[U]
C502.2	Select the components and control elements for hydraulic and pneumatic systems as per the application.	[Ap]
C502.3	Analyze the scenario and provide suitable solution to the problems in hydraulic and pneumatic systems.	[A]
C502.4	Design customized circuits in hydraulics systems for various industrial needs.	[C]
C502.5	Design customized circuits in pneumatics and servo systems for various industrial needs.	[C]

Course Contents:

Fluid power systems and Fundamentals: 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's number, Darcy's equation, losses in pipe, valves and fittings. Properties of Air - Perfect Gas laws. Fluid power - ANSI symbol. **Hydraulic System and Components:** 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 tandem, rod less, telescopic, cushioning mechanism. Construction of double acting cylinder, rotary actuators, fluid motors, gear, vane and piston motors.

Design of Hydraulic Circuits: Construction of Control Components, Directional 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, accumulator's circuits, sizing of accumulators, intensifier, applications of intensifier, intensifier circuit, control of single, double hydraulic, regenerative, sequencing, synchronizing, continuous reciprocation, speed control, fail-safe circuit, control of hydraulic motor.

Pneumatic System and Components: Pneumatic Components, Properties of air, compressors, filter, regulator, lubricator unit, air control valves, quick exhaust valves, and pneumatic actuators. Control of single, double pneumatic, sequencing, semi-automatic, automatic, speed control, synchronizing circuit, pneumatic motor, pneumo-hydraulic circuit, sequential circuit design for simple applications using cascade method. **Design of Fluid Power Circuits:** Servo systems, Hydro mechanical servo systems, electro hydraulic servo systems and proportional valves, Introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits, failure and troubleshooting. **Case studies:** A simple sequence, synchronizing circuits using hydraulic and pneumatic components.

Total Hours:	**45**

Text Books:

1	Ilango Sivaraman, “Introduction to Hydraulics and Pneumatics”, PHI Learning, 2017.
2	Jagadeesha T, “Hydraulics and Pneumatics systems”, Wiley Publications, 2019.
Reference Books:	
1	Anthony Esposito, “Fluid Power with Applications”, Pearson Education, 2019.
2	James R. Daines , Martha J. Daines, “Fluid Power: Hydraulics and Pneumatics”, Goodheart-Willcox; Third Edition, Revised, 2018.
Web References:	
1	http://www.nfpa.com
2	http://www.fluidpowerjournal.com

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C502.1	Understand	Assignment	20
C502.2	Apply	Assignment	20
C502.3	Analyze	Mini project/simulation of circuits	40
C502.4 C502.5	Create		

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	10	10
Understand	40	30	30
Apply	40	30	30
Analyse	-	20	20
Evaluate	-	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C502.1	3	3	2	2									1		3
C502.2	3	3	3	2									2		3
C502.3	3	3	3	2									2		3
C502.4	3	2	3	3							1		2		3
C502.5	3	2	3	3							1		2		3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME013	INDUSTRY 4.0	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Manufacturing Technology-I (with lab), Manufacturing Technology-II (with lab) and Electrical Drives and Microprocessor Laboratory	
Course Objectives:		
1	To introduce the concepts of Industry 4.0	
2	To understand the various systems and technologies used for implementing industry 4.0.	
3	To learn about the fundamentals of IoT, cloud computing and big data analytics.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C013.1	Describe the drivers and enablers of Industry 4.0.	[U]
C013.2	Interpret the smartness in smart factories, smart cities, smart products and smart services.	[U]
C013.3	Study the applications of Industry 4.0	[U]
C013.4	Implement the various systems and technologies used in Industry 4.0.	[Ap]
C013.5	Design the components for Industry 4.0 using learned concepts such as IoT, cloud computing and data analytics.	[C]
Course Contents:		
Introduction to Industry 4.0: The Industrial Revolutions, Characteristics of Industry 4.0, Digitalization and the Networked Economy, Compelling Forces and Challenges for Industry 4.0; Comparison of Industry 4.0 Factory and Today's Factory, Fundamentals of Machine Learning, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation. **Technologies enabling Industry 4.0:** Industrial Internet of Things (IIoT) & Internet of Services, Predictive Analytics, Cyber physical Systems; Robotic Automation and Collaborative Robots; Support System for Industry 4.0, Mobile Computing, Cyber Security, Cloud Computing Basics, Cloud Computing and Industry 4.0. **Application of Industry 4.0:** Smart Manufacturing, Virtual Power Plants, e-commerce for manufacturing, Industrial 3D printing, e-mobility, The Road towards Industry 5.0 -, Impacts of Lean Production System, Connected factory.		
	Total Hours:	**45**
Text Books:		
1	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, 2016.	
2	Alp Ustundag, Emre Cevikcan, “Industry 4.0 Managing The Digital Transformation”, Springer International Publishing, 2018.	
Reference Books:		
1	Lane Thames, Dirk Schaefer, “Cyber Security for Industry 4.0 Analysis for Design and Manufacturing”, Springer International Publishing, 2017.	
2	Best Masters, Christoph Jan Bartodziej, “The Concept Industry 4.0 An Empirical Analysis of technologies and Applications in Production Logistics”, Springer Gabler, Springer Fachmedien Wiesbaden GmbH 2017.	
3	Oliver Grunow, “The Current state of Application Technologies Smart Factory and Industry 4.0”, Studylab, 2016.	
Web References:		
1	https://www.bcg.com/en-in/capabilities/operations/embracing-industry-4.0-rediscovering-growth.aspx	
2	https://www.forbes.com/sites/bernardmarr/2018/09/02/what-is-industry-4-0-heres-a-super-easy-explanation-for-anyone/#53b174589788.	

Online Resources:	
1	https://prod-edxapp.edx-cdn.org/assets/courseware

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C013.1	Understand	Quiz	20
C013.2	Understand	Group Assignment	20
C013.3	Understand		
C013.4	Apply	Case Study / Mini Project	40
C013.5	Create		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	40	40	40
Apply	40	30	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C013.1	3	2	3								3				1
C013.2	3	3	3								3				1
C013.3	3	3	3								3				3
C013.4	3	3	3								3		2		3
C013.5	3	3	2								3		3	2	3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME503	HEAT AND MASS TRANSFER	3/0/0/3
Nature of Course	Theory analytical.	
Pre Requisites	Thermal Engineering, Engineering Thermodynamics.	

Course Objectives:

1	To impart knowledge on the theoretical and analytical concepts to analyze the modes of heat transfer.
2	To enable the students to apply various laws of heat transfer in engineering applications.
3	To enable the students to analyze heat exchangers using LMTD and NTU methods.
4	To interpret the concepts underlying the types of mass transfer.

Course Outcomes:
Upon completion of the course, students shall have ability to

C503.1	Summarize the basics of different modes and laws of heat transfer.	[U]
C503.2	Compute heat transfer and temperature distribution in composite systems and extended surfaces.	[Ap]
C503.3	Interpret and analyse forced and free convection heat transfer.	[A]
C503.4	Appraise the heat exchangers performance using LMTD and NTU methods.	[A]
C503.5	Classify and appraise the different modes of mass transfer.	[A]
C503.6	Evaluate the radiative properties of a surface.	[E]

Course Contents:

Conduction Heat Transfer: Fourier Law of Conduction, General Differential equation of Heat Conduction- Cartesian Coordinates, 1-D Steady State Heat Conduction (Plane Wall, Cylinders) Composite Systems, Extended Surfaces (Circular, Rectangular).

Convection Heat Transfer and Heat Exchangers: Heat Transfer Coefficients – Boundary Layer Concept, External Flow – Flow over Plates, Cylinders, Internal Flow, Phase Change Heat Transfer (descriptive) - Nusselt's theory of condensation and Regimes of boiling, Heat Exchangers**-** Analysis – LMTD & NTU methods (Numericals) Heat pipes (descriptive) – construction and working, Electronic cooling using Heat pipes(descriptive).

Radiation Heat Transfer and Mass transfer: Laws of Radiation, Black and Grey body radiation, shape factor algebra- perpendicular planes, Radiation Shields, Diffusion Mass Transfer – Fick's Law of Diffusion, equimolar counter diffusion, Convective Mass Transfer.

Total Hours: 45

Text Books:

1	Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer", New Age International, 2019.
2	Kothandaraman C.P "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2018.

Reference Books:

1	Yunus.A.Cengel, Afstin J.Ghajar, "Heat and Mass Transfer – Fundamentals and Applications", McGraw Hill, Fifth Edition, 2016.
2	Incropera, F. P. and De Witt, D. P., "Fundamentals of Heat and Mass Transfer", 5th Edition, John Wiley and Sons, New York, 2017.
3	Nag P.K, "Heat and Mass Transfer", McGraw-Hill, 2019.

Web References:

1	www.academia.edu/.../Frank_P_Incropera_Fundamentals_of_heat_and mass_transfer.
2	http://165.165.123.124:444/Mechanical%21ENgineering%20%2825%29/ Heat%20and%21MAss%20Transfer

Online Resources:	
1	https://onlinecourses.nptel.ac.in/noc16_me06.

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C503.1	Understand	Quiz	20
C503.2	Apply	Assignment	20
C503.3	Analyze	Assignment	20
C503.4			
C503.5		Tutorial	20
C503.6	Evaluate		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	10	10
Understand	50	50	40
Apply	20	30	30
Analyse	10	10	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C503.1	3	3	2												
C503.2	2	2	3											3	
C503.3	3	3	3												
C503.4	3	3	2	2					1					3	
C503.5	3	3	2						1						
C503.6	3	3	3	3					1					3	

	3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME504	CAD/CAM LABORATORY	0/0/3/1.5
Nature of Course:	Practical application	
Pre Requisites:	Engineering Drawing	

Course Objectives:

1	To understand and interpret drawings of machine components
2	To prepare the assembly drawings using standard CAD packages.
3	To gain practical experience in handling 3D modeling software system.
4	To understand and interpret program codes for manufacturing different machine components using standard CAM systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C504.1	Recall the fundamentals of computer applications in design and manufacturing.	[R]
C504.2	Discuss the features of computer packages.	[U]
C504.3	Sketch the machine components and assemblies before their actual fabrication.	[Ap]
C504.4	Prepare part programming for a CAD model.	[Ap]
C504.5	Generate the machining codes automatically using the CAM system.	[A]
C504.6	Fabricate the components using RPT machine.	[A]

Course Contents:

Recent trends in CAD/CAM, features of solid modeling packages, CNC technology, codes for part programming, MRP I, MRP II, 3D Printing, Group technology, PLM Softwares.

S.No	List of Experiments (Using appropriate softwares)	CO Mapping	RBT
1	Introduction to CAD & CAM software packages.	C504.2	U
2	3D Modelling of simple components like V Block, corner bracket and Safety valves etc.	C504.3	[Ap]
3	3D Modelling and assembly of Connecting rod.	C504.3	[Ap]
4	3D Modelling and assembly of Pedestal bearing.	C504.3	[Ap]
5	3D Modelling and assembly of Tail stock.	C504.3	[Ap]
6	Manual part programming using G and M codes for turning, step turning, taper turning, multiple turning, facing, multiple facing, thread cutting and radius turning on cylindrical components.	C504.4	[A]
7	CNC Milling program involving linear motion and circular interpolation.	C504.4	[A]
8	CNC Milling program involving contour motion and canned cycles.	C504.4	[A]
9	Simulation of machining operations using CAM software.	C504.5	[A]
10	CNC code generation using CAM software.	C504.5	[A]
11	CNC Turning - Operation and Machining	C504.4	[A]
12	Real time engineering component fabrication using 3D printing machine.	C504.6	[A]
	Total Number of Hours		**45**

Reference Books:	
1	Ibrahim Zeid, “CAD-CAM Theory and Practice”, McGraw-Hill Publishing Co. Ltd., 2015.
2	N.D. Bhatt, “Machine Drawing”, Charotar Publishing House Pvt. Limited., 2016.
3	Gopalakrishnan, K.R, “Machine drawing”, Subash publishers, 2017.
Web References:	
1	http://www.mastercam.com/en-us/Support/Training/Certification
2	www.nptel.ac.in/video.php?subjectId=112102101

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	20	20	20
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	C	d	e	f	g	h	i	j	k	l	1	2	3
C504.1	3	3	2										2	1	
C504.2	3	3	2										2	1	
C504.3	3	3	3						3				3		
C504.4	3	3	3		3								1		
C504.5	3	3	2		3				3			3	2		3
C504.6	3	3	3		3				2			3	2	3	3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME505	HEAT AND MASS TRANSFER LABORATORY	0/0/2/1

Nature of Course	Practical application
Pre Requisites	Nil

Course Objectives:

1	To impart knowledge on applying the analytical concepts to analyze the performance of modes of heat transfer.
2	To enable the students to analyze heat exchangers using LMTD and NTU methods.

Course Outcomes:
Upon completion of the course, students shall have ability to

C505.1	Compute heat transfer and temperature distribution in steady-state, unsteady-state heat conduction and extended surfaces.	[Ap]
C505.2	Appraise the forced and free convection heat transfer in practical applications.	[E]
C505.3	Assess the heat exchangers performance using LMTD and NTU methods.	[E]
C505.4	Evaluate the radiative properties of a surface.	[E]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Determine the thermal conductivity of insulation by using lagged pipe apparatus.	C505.1	[Ap]
2	Experimental determination of Heat Transfer from pin-fin (Forced convection mode).	C505.1	[Ap]
3	Determination of heat transfer coefficient of Natural convection heat transfer from a vertical cylinder.	C505.2	[Ap]
4	Determination of heat transfer coefficient of Forced convection inside tube.	C505.2	[A]
5	Experimental determination of Effectiveness of parallel flow heat Exchanger.	C505.3	[E]
6	Experimental determination of Effectiveness of counter flow heat Exchanger.	C505.3	[E]
7	Determination of Stefan- Boltzmann constant.	C505.4	[E]
8	Determination of Emissivity of a grey surface.	C505.4	[E]
9	Determination of thermal conductivity measurements by guarded plate method	C505.1	[Ap]
10	Determination of thermal conductivity of pipe insulation by using lagged pipe apparatus	C505.1	[Ap]
	Total Hours:		**45**

Reference Books:

1	Kothandaraman C.P “Fundamentals of Heat and Mass Transfer”, New Age International, New Delhi, 2018.
2	Incropera, F. P. and De Witt, D. P., “Fundamentals of Heat and Mass Transfer”, 5th Edition, John Wiley and Sons, New York, 2017.
3	Holman J.P “Heat and Mass Transfer”, McGraw-Hill, 2019.
4	Nag P.K, “Heat and Mass Transfer”, McGraw-Hill, 2019.

Web References:

1	https://virtuallabs.hkust.edu.hk/TubularHeatExchanger/VirtualExperiment
2	http://vmt-iitg.vlabs.ac.in/
3	https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=801&cnt=4
4	http://mfts-iitg.vlabs.ac.in/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	10	10	10
Understand	10	10	10
Apply	10	10	10
Analyse	35	35	35
Evaluate	35	35	35
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C505.1	3	2	2	3										1	
C505.2	2	2	2	3										3	
C505.3	3	1	2	2										2	
C505.4	3	2	3	2										3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Semester – 06

21ME601	DESIGN OF TRANSMISSION SYSTEMS	3/0/0/3
Nature of Course	Theory analytical	
Pre Requisites	Design of Machine Elements	
Course Objectives:		
1	To understand the different types of flexible transmission systems.	
2	To understand the terminology, geometry and basic kinematic concepts of gears.	
3	To learn the design of brakes, clutches and gear box.	
4	To enable the students to design real time transmission system elements.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C601.1	Recall the basic design concepts of transmission systems.	[R]
C601.2	Design and develop the flexible transmission elements for engineering applications by selecting the standard data from design data book and manufacturers catalog.	[A]
C601.3	Design and analyze the stresses in gear drives for power transmission.	[A]
C601.4	Apply the standard procedure to design gear box, clutch and brake systems for engineering applications.	[Ap]
C601.5	Design, fabricate and evaluate a model of the transmission system.	[C]

Course Contents:

Design of Flexible Elements: Belt Drives, Selection of V belts and pulleys, flat belts and pulleys, Introduction to toothed belts, design of chain drives and sprockets.

Spur Gears and Helical Gears: Spur gear – Design of spur gear based on strength and wear considerations. Parallel axis helical gears - force, beam strength, wear strength and design of helical gear. **Bevel and Worm Gears:** Straight bevel gear – Beam strength, wear strength, tooth force analysis, design of bevel gears. Worm Gear – force, stresses, thermal capacity, estimating the size of the worm gear pair.

Design of Gear Boxes: Step ratio, ray diagram, kinematics layout. Design of sliding mesh gearbox, constant mesh gear box, multi speed gear box, Theory of variable speed gear box, Introduction to fluid couplings and Torque converters for automotive applications. **Design of Clutches and Brakes:** Clutches, Design of clutches – Plate clutches–Axial clutches-Cone clutches, Centrifugal Clutches, Electromagnetic clutches. Brakes – Design of block brake, disc brakes.

Total Hours:	**45**

Text Books:

1	Bhandari, V.B., “Design of Machine Elements”, Fifth Edition, Tata McGraw-Hill Publishing Company Ltd., 2020.
2	Juvinall R. C., Marshek K.M., “Fundamentals of Machine component Design”, 7th Edition, John Wiley & Sons Third Edition, 2019.

Reference Books:

1	Richard G. Budynas and J. Keith Nisbett, “Shigley’s Mechanical Engineering Design”, Eleventh Edition, Tata McGraw-Hill, 2020.
2	Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2019.
3	Hamrock B.J., Jacobson B., Schmid S.R., “Fundamentals of Machine Elements”, Third Edition, CRC Press, 2014.

Web References:

1	https://nptel.ac.in/courses/112105124/39
2	https://nptel.ac.in/courses/112/106/112106137/

Online Resources:	
1	https://www.coursera.org/learn/machine-design1
2	https://ocw.mit.edu/courses/mechanical-engineering/2-75-precision-machine-design-fall-2001/index.htm

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C601.1	Remember	Quiz	20
C601.2	Analyze	Group Assignment	20
C601.3	Analyze		
C601.4	Apply		
C601.5	Create	Mini Project / Presentation	40

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	20	20	20
Apply	50	50	40
Analyse	20	20	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C601.1	3	2	2	2									1	1	
C601.2	3	3	3	3									3	1	
C601.3	3	3	3	3									3	1	
C601.4	3	3	3	3									3	1	
C601.5	3	3	3	3									3	3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME602	COMPUTATIONAL MECHANICS	3/0/0/3
Nature of Course	Theory	
Pre Requisites	Engineering Mathematics I & II, Solid Mechanics, Fluid mechanics and machinery	

Course Objectives:

1	To enable the students to understand the principle involved in discretization, the purpose of stiffness matrices and force vectors.
2	To enable the students to apply the concepts of finite element analysis for solving engineering problems.
3	To create confidence among students to solve complex problems in the field of fluid flow.

Course Outcomes:
Upon completion of the course, students shall have ability to

C602.1	Summarize the governing equations for continuum and implementation aspects of FEA and CFD.	[U]
C602.2	Apply the appropriate element for the given structural problems.	[Ap]
C602.3	Solve for stresses, strains and deformation of a structural component due to axial load, transverse load and bending.	[A]
C602.4	Examine the time-dependent non-linear problems by applying various discretization methods and technologies in finite element methods.	[E]
C602.5	Solve simple structural, thermal and fluid flow problems using simulation software.	[A]

Course Contents:

Introduction: Historical background, application to the continuum, governing equations for continuum, discretization, matrix algebra, Rayleigh-ritz method (Problems on cantilever beam, Simply supported beam subjected to point load, uniformly distributed load (UDL) and combination of both point load and UDL), weighted residual method, finite element software packages - advantages and limitations, Introduction to FDM and difference between FEM and FDM.

One Dimensional Elements: General procedure of FEM, coordinates and shapes functions, quadratic shape functions, Galerkin's approach-Element stiffness matrices and load vector, finite element equations: 1D-bar, beam and plane truss elements, Temperature effects. **Two Dimensional Elements**: Triangular Element (CST), Isoparametric elements-four node quadrilateral element, shape functions, element stiffness matrix and force vector, Serendipity element (8 node rectangular element) – only shape function derivation, numerical integration (Gauss quadrature method) - one dimensional problem.

Introduction to CFD: Purpose – Applications - Fundamental physical principles, Models of the flow -Governing equations of fluid dynamics – the continuity, momentum and energy equations (for an infinitesimally small fluid element moving with the flow) - only derivation for the exam purpose.

Total Hours:	**45**

Text Books:

1	Logan D.L, "A First Course in the Finite Element Method", Thomson Learning, Sixth Edition, Cengage learning India pvt ltd, 2016.
2	Muralidhar.K, Sundararajan.T, "Computational fluid flow and heat transfer", Second edition, Narosa publishers, 2014.

Reference Books:

1	Tirupathi R. Chandrupatla and Ashok D. Belugundu, "Introduction to Finite Elements in Engineering", Fifth Edition by Cambridge University, 2022.
2	John D. Anderson, Jr, "Computational fluid dynamics," Indian Edition, McGraw Hill Education, 2017.

Web References:	
1	http://www.nptel.ac.in/courses/105105041/1
2	http://nptel.ac.in/courses/112105045/
Online Resources:	
1	https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C602.1	Understand	Quiz	20
C602.2	Apply	Assignment	20
C602.3	Analyze	Assignment	20
C602.4	Evaluate	Tutorial	20
C602.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	10	10	10
Apply	20	20	20
Analyse	40	40	40
Evaluate	20	20	20
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C602.1	3	2	2	2									3		3
C602.2	3	2	2		3								3		1
C602.3	3	2	3	3	3								3		1
C602.4	3	3	1	2									3		3
C602.5	3	3	3	3	3										
	3 Strongly agreed | 2 Moderately agreed | 1 Reasonably agreed														

21ME603	SIMULATION AND ANALYSIS LABORATORY	0/0/3/1.5
Nature of Course	Problem experimental	
Pre Requisites	Problem solving using C programming, Solid Mechanics, CAD/CAM laboratory	

Course Objectives:

1	To enable students create model for a given component using software.
2	To impart knowledge to perform stress analysis for any given component under various mechanical loading conditions.
3	To enable the students to simulate and analyze engineering components under various thermal loading conditions.
4	To enable the students to verify the simple 2D flow using numerical coding.

Course Outcomes:
Upon completion of the course, students shall have the ability to

C603.1	Design of 3D machine components using analysis software.	[Ap]
C603.2	Solve the simple structural problems using analysis software.	[A]
C603.3	Analyze and evaluate the given component under thermal condition using analysis software.	[E]
C603.4	Validate simple flow problem through CFD analysis.	[E]
C603.5	Develop programs to simulate mechanical system.	[C]

Laboratory Components:

S.No	List of Experiments (Using analysis and simulation softwares)	CO Mapping	RBT
1	Stress analysis of L bracket/ Plate with Hole.	C603.1	[Ap]
2	Stress analysis of axisymmetric component.	C603.2	[A]
3	Stress Analysis using link elements in Trusses	C603.2	[A]
4	Stress analysis in Beam under different loading conditions (Point load and UDL)	C603.2	[A]
5	Modal analysis of Beam.	C603.2	[A]
6	Vibrational Analysis of Spring-Mass System	C603.2	[A]
7	Thermal stress analysis in 2D components.	C603.2	[A]
8	Conductive and convective heat transfer analysis.	C603.3	[E]
9	Flow analysis for velocity and pressure distribution in simple 2D flow over flat plate.	C603.3	[E]
10	Flow and heat transfer analysis of fluid flowing in a circular pipe.	C603.4	[E]
11	Simulation of hydraulic / pneumatic cylinder.	C603.5	[C]
12	Simulation of cam and follower mechanism.	C603.5	[C]

Reference Books:

1	Xiaolin Chen, Y. Yujin Liu, “Finite Element Modelling and Simulation using ANSYS Workbench”, CRC Press, 2015.
2	Sham Tickoo “ANSYS Workbench 14.0 for Engineers & Designers: A Tutorial Approach”, Dreamtech Press, 2012.
3	K.Muralidhar, T.Sundarajan, “Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2014.
4	Soumitra Kumar Mandal, “Basic Electronics”, McGraw Hill Education India Private Ltd., 2013.
5	S.R.Otto,J.P.Danier. “An Introduction to Programming and Numerical Methods in MATLAB”, Springer, 2005.

Web References:

1	https://www.nafems.org/e-learning/
2	http://www.mece.ualberta.ca/tutorials/ansys/
3	http://su2.stanford.edu/training.html

Online Resources:	
1	http://nptel.ac.in/courses/105103140/40
2	http://nptel.ac.in/courses/112105045/
3	https://www.coursera.org/learn/matlab
4	https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000x

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	10	10	10
Understand	10	10	10
Apply	20	20	20
Analyse	20	20	20
Evaluate	20	20	20
Create	20	20	20

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C603.1	3	3	3	2	3				2		3		3	2	
C603.2	3	3	3	3	3				2		2		3	2	
C603.3	3	3	3	3	3				2		3		3	1	
C603.4	3	3	3	3	3				2		3		3	1	
C603.5	3	3	2	3	3				2		2		3	1	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME604	Design Thinking and Mini Project	0/0/3/1.5
Nature of Course	Practical	
Pre Requisites	Manufacturing Technology I and Manufacturing Technology II	
Course Objectives:		
1	To demonstrate the interpersonal skills and technical abilities.	
2	To apply suitable tools and techniques to solve the practical problems.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C604.1	Design and develop a working model.	[C]
C604.2	Develop technical skill, presentation skill and interpersonal behavior.	[Ap]
C604.3	Demonstrate interdisciplinary skill, ethical values and team work.	[Ap]
C604.4	Examine market trends in terms of economics and finance.	[Ap]

Course Guidelines:

Introduction: Identifying an Innovation Challenge, Needs Finding, Observation Techniques, Techniques for Organizing Data. **Ideate:** Rules of Brainstorming, Brainstorm Facilitation. **Prototype:** Role of DT in your work, Prototyping Techniques, Testing Prototypes. **Experiments:** Introduction to Experimental Design, Types of Experiments, Business model canvass.

1. Each student is expected to do a project and form a team of 3 members.
2. Every team shall have a guide who is the member of the faculty of the institution. Identification of faculty guide has to be completed within a week from the day of beginning of sixth semester.
3. The student has to identify and fabricate his/her idea into the project working model by conducting literature survey and finalize it.
4. A project report (of the phase-I) to this effect has to be submitted by the team. Also, the complete design project report has to be submitted by team.
5. Five mid semester reviews and one end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member of the faculty team.
6. During the end semester exam, one internal examiner and one external examiner, appointed by the COE will examine the project phase I done by the students.

Summative assessment based on Continuous and End Semester Examination

Activity	Month	Continuous Assessment [60 marks]	End Semester Examination [40 marks]
Project Evaluation	February	30	100
Project Evaluation	March	30	
Project Evaluation + Presenting in International Conference/Journal	April	40	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C604.1	3	3	2	2									3	3	
C604.2	3	3	3	3					2	3	2			3	
C604.3	3	3	3	3					3	2				3	
C604.4	3	3	3	3					2		3			3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Semester – 07

21ME701	INDUSTRIAL ENGINEERING AND OPERATIONS MANAGEMENT	3/0/0/3
Nature of Course	Concept and Analytical	
Pre Requisites	Manufacturing Technology I & II	
Course Objectives:		
1	To create awareness about the basic industrial engineering concepts.	
2	To understand and apply management principles, basics of quality and statistical quality control.	
3	Ability to apply the suitable mathematical technique to solve the practical problems.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C701.1	Demonstrate knowledge on fundamental concepts of Industrial Engineering.	[U]
C701.2	Apply the quality concepts for continuous improvement.	[Ap]
C701.3	Solve quality related problems in manufacturing using control charts	[A]
C701.4	Make important business decisions using statistical and analytical methods.	[Ap]
C701.5	Solve the real world problems using suitable operation research technique.	[A]

INDUSTRIAL ENGINEERING AND MANAGEMENT: Industrial Engineering: Definition, Objectives and Techniques. Industrial Engineering application in service sectors. Productivity concepts and applications. Work study -concept and need, Method study procedure, Therbligs, Standard Time calculation: Stop-watch time study. Comparison of work measurement techniques.

QUALITY MANAGEMENT: Introduction - Definition of quality - Dimensions of product and service quality - Contributions of Deming, Juran and Crosby. Continuous process improvement - PDCA cycle, 5S, Kaizen. The seven traditional tools of quality - Quality Function Development (QFD) – Failure mode and effect analysis (FMEA). Definition of SQC, benefits and limitation -Variation in process causes of variation –Theory of control chart- uses of control chart –Control Charts for X bar, R, np, p,c charts. Solving control chart problems using software packages (Not for examination).

OPERATIONS RESEARCH: Introduction, LPP models: Formation-graphical solution – simplex algorithm. Transportation models: Feasible solutions (NW method- Least cost method- Vogels' approximation method). Project networks - Introduction and problems only in network construction.

Total Hours	**45**

Text Books:	
1	Dale H. Besterfiled, et al., "Total quality Management", Pearson Education Asia, Fourth Edition, 2018.
2	Taha H.A, "Operation Research", Pearson Education sixth edition, 10th Edition, 2019.
3	Eugene Grant and Richard Leavenworth, Statistical Quality Control, 7th Edition McGraw Hill Education, 2017.
Reference Books:	
1	Frederick S. Hillier and Gerald J. Lieberman "Introduction to Operations Research", 11th Edition McGraw Hill Education, 2021.
2	Martand T Telsang, Industrial Engineering And Production Management, S.Cvhand Publishers, 2018 .

Web References:	
1	https://www.accessengineeringlibrary.com/subject/industrial_engineering
2	http://asq.org/learn-about-quality/statistical-process-control/overview/tutorial.html
Online Resources:	
1	http:// freevideolectures.com › Mechanical › IIT Madras › Operations Research
2	https://www.sqconline.com/acceptance-sampling-course

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C701.1	Understand	Group Assignment	20
C701.2, C701.4	Apply	Assignment	40
C701.3	Analyze	Case study	20
C701.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	20	20
Understand	50	30	30
Apply	20	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C701.1	3														
C701.2	3											1	2		
C701.3	3	3	3										3		
C701.4	3	3	1	2								1	2		
C701.5	3	3	3	2									3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME702	MECHATRONICS	3/0/0/3

Nature of Course	Theory &Practical Application
Pre Requisites	Measurements and instrumentation laboratory, Fluid Mechanics and Machinery (with lab), CAD/CAM laboratory

Course Objectives:

1	To learn industrial automation using hydraulics and pneumatics circuits.
2	To understand and classify the advantages in automation using of Sensors, PLC and Robotics.
3	To train the students in the different aspects of Sensors, PLC programming languages and robot languages.

Course Outcomes:
Upon completion of the course, students shall have ability to

C702.1	Describe the hydraulic and pneumatic circuits for industrial applications.	[U]
C702.2	Create and simulate hydraulic and pneumatic circuits.	[C]
C702.3	Study the concepts of sensors, PLC and robotics.	[U]
C702.4	Select suitable Sensors, PLC &robot for specific application.	[Ap]
C702.5	Prepare Programs to automate the six axes articulated robot.	[A]

Course Contents:

INTRODUCTION: Definition, Key elements, Mechatronics approach for Design process, Concept of Siemens Totally Integrated Architecture. Industrial Networking, HMI systems and Wireless controls. **SENSORS AND APPLICATIONS:** Mechatronic control in automated manufacturing, Traditional Vs Mechatronics approach, Integrated product design, General principle- Sensor for motion and position measurement- Force sensor- Pressure sensor- Torque sensor – Tactile sensor - Temperature sensor- Ultrasonic sensor- Piezoelectric sensor. Application of sensors in modern industry.

ACTUATORS FOR MECHATRONICS SYSTEM: Types of actuators and their working principles, control valves, direction, pressure and flow, comparison of hydraulic, pneumatic and electrical actuators - Pneumatic elements, electro pneumatic system, circuit design, examples, hydraulic elements, electro hydraulic system, cascade method. Introduction to PLC-Ladder Logic.

REAL TIME INTERFACING: Introduction of data acquisition and control system, Overview of I/O process, Interfacing of various sensors, Architecture of a Virtual instrument and its relation to the operating system. Introduction of Arduino boards & IDE Software– Programming Basics. **INDUSTRIAL ROBOTICS:** Robot Sensors, Robotic Vision Systems, Introduction to RAPID Programming; Case study – Pick and Place robot, automatic car parking system and other applications.

Total Hours:	**45**

Text Books:

1	Larry T. Ross, Stephen W. Fardo, Michael F. Walach, Larry T. Ross, Stephen W.Fardo, Michael F. Walach, “Industrial Robotics Fundamentals - Theory and Applications”,2nd edition ,2021.
2	Dr. Deepali A. Godse, Atul P. Godse, Dr. Deepali A. Godse, Atul P. Godse, “Microprocessors & Introduction to Microcontroller”, 1st edition,2020
3	Andrea Vacca, GermanoFranzoni, Andrea Vacca, GermanoFranzoni , “Hydraulic Fluid PowerFundamentals, Applications, and Circuit Design”, 1st edition,2021
4	William Bolton, “Electronic Control Systems in Mechanical and Electrical Engineering”, 7th edition,2018.

Reference Books:

1	R.K.Mittal, I.J. Nagrath, “Robotics and Control”, McGraw Hill Education, 2017.

2	Zeev Bahir, “Electrical Drive Control: Textbook with Applicative Aspects”, CreateSpace Independent Publishing Platform, 2015.
Web References:	
1	http://www.electrical4u.com/electrical-drives/
2	http://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
Online Resources:	
1	http://nptel.ac.in/courses/108104011/
2	http://nptel.ac.in/courses/108107029/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C702.1	Understand	Quiz	20
C702.2	Create	Assignment	20
C702.3	Understand	Assignment	20
C702.4	Apply	Tutorial	20
C702.5	Analyse		

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	30	30	30
Understand	20	20	20
Apply	50	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C702.1	3	2											3		
C702.2	3	3	3										3		
C702.3	3	3													
C702.4	3	3	3												
C702.5	3	3	3												3
	3 Strongly agreed				2 Moderately agreed							1 Reasonably agreed			

21ME703	MECHATRONICS LABORATORY	0/0/3/1.5
Nature of Course	Practical application	
Pre Requisites	Measurements and instrumentation laboratory, Fluid Mechanics and Machinery (with lab), CAD/CAM laboratory	

Course Objectives:

1	To learn industrial automation using hydraulics and pneumatics circuits.
2	To understand and classify the advantages in automation using of Sensors, PLC and Robotics.
3	To train the students in the different aspects of Sensors, PLC programming languages and robot languages.

Course Outcomes:
Upon completion of the course, students shall have ability to

C703.1	Actuate and simulate various hydraulic and pneumatic circuits for industrial applications.	[Ap]
C703.2	Identify various sensors to calculate appropriate parameters like pressure, temperature and torque.	[Ap
C703.3	Identify the logics of a Programmable Logic Controller to actuate the robotic sensors in ABB Robot.	[Ap]
C703.4	Study the TCP to actuate the six axes articulated robot.	[U]
C703.5	Prepare programs to automate the six axes articulated robot to perform various operations.	[Ap]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Design and Simulation of pneumatic circuit for actuating single and double acting cylinder.	C703.1	[C]
2	Design and Simulation of Logical functions (AND, OR) for control of double acting cylinder.	C703.2	[C]
3	Design and Simulation of metering-in and metering-out circuits.	C703.2	[C]
4	Simulation and Actuation of Sequencing Circuit A+B+B-A-.	C703.2	[C]
5	Pneumatic circuit for single cycle automation of multi cylinder in sequence of A+B+B-A- using cascade method.	C703.2	[C]
6	Measurement of displacement using LVDT	C703.3,4	[Ap]
7	Measurement of torque using Torque Measurement device	C703.3,4	[Ap]
8	Measurement of pressure using bourdon gauge	C703.3,4	[Ap]
9	TCP teaching to Robot	C703.3,4	[Ap]
10	Teach the ABB six robot to identify the given component is metal or non-metal using teach pendant	C703.3,4	[Ap]
11	Perform a matrix palletizing operation of ABB six axis robot using teach pendant with single suction cup	C703.3,4	[Ap]
12	Electro pneumatic circuit using PLC	C703.3,4	[Ap]

Total Hours: 45

Reference Books:

1	R.K.Mittal, I.J. Nagrath, “Robotics and Control”, McGraw Hill Education, 2017.
2	Zeev Bahir, “Electrical Drive Control: Textbook with Applicative Aspects”, CreateSpace Independent Publishing Platform, 2015.

Web References:

1	http://www.electrical4u.com/electrical-drives/

2	http://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
Online Resources:	
1	http://nptel.ac.in/courses/108104011/
2	http://nptel.ac.in/courses/108107029/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
75	**25**	**100**	**60**	**40**	**100**

Assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment (60%) [100 Marks]**		**End Semester Practical Examination (40%) [100 Marks]**
	FA (75 Marks)	**SA (25 Marks)**	
Remember	10	10	10
Understand	10	10	10
Apply	30	30	30
Analyse	40	40	40
Evaluate	10	10	10
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C703.1	3	3													
C703.2	3	3													
C703.3	3	3	3												3
C703.4	3	3													
C703.5	3	3	3												3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME704	Phase I – Project Work	0/0/2/1
Nature of Course	Practical	
Pre Requisites	-	

Course Objectives:

1	To demonstrate the technical and literature survey abilities.
2	To identify suitable tools and techniques to solve the practical problems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C704.1	Study the problem and identify the solution space.	[A]
C704.2	Conduct literature survey.	[A]
C704.3	Develop technical skill, presentation skill and interpersonal behavior.	[Ap]
C704.4	Demonstrate interdisciplinary skill, ethical values and team work.	[Ap]
C704.5	Examine business/market trend in terms of economics and finance.	[Ap]

Course Guidelines:

1. Each student is expected to do a project and form a team of 3 members.
2. Every team shall have a guide who is the member of the faculty of the institution. Identification of faculty guide has to be completed within a week from the day of beginning of seventh semester.
3. The student has to identify and select the problem to be addressed as his/her project work by conducting a complete literature survey and finalize a comprehensive aim and scope of his/her work to be done.
4. 25% of the total project work (up to design phase) has to be completed by the end of seventh semester.
5. A project report (of the phase-I) to this effect has to be submitted by the team. Also, the complete design project report has to be submitted by team.
6. Two mid semester reviews and one end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member of the faculty team.
7. During the end semester exam, one internal examiner and one external examiner, appointed by the COE will examine the project phase I done by the students.

Summative assessment based on Continuous and End Semester Examination

Activity	Month	Continuous Assessment [60 marks]	End Semester Examination [40 marks]
Problem Statement	August	30	100
Project Evaluation (Up to design phase)	September	30	
	October	40	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C704.1	3											2	2		
C704.2	3								3			1			
C704.3	2								3			3			
C704.4	3								2			2			
C704.5	2								3			2			

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Semester – 08

21ME801	Phase II – Project Work	0/0/24/12
Nature of Course	Practical	
Pre Requisites	-	
Course Objectives:		
1	To demonstrate technical, interdisciplinary and interpersonal abilities.	
2	To apply suitable tools and techniques to solve the practical problems.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C801.1	Design, analyse and develop a working model.	[C]
C801.2	Design, optimize and automate a technical model.	[C]
C801.3	Develop technical skill, presentation skill and interpersonal behavior.	[Ap]
C801.4	Demonstrate interdisciplinary skill, ethical values and team work.	[Ap]
C801.5	Examine business/market trend in terms of economics and finance.	[Ap]

Course Guidelines:

1. The entire semester shall be utilized by the students to do their project work by receiving the directions from the guide. The time may be used for library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present periodical seminars about the progress made in the project.
2. The same team formulated in Phase I shall proceed with the same problem statement in Phase II. The team shall be guided by the faculty guide deputed during Phase I.

Any change in the team members or problem statement or faculty guide due to unavoidable circumstances shall be initiated after the approval of the project coordinator and Head of the department.

3. The progress of the project is to be evaluated on a continuous basis by conducting a minimum of three reviews. The review committee may be constituted by the Head of the Department.
4. Each batch of students shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be in typewritten form as specified in the guidelines issued by the COE.
5. The project work is evaluated jointly by external and internal examiners constituted by the COE, based on oral presentation and the project report. The candidate is expected to publish the project work in peer reviewed journal.

Summative assessment based on Continuous and End Semester Examination

Activity	Month	Continuous Assessment [60 marks]	End Semester Examination [40 marks]
Project Evaluation	February	30	100
Project Evaluation	March	30	
Project Evaluation + Presenting in International Conference/Journal	April	40	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C801.1	3	3		2					2		2		3	3	
C801.2	3	3		3	3				2		2		3	3	
C801.3	2			2				3	3		1		2	3	
C801.4	2			2	3			3	3		3			3	
C801.5	3			3	3			2	2		3			3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Elective Stream I – Engineering Design

21ME901	PRODUCT DESIGN AND DEVELOPMENT	3/0/0/3
Nature of Course	Theory	
Pre requisites	Design of Machine Elements, Manufacturing Technology	
Course Objectives:		
1	To enable the students to gain knowledge on the process of product development based on customer needs.	
2	To enable the students to understand the standard procedure available for concept development.	
3	To facilitate the students to use design process and identify system level design issues.	
4	To make the students familiarize with the intellectual property rights.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C901.1	Recall the basic product development process.	[R]
C901.2	Apply the design thinking process for product development.	[Ap]
C901.3	Elaborate the use of computers in decision making	[U]
C901.4	Discover the IPR related issues and patent registration.	[U]
C901.5	Analyze the feasibility of the proposed project.	[A]
Course Contents:		
INTRODUCTION: Product Design and Development, Organizations. Development Process, Product Planning, Identifying opportunities, Customer Needs, Product Life Cycle, Design thinking. **CONCEPT DEVELOPMENT**: Product and Target specification, various steps in concept generation, Brainstorming, Selection of concepts, Pugh selection method, Concept screening and concept scoring **DESIGN PROCESS** Concept Testing, Concept Implementation. Product specification, Product Architecture, System level design issues. Embodiment design, Robust design and DFx. **PLANNING FOR MANUFACTURE AND MANAGEMENT** Detail Design, Design Management, Project planning and control, Production design specification (PDS), Design review, Value analysis/engineering. **INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS** Intellectual Property Rights, Write the description of the invention, Refine Claims, Pursue application. Economics and Management Accelerating Projects, Project Execution.		
	Total Hours:	**45**
Text Books:		
1	Karl T Ulrich & Steven D Eppinger, “Product design and development” New York, McGraw-Hill Education, 2016.	
2	Ken Hurst, “Engineering Design Principles”, Elsevier Science and Technology Books, 2014.	
Reference Books:		
1	G. E. Dieter, “Engineering Design”, McGraw – Hill International, 2013.	
2	Kevin N A otto, Kritine I Wood, “Product Design”, Prentice Hall Publications, 2013.	
3	Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, “Design Thinking: Handbook”, World Scientific Publishing Co. Pte. Ltd. 2020.	
Web References:		
1	http://www.electrical4u.com/digital-electronics.htm	
2	http://www.technologystudent.com/elec1/dig1.htm	
Online Resources:		
1	https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1	

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C901.1	Remember	Quiz	20
C901.2	Apply	Assignment	20
C901.3 & C901.4	Understand	Technical Presentation	20
C901.5	Analyze	Group Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	40	40	40
Understand	30	30	30
Apply	20	20	20
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C901.1	2	3	2	2										3	
C901.2	2	3	3										3	2	
C901.3	3	3	3	2									3	2	
C901.4	3	3	3										2		
C901.5	3	3	2	2										3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME902	TOOL AND DIE DESIGN	3/0/0/3
Nature of Course	Concept and Analytical	
Pre requisites	Engineering Mechanics, Strength of Materials, Manufacturing Technology II	

Course Objectives:

1	To enable the students to design locating devices and clamps
2	To design the jigs and fixtures for simplifying manufacturing process
3	To design the tools for Bending, Forming and Drawing operations
4	To study the design process of press tools

Course Outcomes:
Upon completion of the course, students shall have ability to

C902.1	Interpret various terminologies of Jigs and Fixtures	[U]
C902.2	Design Jigs and Fixtures for Manufacturing, Testing and Assembly applications	[A]
C902.3	Interpret Various Terminologies of Press Tools and Dies	[U]
C902.4	Design Press Tools and Dies Using Various Design Rules	[A]
C902.5	Design Forming Tools and Moulds Using Various Design Rules	[A]

Course Contents:

INTRODUCTION AND BASIC PRINCIPLES OF JIGS AND FIXTURES

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices –– Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures

TERMINOLOGIES AND ELEMENTS OF PRESS TOOLS AND DIES

Press Working Terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies. Bending and Drawing Dies- Blank development -Types of bending dies – Design and development of bending and drawing dies.

DESIGN OF MOULDS AND FORMING TECHNIQUES

Basic construction of mould – Types of moulds – Mould parts –Mould clamping methods, Mould lifting arrangements. Design of different circuits in mould design (cooling, pouring and flow circuits). Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction – tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

Total Hours:	**45**

Text Books:

1	Donaldson C., Lecain G.H. and Goold V.C. “Tool Design” McGraw Hill Education; 4 edition, 20 April 2012.
2	Joshi, P.H. “Jigs and Fixtures”, Thirs Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017

Reference Books:

1	Joshi P.H “Press tools: Design and Construction”, S.Chand Publishing, 2012.
2	Donaldson, Lecain,Gooldand Joyeet “Tool Design”, Fourth Edition, Tata McGraw Hill, 2012.

3	Design Data Hand Book, PSG College of Technology, Coimbatore
Web References:	
1	http://www.dimensionalacademy.com/courses/mechanical/machine-tool-drawing.html/
Online Resources:	
1	http://www.toolingu.com/ilt/915101/Design-for-TOOL-DFT/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C902.1 & C902.3	Understand	Tutorials/Assignments	20
C902.2, C902.4 & C902.5	Analyze	Group Assignment	20
		Individual Assignment / Mini Project	40

Assessment based on Summative and End Semester Examination

Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	30	30	30
Understand	20	20	20
Apply	50	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**		
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**	
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C902.1	3	2	2										3	1	
C902.2	3	3	3										3	1	
C902.3	3	3	3										3	1	
C902.4	3	3	3								2		3	1	
C902.5	3	3	3	3							2		3	1	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME903	FUNDAMENTALS OF FRACTURE MECHANICS	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	Strength of materials	
Course Objectives:		
1	To introduce the stress calculation at crack tip and their needs.	
2	To enable the students to understand the critical failure for different crack geometries.	
3	To enable the students to understand the different modes of fracture.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C903.1	Describe the fundamentals of failures and fracture mechanics	[U]
C903.2	Formulate governing equation for elastic problems	[Ap]
C903.3	Calculate stresses/displacements around the crack tip for different modes of fracture	[A]
C903.4	Analyze failed engineering components under different modes of fracture.	[A]
C903.5	Describe the finite element implementation in fracture mechanics.	[U]

Course Contents:

Introduction to Fracture Mechanics: Failures in structures – types and causes, historical perspective, fracture mechanics approach to design -energy criterion, stress intensity approach, time dependent crack growth and damage tolerance, effect of material properties on fracture. Linear Elastic Fracture Mechanics (LFEM): Stress concentration effect of flaws, Griffith energy balance, the energy release rate, instability and resistance curve (R-curve), stress analysis of cracks, relationship between stress intensity factor and energy release rate (K and G), crack tip plasticity, mixed mode crack initiation and propagation.

Elastic Plastic Fracture Mechanics (EPFM): Crack-Tip-Opening Displacement (CTOD), the J contour integral and its determination, relationships between J and CTOD, crack-growth resistance curves, J-controlled fracture. Fracture mechanism in metals and non-metals: Ductile fracture, cleavage, the ductile-brittle transition, intergranular fracture, fracture in polymeric materials, and fracture in ceramic and ceramic composites**.**

Applications: Introduction to fracture toughness testing of metals and non-metals for determination of fracture parameters, Application of fracture mechanics concepts in the analysis of fatigue crack growth. Computational fracture mechanics: Overview of numerical methods for fracture mechanics problems, traditional methods in computational fracture mechanics – point matching and energy methods, the energy domain integral, finite element implementation, design of finite element mesh, linear elastic convergence study, analysis of growing cracks.

	Total Hours:	**45**

Text Books:	
1	Anderson T. L. – ‘Fracture Mechanics: Fundamentals and Applications’ – CRC Press – 2017 – 4th Edition
2	Surjya Kumar Maiti- ‘Fracture Mechanics: Fundamentals and Applications’ Cambridge University Press 2016.
Reference Books:	
1	Robert Ritchie, Dong Liu – ‘Introduction to Fracture Mechanics -Elsevier 1st Edition - May 27, 2021
2	Ted L. Anderson, “Fracture Mechanics: Fundamentals and Applications”, CRC Taylor and Francis, 4th Edition, 2017

Web References:	
1	https://nptel.ac.in/courses/112/106/112106065/
2	https://www.youtube.com/watch?v=G5mcTw-PLEI

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C903.1 & C903.5	Understand	Assignment	20
C903.2	Apply	Quiz	20
C903.3 & C903.4	Analyze	Group Assignment / Case Study	40

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	40	30	30
Apply	40	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs											PSOs		
	a	b	c	d	e	f	g	h	i	j	k	1	2	3
C903.1	2	2	3	2								1	1	
C903.2	3	2	2	2								1	1	1
C903.3	2	2	2	3								2	1	1
C903.4	2	2	3	3								1	1	1
C903.5	2	2	3	2										

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME904	DESIGN FOR MANUFACTURING AND ASSEMBLY	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Manufacturing Technology II	
Course Objectives:		
1	To enable the students to understand the general design guidelines of design for manufacture and assembly.	
2	To provide the knowledge on minimizing the cost/time, maximizing the quality and ease of manufacture and assembly.	
3	To enable the students to understand the principles and design rules pertaining to design for casting, welding and machining.	
4	To outline the features of DFMA software.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C904.1	Summarize the design procedure of engineering products in order to minimize the cost/time.	[U]
C904.2	Analyse the importance of tolerance and process capability in promoting interchangeability and selective assembly.	[A]
C904.3	Analyze the design process of engineering products for ease of assembly and machining.	[A]
C904.4	Apply the design concepts for engineering products for casting, welding and machining operations.	[Ap]
C904.5	Study the design parameters of a product using DFMA software	[U]
Course Contents:		
DFMA Introduction: Engineering design – Kinds of design – Design process steps – Factors influencing design – Concurrent Engineering – Manufacturing process and material selection – Evaluation methods for material selection. Tolerance analysis: Process capability analysis – Cumulative effect of tolerances – Centrality analysis – Compound assembly – Selective and Interchangeable assembly – Grouped Datum systems – Geometric Dimensioning &Tolerances: Symbols – Feature Control frame – Virtual Tolerance. **Design for casting, welding and machining:** Design for castings – Design for weldments – Design for forgings – Design for sheet metal formed parts – Design for powder metallurgy parts – Design for plastic parts. Design for machining – Design for economy – Economic Analysis of Assembled parts - Design for clampability – Design for ease of assembly – Design for disassembly. **DFMA software:** Advances in DFMA- Design for robustness – Axiomatic design – Design for environment – DFA index – Poka Yoke – Lean principles – MUDA – Six sigma concepts – Computer aided DFA using software.		
	Total Hours:	**45**
Text Books:		
1	Matousek, R. “Engineering Design” Blackie and Son Limited, Glasgow, 2018.	
2	Dieter, G.E. “Engineering Design: A Materials and processing Approach”, McGraw Hill Co. Ltd, 5th edition, 2012.	
Reference Books:		
1	Eggert, R.J. “Engineering Design” Pearson Education, Inc. New Jersey, 2014.	
2	Peck, H. “Designing for Manufacture”, Pitman Publications, London, 2013.	
3	KalandarSaheb, S.D and Prabhakar, O. “Engineering Design for Manufacture”, ISPE 2014.	
4	Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, “Product design for manufacture and assembly”, Second edition, Taylor and Francis, 2015.	

Web References:	
1	www.dfma.com
Online Resources:	
1	www.nptel.ac.in/courses/107103012
2	www.mjme.ir-International journal of advanced design and manufacturing

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C904.1	Understand	Class presentation	20
C904.2	Analyze		
C904.3	Analyze	Assignment	40
C904.4	Apply		
C904.5	Understand	Case study using DFMA software	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	10
Understand	20	20	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C904.1	3	2	2	2									2	3	
C904.2	3	3	3	2									2	2	
C904.3	3	3	3	3									2	2	
C904.4	3	2	2	3									2	3	
C904.5	3	2	3	3	3							1	3	2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME905	OPTIMIZATION TECHNIQUES IN ENGINEERING DESIGN	3/0/0/3
Nature of Course	Theory analytical	
Pre Requisites	Industrial Engineering and Operations Management	

Course Objectives:

1	To enable the students to have an in-depth knowledge about the optimization techniques applied to industrial operations.
2	To make the students understand and apply optimization techniques to real world problems.
3	To enable the students to develop the mathematical techniques and algorithms to practical problems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C905.1	Study the basics of optimization techniques applied to engineering problems.	[U]
C905.2	Formulate and solve non-linear programming problems.	[Ap]
C905.3	Solve real time integer programming problems	[Ap]
C905.4	Solve dynamic programming problems as applied to real time scenarios.	[Ap]
C905.5	Implement non-traditional optimization techniques to solve complex managerial problems.	[E]

Course Contents:

Non-Linear Optimization: Introduction to Non-linear optimum design-General principles of optimization–Problem formulation & their classifications. Single variable and multivariable optimization. Non-linear Optimization with equality and inequality constraints. Direct methods–Indirect methods using penalty functions. Lagrange multipliers -Geometric programming**.**

Integer Programming Problems: Introduction- Integer Programming formulations. Branch and bound technique. Gomary's cutting plane method. **Dynamic Programming Problems:** Introduction to Dynamic Programming (DP) - Bellman's principle of optimality. Application of DP-Capital budgeting, Reliability improvement. Shortest path and cutting stock problems.

Nontraditional Optimization: Introduction to non-traditional optimization, Computational Complexity – NP-Hard and NP-Complete. Taguchi method, working principles of Genetic Algorithm, Simulated Annealing and Particle Swarm Optimization, Introduction to Fuzzy Logic System Components: Fuzzification, Membership value assignment, development of rule base and decision-making system, Defuzzification to crisp sets, Defuzzification methods. Neural network applications: Process identification, control, fault diagnosis and load forecasting. Simulation of Genetic programming (Not for examination).

Total Hours: 45

Text Books:

1	Taha H.A, "Operation Research", Pearson Education sixth edition, 10th Edition 2017.
2	Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall India (Pvt) Ltd., New Delhi, 2018.

Reference Books:

1	D.K. Pratihar and S.P. Simon, Soft Computing techniques, Oxford University Press, 2017.
2	S. Rajasekaran and G.A.V. Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2019.

Web References:

1	http://growingscience.com/beta/msl/570-non-conventional-optimization-techniques-in-optimizing-non-traditional-machining-processes-a-review.html

2	https://www.britannica.com/science/optimization
Online Resources:	
1	https://www.coursera.org/learn/algorithms-npcomplete
2	http//www.nptel.ac.in/downloads/105108127

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C905.1	Understand	Quiz	20
C905.2 & C905.3	Apply	Tutorial	20
C905.4	Apply	Case Study	20
C905.5	Evaluate	Group Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	20	20	10
Apply	20	10	20
Analyse	40	40	40
Evaluate	10	20	20
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C905.1	3	2											3		
C905.2	3	3	2										3		
C905.3	3	3	3	2	3								3		
C905.4	3	3	3	2									3		
C905.5	3	2	3	2	3							2	3		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME906	INDUSTRIAL ROBOTICS	3/0/0/3
Nature of course	Concept and Theory	
Pre requisites	Engineering Mechanics, Kinematics of Machinery	

Course Objectives:

1	To familiarize the students in industrial automation, robots and its application.
2	To enable the students to familiarize with the kinematics of robots.
3	To impart knowledge on robot end effectors, arm and their design.
4	To enable the students to write programs for Robot.
5	To impart knowledge on various sensors and their applications in robots.

Course Outcomes:

Upon completion of the course, students shall have ability to

C906.1	Summarize the types, principles and applications of industrial robots and sensors	[U]
C906.2	Elaborate the types of robotic manipulators and gripper configuration based on kinematics and dynamics of robot.	[U]
C906.3	Analyze the drive mechanism and power transmission methods used in robots.	[A]
C906.4	Design the various components of a robot by applying the learnt concepts such as kinematics, transmission and control mechanism, sensors and programming language.	[C]
C906.5	Describe the industrial applications of robots.	[U]

Course Contents:

Introduction to Robot, Kinematics and dynamics: Robot definition: Robotic systems - Its role in automated manufacturing; robot anatomy; robot classifications and specifications - Types of industrial robots - Work envelope - Flexible automation versus Robotic technology. Translations, Rotations and Transformations - Forward and reverse transformation, homogeneous transformations - Forward and inverse Kinematics Of three & four Degree of Freedom Robot Arm. Robot Arm dynamics. ABB – SCARA robot anatomy and it's working. Cobotics - Basics and working.

Robot drives, controls and power transmission: Robot drive mechanisms – hydraulic – pneumatic and electric, Mechanical transmission methods. Electronic and Pneumatic manipulators - Construction of Manipulators. Different Types of Controllers-Proportional, Integral, Differential, PID controllers. Classification of End effectors - Drive system for grippers-Mechanical-adhesive-vacuum-magnetic-grippers. Active and passive grippers.

Robot sensors, programming language and Industrial Applications Robot sensors, different types of contact and non-contact sensors. Robot languages and programming techniques**.** Robotic vision systems, image representation, object recognition and categorization, Role of artificial intelligence in robotics. Material transfer, Machine loading, Assembly, inspection, processing operations and service robots, Robots in continuous arc welding, Robot cell.

Total Hours:	**45**

Text Books:

1	Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill Education, 2nd Edition, 2018.
2	Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2019

Reference Books:	
1	Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 2017
2	M.P Groover, M Weiss, R M Gnagel and N G Ordrey, “Industrial Robotics”, Tata McGraw - Hill, New Delhi, 2019
Web References:	
1	http://www.robotics.org/
2	http://www.robotbooks.com/general-robotics-links.htm
Online Resources:	
1	https://www.edx.org/course/robotics-columbiax-csmm-103x
2	https://www.edx.org/course/robot-mechanics-control-part-i
3	https://www.edx.org/course/robot-mechanics-control-part-ii

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C906.1	Understand	Quiz	20
C906.2 & C906.5	Understand	Class Presentation/ Assignment	20
C906.3	Analyze	Assignment / Mini Project	40
C906.4	Create		

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	20	30	30
Apply	30	30	30
Analyse	30	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C906.1	3	2	2	3	3								1		3
C906.2	3	3	2										1		3
C906.3	3	3	2												3
C906.4	3	2	3	2	3								1		3
C906.5	3	1	1	2	2								1		3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME907	ENGINEERING FAILURE ANALYSIS	3/0/0/3
Nature of Course	Theory Analytical	
Pre Requisites	Engineering Mechanics, Kinematics of Machinery, Dynamics of Machinery	
Course Objectives:		
1	To impart knowledge on failure of mechanical components and the theory behind it.	
2	To enable the students to understand the various modes of failure.	
3	To equip students with knowledge on skills required to carry out the failure analysis.	
4	To enable the students to understand the various tools used for failure analysis.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C907.1	Identify and explain different types of failure of engineering materials and their characteristic features.	[U]
C907.2	Apply various theories of failure to the components subjected to multidirectional loading.	[Ap]
C907.3	Apply the principles of fracture mechanics and design for failure against fracture.	[Ap]
C907.4	Design for failure against wear failure and creep loading	[E]
C907.5	Develop expertise on the experimental techniques and simulations utilized for failure analysis	[E]

Course Contents:

Introduction: Material failure modes and their identification; Systematic approach to failure analysis. Tensile test, Static loading, Combined stress, Principal stresses, Theories of failure, Fracture processes, Meaning of ductile and brittle fracture, fracture mechanics and failure.

Fatigue: Loading under high cycle fatigue conditions, Test methods, S-N-P curves, endurance diagrams, influence factors - Low cycle fatigue, fretting fatigue; Fatigue design for combined stress; cumulative damage and life prediction. **Wear**: Types of wear, analysis of wear failures, wear at elevated temperatures. **Creep:** Mechanics of creep, inter-granular, trans-granular creep, Creep test, Creep strain rate-time curves, Deformation mechanism map; High temperature properties of materials.

Failure Analysis & Tools: Application of Poisson, exponential and Weibull distributions for reliability, bath tub curve, parallel and series systems, MTBF, MTTR, FMEA-design process, FMEA, analysis of causes of failure modes, ranks of failure modes; Fault tree analysis; Industrial case studies on FMEA.

Total Hours:	**45**

Text Books:	
1	Anderson T L , "Fracture Mechanics: Fundamentals and Applications", 4th Edition, Taylor and Francis, 2017.
2	Michael F Ashby , "Materials Selection in Mechanical Design", 3rd Edition, Butterworth – Heinemann, 2016.
Reference Books:	
1	Hock-Chye Qua, Applied Engineering Failure Analysis: Theory and Practice, CRC press, Taylor & Francis, U.K, 2017.
2	Abdel Salam Hamdy Makhlouf, Mahmood Aliofkhazraei, Handbook of Materials Failure Analysis with Case Studies from the Aerospace, BH, Elsevier,U.K, 2016.
Online Resources:	
1	https://nptel.ac.in/courses/112/107/112107241/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C907.1	Understand	Quiz	20
C907.2	Apply	Assignment	20
C907.3	Apply	Case Study	20
C907.4	Evaluate	Tutorials	20
C907.5	Evaluate		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	10	10	10
Apply	30	30	30
Analyse	40	40	40
Evaluate	10	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C907.1	3	2	2	2									2		
C907.2	3	3	2	2									2		
C907.3	3	3	3										2		
C907.4	3	3	2	3									2		
C907.5	3	3	2	3								2	2		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME908	MEMS/NEMS	3/0/0/3
Nature of Course	Theory	
Pre requisites	Basics of Physics and Chemistry	
Course Objectives:		
1	To make the students learn various techniques available to make micro shapes using various materials.	
2	To impart the methodologies to be followed in micro fabrication and forming.	
3	To enhance the students knowledge about MEMS / NEMS devices and their applications.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C908.1	Recall the basic concepts related to MEMS / NEMS.	[R]
C908.2	Elaborate the various fabrication techniques and micro machining processes for MEMS / NEMS.	[U]
C908.3	Use various fabrication techniques to develop a MEMS / NEMS System.	[Ap]
C908.4	Analyze the characteristics of MEMS and NEMS devices.	[A]
C908.5	Interpret the principles and applications of MEOMS	[U]

Course Contents:

INTRODUCTION TO MEMS/NEMS: Introduction – MEMS vs NEMS - Evolution of Micro-sensors and MEMS Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Introduction to NEMS - a journey from MEMS to NEMS, MEMS based nanotechnology – fabrication, film formation and micromachining, Nano-mechanical Resonators, Nano-mechanical Sensors. NEMS architecture, Surface Plasmon effects, energy conversion in NEMS and MEMS **LITHOGRAPHY:** Introduction to Photolithography - Photolithography Resolution - Enhancement Technology Beyond Moore's Law - Next Generation Lithographies– Emerging Lithography Technologies.

ADDITIVE TECHNOLOGY: Introduction –Silicon Growth -Doping of Si - Oxidation of Silicon-Physical Vapor Deposition - Chemical Vapor Deposition- Silk-Screening or Screen-Printing - Sol-Gel Deposition Technique. Plasma Spraying - Deposition and Arraying Methods of Organic Layers in BIOMEMS and BIONEMS - Thin versus Thick Film Deposition - Selection Criteria for Deposition Method. Nanofabrication with EBL & IBL.

MINIATURIZATION TECHNIQUES Introduction - Absolute and Relative Tolerance in Manufacturing - Historical Note: Human Manufacturing - Top-Down Manufacturing Methods-Surface Micromachining, Silicon on Insulator Technology (SOI), Bottom-Up Approaches - modelling, brains, packaging, sample preparation and new MEMS materials Introduction-Modelling, Brains in Miniaturization- Packaging, Substrate Choice. **MINIATURIZATION APPLICATIONS**: Introduction to Scaling - Scaling effects - Scaling laws in miniaturization - Actuators, Fluidics - Other Actuators - Integrated Power miniaturization applications-Introduction - Definitions and Classification Method – MOEMS – Principles and Applications to Automotive, Telecom and Biomedical.

Total Hours:	**45**

Text Books:	
1	Tai-Ran-Hsu, “MEMS & Microsystems: Design and Manufacture”, McGraw Hill, 17th Reprint, 2013.
2	Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2nd Edition, 2011.
Reference Books:	
1	V.K. Jain, “Micromanufacturing Processes”, CRC Press, 2016.
2	Marc J Madou, “Fundamentals of Microfabrication and Nanotechnology”, CRC Press, 2011.
Web References:	
1	https://youtu.be/ZcCXFrHQ7Ao/Introduction to Materials Science for MEMS and NEMS
Online Resources:	
1	MEMS and Microsystems - https://nptel.ac.in/courses/117105082/
2	https://www.coursera.org/learn/MEMS/NEMS

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C908.1	Remember	Quiz	20
C908.2 & C908.5	Understand	Assignment	20
C908.3	Apply	Technical Presentation	20
C908.4	Analyse	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	30	20
Understand	40	30	40
Apply	30	30	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	3
C908.1	3	2	1											1	
C908.2	3	1	1			1								2	
C908.3	2	3	3											1	
C908.4	2	3	3											2	
C908.5	2	1	1		3									1	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME909	SURFACE ENGINEERING	3/0/0/3
Nature of Course	Concepts and Analytical	
Pre requisites	Engineering Mechanics and Fluid Mechanics and Machinery	
Course Objectives:		
1	To provide greater insight into the science and technology of interacting surfaces in relative motion.	
2	To study in detail about surfaces, friction, wear, lubrication and their effects.	
3	To apply the concepts to the design of hydro dynamic, hydro static and rolling element bearings.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C909.1	Describe the fundamentals of friction, wear and lubrication.	[U]
C909.2	Illustrate the concept of wear and lubrication to solve inter-disciplinary engineering problems.	[Ap]
C909.3	Apply the concepts of lubrication to design of rolling element bearings.	[Ap]
C909.4	Analyze the different types of surface coating techniques	[A]
C909.5	Correlate the surface coating techniques with nano tribology	[A]
Course Contents:		
Friction and Wear - Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction - Friction of metals - Friction of non metals. Friction of lamellar solids - friction of Ceramic materials and polymers - Rolling Friction - Source of Rolling Friction - Stick slip motion - Measurement of Friction. Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear - Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture wear - Wear of Ceramics and Polymers - Wear Measurements. **Lubrication and Film Lubrication Theory -** Types and properties of Lubricants –Lubrication regimes-Testing methods - Hydrodynamic Lubrication - Elasto hydrodynamic lubrication-Boundary Lubrication - Solid Lubrication Hydrostatic Lubrication. Fluid film in simple shear – Viscous flow between very close parallel plates – Shear stress variation Reynolds Equation for film Lubrication – High speed loaded/unloaded journal bearings-The Somerfield diagram. **Surface Engineering &Nano tribology -** Surface modifications – Transformation Hardening, surface fusion – Thermo chemical processes – Surface coatings Recent development in coatings DLC, CNC thick coatings– Coating of polymers and plastics- Measuring techniques-Plating and anodizing – Fusion Processes – Vapour Phase processes. Nano tribology-Introduction, SFA studies- AFM/FFM studies.		
	Total Hours:	**45**
Text Books:		
1	Bharat Bhusan, 'Introduction to Tribology', 2nd Edition, John Wiley & sons, Ltd. 2016.	
2	Harish Hirani, "Fundamentals of Engineering Tribology with Applications", Cambridge University Press, 2017.	
Reference Books:		
1	Ramsey Gohar "Fundamentals of Tribology" World Scientific Publishing Europe Ltd, 2018.	
2	V.B.Bhandari "Design of Machine Elements "Fourth Edition. Tata McGraw hill Edition Pvt, 2016.	

Online Resources:	
1	https://nptel.ac.in/courses/113/105/113105086/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C909.1	Understand	Quiz/Presentation	20
C909.2 & C909.3	Apply	Group Assignment	40
C909.4 & C909.5	Analyze	Case study	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C909.1	2													1	
C909.2	3	3	2											2	
C909.3	3		2											2	
C909.4	3		2											3	
C909.5	3	3			1									2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Elective Stream II – Thermal Engineering

21ME910	NON-CONVENTIONAL ENERGY SOURCES	3/0/0/3
Nature of Course	Theory	
Pre Requisites	Engineering Thermodynamics, Fluid Mechanics and Machinery and Heat and Mass Transfer	

Course Objectives:

1	To understand and analyze the various non-conventional energy resources and their environmental merits.
2	To discuss technologies for utilization of non-conventional energy sources.
3	To enable the students to understand the various economics involved in the utilization of non-conventional energy sources.

Course Outcomes:

Upon completion of the course, students shall have ability to

C910.1	List the various sources of non-conventional energy	[R]
C910.2	Interpret the ways in optimizing and selecting an alternate energy source	[U]
C910.3	Explain the various means to utilize the non-conventional energy resources	[U]
C910.4	Identify the impact of alternate energy resources on the environment	[Ap]
C910.5	Analyze the scope of newer sources of energy and their application	[A]

Course Contents:

Role and potential of new and renewable source: The solar energy option – Solar Cells – PV Systems, Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion, Solar Radiation – Measurements of solar Radiation and sunshine – PV Applications and state of the art applications like solar walls, solar refrigeration, Floatovoltaic cell.

Energy available from wind: Basis of Wind energy conversion, Lift and drag, Effect of density, Angle of attack, Wind Energy generators and its performance – Wind Energy Storage – Applications – Hybrid systems – State of the art technology trends for offshore wind energy operation. **Biomass:** Biogas, Source, Composition, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, Bio gas production Aerobic and anaerobic bio-conversion process, Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and economics. Photosynthesis, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production - Government Policy and Status of Bio fuel technologies in India.

Other potential sources: Principle of Ocean Thermal Energy Conversion (OTEC), Open and closed OTEC Cycles, Problems associated with ocean thermal energy conversion systems – Small hydro turbines. Geothermal energy sources - Power plant and environmental issues – potential in India, Fuel cells – technologies, types – economics and power generation, Sonofusion – energy from bubbles, Magneto-hydro-dynamic (MHD) energy conversion, Fuel from sea – concept, Green islands- Canary Island.

Total Hours:	**45**

Text Books:

1	G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2018.
2	S.P. Sukhatme, J K Nayak, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2017.
3	B. H. Khan, “Non-Conventional Energy Resources”, McGraw Hill Education India Private Ltd., New Delhi, 2017.

Reference Books:	
1	C. Godfrey Boyle, “Renewable Energy - Power for a Sustainable Future”, Oxford University Press, U.K., 2017
2	D. Twidell, J.W. & Weir, A., “Renewable Energy Sources”, EFN Spon Ltd., UK, 2015
3	David M. Buchla, Thomas E. Kissell, Thomas L. Floyd, “Renewable Energy Systems”, Pearson Education, 2017.
Web References:	
1	https://www.udemy.com/climate-change-and-renewable-energy
2	https://nptel.ac.in/courses/121/106/121106014/
3	https://nptel.ac.in/courses/103/103/103103206/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C910.1	Remember	Group Assignment	20
C910.2 & C910.3	Understand	Presentation	20
C910.4	Apply	Individual Assignment	20
C910.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	40	40	40
Apply	30	30	30
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C910.1	3					1	1							1	
C910.2	2		1			3	3							2	
C910.3	3					3	3							2	
C910.4	3					3	3							3	
C910.5	3		1			3	3							2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME911	REFRIGERATION AND AIR CONDITIONING	3/0/0/3
Nature of Course	Theory analytical	
Pre Requisites	Engineering Thermodynamics and Thermal Engineering.	
Course Objectives:		
1	To understand the vapour compression and vapour absorption system operation.	
2	To analyse the refrigeration cycles and methods for improving their performance.	
3	To familiarize the components of refrigeration system.	
4	To design air conditioning systems using cooling load calculations.	
5	To know the application of refrigeration and air conditioning systems.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C911.1	Describe the principles and applications of refrigeration and air conditioning systems.	[R]
C911.2	Differentiate the various types of refrigeration and air conditioning systems.	[U]
C911.3	Calculate the performance of refrigeration and air conditioning systems.	[Ap]
C911.4	Analyse the methods to improve the performance of refrigeration and air conditioning systems.	[A]
C911.5	Analyse various transport air conditioning systems.	[A]
Course Contents:		
Introduction to Refrigeration – Basic Definition, **Air Refrigeration Cycles**-,Bell-Coleman cycle analysis, Air Refrigeration systems-simple air cooling system and boot strap air cooling system (descriptive), merits and demerits. **Vapour Compression Refrigeration system and Vapour Absorption Refrigeration Systems** – Vapour Compression system - Working and analysis, Limitations, Effects of sub cooling and super heating, Compound Vapour Compression Refrigeration Systems (descriptive). **Vapour Absorption Refrigeration Systems (Descriptive)**-Water-Ammonia Systems, Water-Lithium Bromide System, Contrast between the two systems, Modified System with Rectifier and Analyzer Assembly, Absorbent – Refrigerant combinations. **Refrigeration System Equipments and Air Conditioning Systems -** Classification, Selection and Nomenclature of refrigerants. Refrigeration systems Equipment - Compressors, Condensers, Expansion Devices and Evaporators, Testing and charging of refrigeration units. **Air Conditioning Systems-** Different Air-Conditioning Systems – Central Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems, Mathematical Analysis of Air-Conditioning Loads, Introduction to HVAC systems (descriptive), air conditioning in automobiles and Trains – Automotive A/C manual control system case study.		
	Total Hours:	**45**
Text Books:		
1	Arora,C.P. ”Refrigeration and Air Conditioning”, Third edition, Tata McGraw Hill, New Delhi, 2017.	
2	Ananthanarayanan.P.N, “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 5th edition, New Delhi, 2019.	

Reference Books:	
1	Manohar Prasad, “Refrigeration and Air conditioning”, New Age International (P) Ltd, New Delhi, 2020.
2	Arora.S.C and Domkundwar.S, “A course in Refrigeration and Air conditioning”, DhanpatRai (P) Ltd., New Delhi, 2019.
Online Resources:	
1	http://nptel.ac.in/courses/112105128/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C911.1	Remember	Quiz	20
C911.2	Understand	Presentation	20
C911.3	Apply	Group Assignment	20
C911.4	Analyze		
C911.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C911.1	3													2	
C911.2	3													2	
C911.3	3	2	3											3	
C911.4	3	3	3											3	
C911.5	3	3	3											3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME912	ALTERNATE FUELS AND E-VEHICLE TECHNOLOGY	3/0/0/3
Nature of Course	Theory technology	
Pre Requisites	Thermal engineering and Automobile engineering	
Course Objectives:		
1	To familiarize the importance of alternate fuels.	
2	To understand the combustion and emission characteristics of various liquid and gaseous alternate fuels.	
3	To impart knowledge on e-vehicles.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C912.1	Describe the limitations of fossil fuels and need for alternate fuels.	[U]
C912.2	Identify the sources and properties of various liquid and gaseous fuels.	[Ap]
C912.3	Identify the criteria for storage, distribution and safety aspects of alternative fuels.	[Ap]
C912.4	Examine the engine requirements and categorize the combustion characteristics of alternate fuels.	[A]
C912.5	Analyze the technology behind developing of e-vehicles.	[A]
Course Contents:		
Introduction: Fossil fuels and their availability – Potential alternate liquid and gaseous fuels – Merits and demerits of various alternate fuels. **Liquid fuels:** Alcohol – Methods of production – Properties – Blends of gasoline and alcohol – Combustion and emission characteristics in SI and CI engines – Properties of alcohol esters, Vegetable oils – Feed stock – Properties – Esterification – Biodiesel preparation and its performance and emission characteristics – Storage – Economics. **Gaseous Fuels:** Production and properties of CNG, LPG, biogas and producer gas – Performance and emission in SI/CI engines – Storage - Distribution and safety aspects. Hydrogen – Sources – Properties – Production – Transportation – Storage and safety aspects – Performance and emission characteristics – Application in fuel cell. **E-Vehicle Technology:** Need for E-Vehicles, Layout of an electric vehicle – System components – Electronic control system – High energy and power density batteries – Charging methods - Advantages and limitations of e-vehicles, Hybrid vehicles. Case studies: Design of Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).		
	Total Hours	**45**
Text Books:		
1	Amit Sarin, “Biodiesel - Production and Properties”- RSC Publishing - ISBN: 978-1-84973-470-7, 2017.	
2	Sunggyu Lee, James G. Speight, Sudarshan K. Loyalku- “Handbook of Alternative Fuel Technologies”- CRC Press - 2015.	
Reference Books:		
1	James D. Halderman, “Hybrid and Alternative Fuel Vehicles”- Pearson publication – 2015.	
2	Curtis D. Anderson and Judy Anderson, “Electric and Hybrid Cars - A History” - McFarlad & Company, Inc, Publishers - 2018.	
3	Nick Wagoner and Sheryl Wagoner, “Alternate Fuels: An Overview” - Thomson Delmar Learning – 2017.	

Web References:	
1	https://nptel.ac.in/courses/112104033/39
2	https://fueleconomy.gov/feg/current.shtml
Online Resources:	
1	https://afdc.energy.gov/fuels/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C912.1	Understand	Online Quiz	20
C912.2 & C912.3	Apply	Assignment	20
C912.4	Analyze	Group Assignment	20
C912.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	20	20
Understand	40	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C912.1	3	2	3											1	
C912.2	2	3												3	
C912.3	2	3												3	
C912.4	3	3												3	
C912.5	3		2											2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME913	TURBO MACHINES	3/0/0/3
Nature of Course	Theory analytical	
Pre requisites	Engineering Thermodynamics and Thermal Engineering	
Course Objectives:		
1	To study the concept of unified theory applicable to all turbo machines.	
2	To impart the fundamental knowledge about the design variations of turbo machines.	
3	To design and develop the turbo machines.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C913.1	Explain the basics of turbo machines including dimensional analysis	[U]
C913.2	Apply the concept of velocity triangle in determining the performance of the turbo machines	[Ap]
C913.3	Calculate the efficiencies and losses in the performance characteristics of the turbo machines	[A]
C913.4	Estimate the power and operational characteristics of the compressors.	[E]
C913.5	Assess the power and operational characteristics of the Wind Turbines.	[E]
Course Contents:		
Introduction: Thermal Turbo machines, Classification, General energy equation, Velocity triangles, Work, T-S and H-S diagram, Dimensional analysis, Non-dimensional parameters of compressible flow Turbo machines, Similarity laws. Role of turbo machines in present and future industries. **Compressors:** classifications, Constructional details, Stage velocity triangles, H-S diagram, Stage efficiencies and losses, Surging and Stalling, Performance characteristics **Pumps**- Centrifugal pumps – Work done - Head developed - Pump output and Efficiencies - priming - minimum starting speed - Cavitation, **Axial flow pumps** – Characteristics - Constructional details - Non-dimensional parameters – Efficiencies - Vibration and Noise in hydraulic pumps. **Wind turbines:** Definition and classifications, Constructional details, Horizontal axis wind turbine, Power developed, Axial thrust and Efficiency. Turbo expander, Turbo prop, Mixed flow compressor. Case study in Turbo Machine for power plants.		
	Total Hours:	**45**
Text Books:		
1	Yahya, S M, Turbines Compressors and fans, 4th edition, Tata McGraw-Hill, 2019.	
2	Dixon, S L, Fluid Mechanics and Thermodynamics of Turbo machinery 7th Edition, Elsevier Butterworths Heinemann, 2017.	
Reference Books:		
1	Cohen H, Rogers,G F C and Saravan motto H I H, Gas Turbine Theory, John Wiely, 6th Edition 2016.	
2	Ganesan, V., Gas Turbines, Tata McGrawHill, 2018.	
3	Prithvi Raj, D and Gopalakrishnan, G, “A Treatise on Turbomachines”, Scitech publication, 2016.	

Web References:	
1	www.academia.edu/turbomachines
Online Resources:	
1	https://nptel.ac.in/courses/112106200/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C913.1	Understand	Quiz	20
C913.2	Apply	Assignment	20
C913.3	Analyse	Assignment/Case Study	20
C913.4 & C913.5	Evaluate	Group Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	30	30
Understand	20	20	20
Apply	30	30	30
Analyse	10	10	10
Evaluate	10	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C913.1	3	3												1	
C913.2	3	2	2											2	
C913.3	3	2	2											2	
C913.4	3	3	3											3	
C913.5	3	3	3											3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME914	GAS DYNAMICS AND JET PROPULSION	3/0/0/3
Nature of Course	Theory analytical	
Pre requisites	Engineering Thermodynamics and Thermal Engineering	
Course Objectives:		
1	To understand the basic difference between incompressible and compressible flow.	
2	To analyse the phenomenon of shock waves and its effect on flow.	
3	To gain basic knowledge about jet propulsion.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C914.1	Study the behavior of various flow regimes.	[U]
C914.2	Assess the properties of fluid when the fluid flows under different flow conditions.	[Ap]
C914.3	Analyse the flow behavior and consequent loads due to flow.	[A]
C914.4	Analyse the shock in flows.	[A]
C914.5	Estimate propulsion efficiency and design inlets and nozzles.	[E]

Course Contents:

Compressible flow fundamentals: Energy and momentum equations for compressible fluid flows, Various regions of flow, Reference Velocities, Stagnation state, velocity of sound, Critical states, Mach Number, (Significance and Characteristics) Critical Mach number, Types of waves, Mach cone, Mach angle, Effect of Mach Number on compressibility. **Flow through variable area ducts:** Isentropic flow through variable area ducts, T-s, h-s diagrams for nozzles & diffusers, Mach number variation, Area ratio as a function of Mach number, Mass flow rate through nozzles & diffusers, Effect of friction in flow through Nozzles.

Fanno and Rayleigh flow: 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. Isothermal flow with friction in constant area ducts, Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties.

Normal shock: 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 nozzles with shock, normal shock in Fanno and Rayleigh flows. Flow with oblique shock (Elementary treatment only), The shock tube. **Jet propulsion:** Aircraft propulsion, Types of Jet Engines, Energy flow through Jet Engines, Study of turbojet engine, Performance of Turbo jet engines-thrust and thrust power, propulsive and overall efficiencies.

Total Hours:	**45**

Text Books:	
1	Yahya. S.M., “Fundamental of Compressible Flow”, New Age International (p) Ltd., New Delhi, 2018.
2	Patrich.H. Oosthvizen, William E.Carscallen, “Compressible Fluid Flow”, McGraw-Hill Education, 2017.
Reference Books:	
1	Cohen. H., Rogers R.E.C and Sravanamutoo, “Gas Turbine Theory”, Addison Wesley Ltd., 2016.
2	Ganesan. V., “Gas Turbines”, McGraw-Hill Education, New Delhi, 2015.
3	Balachandran.P, “Fundamentals of Compressible Fluid Dynamics”, Prentice Hall of India, New Delhi, 2018.

Web References:	
1	http://www.grc.nasa.gov/WWW/K-12/airplane/bgp.html
2	https://ocw.mit.edu/search/ocwsearch.htm?q=gas%20dynamics

Online Resources:	
1	https://nptel.ac.in/courses/112106166/
2	http://history.nasa.gov/SP-4219/Contents.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C914.1	Understand	Quiz	20
C914.2	Apply	Group Assignment	20
C914.3	Analyze	Case Study	20
C914.4			
C914.5	Evaluate	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	20	10	10
Apply	40	40	40
Analyse	30	30	30
Evaluate	-	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C914.1	2	3	1											1	
C914.2	3	3	2											2	
C914.3	3	3	2											2	
C914.4	3	3	3											2	
C914.5	3	3	3											3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME915	POWER PLANT ENGINEERING	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	Engineering thermodynamics and Thermal engineering	
Course Objectives:		
1	To provide a general perspective of power plant engineering indicating the role of mechanical engineers in their operation and maintenance.	
2	To understand the construction, working principles and advantages of a combined gas turbine, steam turbine, hydro, diesel and nuclear power plants.	
3	To create awareness about renewable energy, cost of electric energy, tariff calculation and economics of various power plants.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C915.1	Recall the various techniques used for power generation.	[R]
C915.2	Describe the functioning of components in steam power plant.	[U]
C915.3	Sketch the design layout and explain the working of diesel, gas turbine, hydroelectric, nuclear power plants.	[Ap]
C915.4	Identify the ways to extract power from renewable/non-conventional energy sources.	[Ap]
C915.5	Analyze the economic feasibility and its implications on power generating units.	[A]

Course Contents:

Coal based thermal power plant: Components and layout, Boiler classification – Types of boiler – Fire tube and water tube boilers - High pressure and supercritical boilers – Positive circulation boilers - Fluidized bed boilers – Waste heat recovery boiler – Feed water heaters – Super heaters – Reheaters – Economiser – Air heaters, Coal handling and preparation – Combustion equipment and firing methods – Mechanical stokers – Pulverized coal firing systems, Ash handling systems, Electrostatic precipitator, Feed water treatment, Forced draft and induced draught, Surface condenser, Cooling tower – Types.

Hydro power plant: Classification of hydro-electric power plants – Selection of prime movers – Governing of turbines. **Diesel power plant:** Components and layout, Selection of Engine type, Starting and stopping – Heat balance – Supercharging of diesel engines. **Nuclear power plant:** Principles of nuclear energy – Energy from fission and fuel burnup – Decay rates and half-lives – Nuclear reactor – Types – Boiling Water Reactor – Pressurized Water Reactor – Fast Breeder Reactor – Reactor materials – Radiation shielding. **Gas turbine power plant:** Components and layout, Open and closed cycles – Intercooling – Reheating and regenerating – Combined cycle power plant.

Renewable/Non-conventional energy based power plant: Construction and working of wind, tidal, solar photo voltaic, geothermal, biogas and ocean Thermal Energy Conversion power plants. **Economics of power plant:** Actual load curves – Cost of electric energy - Fixed and operating costs - Energy rates – Types of tariffs – Energy management and energy audit - Economics of load sharing – variable load operation – Comparison of economics of various power plants.

Total Hours	**45**

Text Books:

1	P.K. Nag, “Power Plant Engineering”, McGraw – Hill Education, Fourth Edition, 2017.
2	Frederick T. Morse, “Power Plant Engineering”, Affiliated East-West-Press Private Ltd., New Delhi, 2015.

Reference Books:	
1	Dipak Kumar Mandal, Somnath Chakrabarti, Arup Kumar Das, Prasanta Kumar Das, “Power Plant Engineering: Theory and Practice”, Wiley, 2019.
2	Domkundwar, Arora Domkundwar, “Power Plant Engineering”, Dhanpat Raj & Co. (P) Ltd., 2016.
3	R. K. Rajput, “A Textbook of Power Plant Engineering”, Shree Hari Publications, 2021.
Web References:	
1	www.academia.edu
Online Resources:	
1	https://nptel.ac.in/courses/112107216/
2	https://nptel.ac.in/courses/108105058/8
3	https://nptel.ac.in/courses/121/106/121106014/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C915.1	Remember	Quiz	20
C915.2	Understand	Group Discussion / Assignment	20
C915.3 & C915.4	Apply	Assignment	20
C915.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	40	40	40
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**I**	**j**	**k**	**l**	**1**	**2**	**3**
C915.1	3	3	1											1	
C915.2	3	2	1											2	
C915.3	3	3	3											2	
C915.4	3	3	3											2	
C915.5	3	2	1												

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME916	ENERGY CONSERVATION AND MANAGEMENT	3/0/0/3
Nature of Course	Theory	
Pre requisites	Engineering Thermodynamics Thermal Engineering	
Course Objectives:		
1	To study the concept of energy audit used in energy calculation.	
2	To understand the energy management and conservation.	
3	To impart the fundamental knowledge on energy conservation in thermal systems.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C916.1	Identify the demand supply gap of energy and it's utilization.	[U]
C916.2	Analyze the energy accounting and balancing.	[A]
C916.3	Evaluate the energy data of industries and suggest methodologies for energy savings.	[E]
C916.4	Sketch the energy flow diagram of an industry and identify the energy wasted or a waste stream	[Ap]
C916.5	Measure the performance of Electrical machines used in Industries.	[E]
Course Contents:		
Energy Audit And Resource Management - Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing. Energy resource management – Energy Management information systems – Computerized energy management – Energy economics – discount rate, payback period, internal rate of Return, life cycle costing **Energy Conservation in Thermal Systems** - Boiler – efficiency testing, excess air control, Steam distribution & use – steam traps, condensate recovery, flash steam utilization, Thermal Insulation. Heat exchanger networking –concept of pinch, target settling, problem table approach, Energy conservation in Pumps, Fans (flow control) and blowers, Compressed Air Systems, Refrigeration and air conditioning systems – Waste heat recovery recuperators, heat sheets. **Potential Areas for Electrical Energy Conservation in Industries** – Energy Management Opportunities in Electrical Heating, Lighting System, Cable Selection – Energy Efficient Motors - Factors Involved in Determination of Motor Efficiency- Adjustable AC Drives, Application & its use Variable Speed Drives Belt Drives.		
	Total Hours:	**45**

Text Books:	
1	P. Venkataseshaiah K.V. Sharma "Energy Management and Conservation", Wiley publication, 2019.
2	Umesh Rathore, "Energy Management", S.K. Kataria & Sons, 2016.
Reference Books:	
1	Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 2018.
2	William J. Kennedy, Wayne C. Turner, Prentice-Hall,2017
Web References:	
1	Energy Manager Training Manual (4 Volumes) available at ww.energy manager training.com,a website by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power,Government of India.
2	https://www.bsigroup.com/energy_mgt/training_course/080815 80815

Online Resources:	
1	https://www.gutenberg.org/cache/epub/11448/pg11448.html
2	https://www.udemy.com/course/energy-management-principles-revealed/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C916.1	Understand	Quiz	20
C916.2	Analyse	Assignment	20
C916.3 & C916.5	Evaluate	Technical Presentation	20
C916.4	Apply	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	30	30
Understand	20	20	20
Apply	30	30	30
Analyse	10	10	10
Evaluate	10	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C916.1	3	3												3	
C916.2	3	3												2	
C916.3	3	3												2	
C916.4	3	2												2	
C916.5	3	3												2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME917	INTERNAL COMBUSTION ENGINES	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Engineering Thermodynamics, Thermal Engineering	

Course Objectives:

1	To understand the working of different IC engines and components.
2	To impart knowledge on pollutant formation, pollution control and alternate fuels.
3	To create awareness about recent developments in IC engines.

Course Outcomes:
Upon completion of the course, students shall have ability to

C917.1	Recall the concepts of combustion in IC engines	[R]
C917.2	Elaborate on the working principles of spark ignition and compression ignition engines	[U]
C917.3	Explore the formation of exhaust gas components	[Ap]
C917.4	Analyse the characteristics of various emission control methods	[A]
C917.5	Discover the advances in IC engines	[Ap]

Course Contents:

Spark Ignition Engines: Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion– Combustion chambers- Air fuel ratio- Design of carburetor- Derivation of fuel jet size and venture size - **Compression Ignition Engines:** Diesel Fuel Injection Systems - Stages of combustion –Direct and Indirect injection systems – Combustion chambers – Fuel spray behavior - Spray structure and spray penetration – Air motion - Introduction to Turbo charging.

Pollutant Formation and Control: Pollutant – Sources – Formation of Carbon Monoxide, Un-burnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement - Emission norms (Bharat stage VI) and Driving cycles.

Recent Trends: Air assisted Combustion - Homogeneous charge compression ignition engines – Lean burn engine - Stratified charge engine, Surface ignition engine, Electronic engine management systems- Variable Geometry turbochargers – Common Rail Direct Injection Systems – Onboard Diagnostics – Other competing technologies (hybrid vehicles and fuel cells)

Total Hours:	**45**

Text Books:

1	John B Heywood, “Internal Combustion Engine Fundamentals”, McGraw-Hill Education, 2018.
2	Ganesan, "Internal Combustion Engines", Tata McGraw-Hill, 2017.

Reference Books:

1	William B. Ribbens, Norman P. Mansour,” Understanding Automotive Electronics”, Newnes (an imprint of Butterworth-Heinemann Ltd); 8th Revised edition edition, 2016.
2	James E. Duffy, Howard Bud Smith,”Auto Fuel and Emission Control Systems Technology”, Goodheart-Willcox, 2017.
3	Mathur. R. B. and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons, 2016.

Web References:

1	http://nptel.ac.in/courses/112103019/Cryogenic engineering.
2	http://pioneer.netserv.chula.ac.th/~kjirapon/self-practice.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C917.1	Remember	Objective type Quiz	20
C917.2	Understand	Assignment	20
C917.3, C917.5	Apply	Assignment	20
C917.4	Analyze	Case study/ Presentation	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	40	30	30
Understand	30	30	30
Apply	20	30	30
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C917.1	3													2	
C917.2	3		2											1	
C917.3	3	2												3	
C917.4	3	3												3	
C917.5	3	2												2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME918	CRYOGENIC ENGINEERING	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Engineering Thermodynamics Thermal Engineering	

Course Objectives:

1	To make the students understand the properties of cryogenic fluids, various liquefaction cycles, liquefaction systems and components in liquefaction system.
2	To make them understand the effect of rectification, absorption systems for purification, binary mixtures, T-C and H-C diagrams
3	To make the students understand the types of cryogenic refrigerators, various methods of handling cryogens and its applications.

Course Outcomes:
Upon completion of the course, students shall have ability to

C918.1	Define the basic concepts of cryogenic and liquefaction cycles.	[R]
C918.2	Elaborate the working principles of rectification, purification and liquefaction.	[U]
C918.3	Explore the various types of cryogenic refrigerator and understand its working procedure.	[Ap]
C918.4	Analyse the characteristics of various cryogens and explain their applications.	[A]
C918.5	Analyse the safety of cryogenic propellants.	[A]

Course Contents:

Introduction : Insight on Cryogenics, Methods of producing cold - thermodynamic basis, first and second law analyses, Vapour compression systems, Properties of Cryogenic fluids, and Material properties at Cryogenic temperatures. **Liquefaction Cycles:** Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles, Inversion Curve-JouleThomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Critical components in Liquefaction Systems.

Separation of Cryogenic Gases: Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis – McCabe Thiele Method. Adsorption Systems for purification. **Cryogenic Refrigerators:** J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

Handling of Cryogens and Applications: Cryogenic Dewar Construction and Design, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Safety of cryogenic propellants for rocket propulsion, Different Types of Vacuum Pumps, Instrumentation to measure Flow, Level and Temperature. Applications of Cryogenics in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications.

Total Hours	**45**

Text Books:

1	Klaus D.Timmerhaus and Thomas M.Flynn, “Cryogenic Process Engineering”, Springer US, 2018.
2	Thomas M.Flynn, “Cryogenic Engineering”, Marcel Dekker, New York, 2018,

Reference Books:

1	Mukhopadhyay, Mamata, “Fundamentals of Cryogenic Engineering”, Prentice Hall India Learning Private Limited, 2018.
2	G.Venkatarathnam, “Cryogenic Mixed Refrigerant Processes”, Springer Publication, 2010.
3	Randall F.Barron, “Cryogenic Systems”, McGraw Hill, 2018.

4	Robert W. Vance, “Cryogenic Technology”, John wiley & Sons, Inc.2016, New York.
Web References:	
1	http://www.wiley-vch.de/contents/ullmann/ull_10211.html.
2	http://www.onecro.com
3	http://www.caddet-ee.org/search/produce.cfm?ID=R072
4	http://www.sumkasons.20m.com/In2.html
5	http://www.thtcryogenics.freeserve.co.uk/crogenics.html

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C918.1	Remember	Presentation/Quiz	20
C918.2	Understand	Assignment	20
C918.3	Apply	Group Assignment	20
C918.4 C918.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	40	30	30
Understand	40	40	40
Apply	10	20	20
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C918.1	3	3												1	
C918.2	3	3												1	
C918.3	3	3												2	
C918.4	3	3												3	
C918.5	3	3												3	
	3 Strongly agreed					2 Moderately agreed						1 Reasonably agreed			

Elective Stream III – Manufacturing/ Industrial Engineering

21ME919	COMPOSITE MATERIALS, PROCESSING AND APPLICATIONS	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Metallurgy and Materials Testing	
Course Objectives:		
1	Introduce the concepts of modern composite materials and update the students with the knowledge on fabrication and testing of composites.	
2	To make the students understand the different types of composite materials, their properties and applications.	
3	Describe the fundamental fabrication processes for polymer matrix, metal matrix and ceramic matrix composites.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C919.1	Recall the types of composite materials and their characteristic features.	[R]
C919.2	Identify the suitable technique for manufacturing different types of composite materials.	[U]
C919.3	Estimate the mechanical properties of composites.	[A]
C919.4	Predict the applications of composite materials for automotive, aerospace and industrial sectors.	[Ap]
C919.5	Discover the advancements in composites and its applications.	[Ap]

Course Contents:

Polymer matrix composites: Understand the concepts of Polymer matrix resins-thermosetting, thermoplastic-various types of reinforcements used in PMC, merits, demerits and applications of PMC. **PMC manufacturing processes**: Hand layup processes, Spray up processes, Bag moulding, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding. Pultrusion, Filament winding.

Metal matrix composites: Understand the concepts of MMC, Types of Metal matrix composites, Types of reinforcements used in MMC, Volume fraction, Rule of mixtures, Influence of interface bonding between matrix and reinforcement on mechanical properties of composite, coating on reinforcements, merits, demerits and applications of MMC, Nanofillers and Nanocomposites. **Processing of MMC** – Powder metallurgy process - diffusion bonding, stir casting – squeeze casting, friction stir processing, Testing of composites as per ASTM standard, Inspection of components using ultrasonic flaw detector.

Ceramic matrix composites: Understand the concepts of Engineering ceramic materials, Ceramic matrix composites, and various types of Ceramic Matrix composites, merits, demerits and applications of CMC. **Processing of CMC**: Sintering - Hot pressing, Cold isostatic pressing (CIP), Hot isostatic pressing, **Advances in Composites:** Carbon-Carbon Composites: Understand the concepts of Carbon-carbon composites, merits, demerits and applications of CCC. Processing of Carbon composites: chemical vapour deposition, Sol-gel technique, 3D printing of composites.

Total Hours:	**45**

Text Books:

1	Ronald, F. Gibson, “Principles of Composite Material Mechanics”, Fourth Edition, CRC Press, 2016.
2	Daniel Gay “Composite Materials: Design and Applications”, Third Edition, CRC Press, 2014.

Reference Books:	
1	Deborah D.L. Chung, “Composite Materials”, Second Edition, Springer, 2014.
2	Nikhilesh Chawla, Krishan K. Chawla, “Metal Matrix Composites”, Second Edition, Springer, 2013.
3	Chawla K.K., “Composite Materials”, Springer – Verlag, 2012.
Web References:	
1	https://www.youtube.com/watch?v=VMH6qbED7pg
2	https://www.youtube.com/watch?v=LHHAPJbakEc
Online Resources:	
1	https://nptel.ac.in/courses/112104168/
2	https://nptel.ac.in/courses/101104010/1

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C919.1	Remember	Quiz	20
C919.2	Understand	Assignment	20
C919.3	Analyse	Technical Presentation	40
C919.4 C919.5	Apply		

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	50	20	20
Understand	30	30	30
Apply	20	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C919.1	3													2	
C919.2	3													1	
C919.3	3	3	3											3	
C919.4	3	3	3											3	
C919.5	3	3	3												

	3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed	

21ME920	INDUSTRIAL LAYOUT, ERGONOMICS AND SAFETY ENGINEERING	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	Manufacturing Technology I & II	

Course Objectives:

1	To acquire knowledge about the importance of industrial layout and safety.
2	To enable the students to identify the causes of accidents and its impact.
3	To impart knowledge on Occupational Safety and Health Assessment Series in jobsite safety.
4	To enable students to implement the hazard and risk assessment techniques.

Course Outcomes:
Upon completion of the course, students shall have ability to

C920.1	Identify the key factors for location decision and site selection.	[R]
C920.2	Interpret all types of plant layouts for better industrial layout design.	[U]
C920.3	Summarize the OSHA's general reporting and record keeping rules and guidelines.	[U]
C920.4	Implement the ergonomic aspects in product design.	[Ap]
C920.5	Examine the ability to avoid, prevent and control workplace hazards.	[A]

Course Contents:

Plant Layout: Plant location and site selection, Importance of Plant Location, Dynamic Nature of Plant Location, Facilities Design Procedure, Principles of Plant layout and Types, factors affecting layout, methods, factors governing flow pattern, travel chart, analytical tools of plant layout, layout of manufacturing shop floor, repair shop, services sectors and process plant, Evaluation and Improvement of Layout, Quantitative methods of Plant layout: CRAFT and CORELAP, Relationship diagrams.

Hazards: Industrial accidents, Electrical hazards, detection and prevention of electrical hazards, Chemical hazardous materials, material safety Material Safety Data Sheet (MSDS Fire hazard and life safety) Mechanical hazards and machine safe guarding common mechanical hazards, safeguarding and OSHA's requirement for safeguarding Industrial safety awareness Safety health and the environment Hazards of the environment Hazardous waste reduction Cost of accident and accident preventions Workman's compensation issues. Hazard analysis, prevention and safety management, Tactile and non-tactile methods

Safety and Health: Safety and health training, Introduction to OHSAS, OSHA Worker's Rights, Employer Responsibilities Occupational safety and work place violence. **Ergonomics:** Interdisciplinary nature of ergonomics, Ergonomic considerations including repetitive motion, Stress and safety, Economics of Ergonomics considerations in workplace lightings, workstation design, welfare facilities, work posture.

Total Hours: 45

Text Books:

1	Theresa Stack, Lee T. Ostrom, Cheryl A. Wilhelmsen "Occupational Ergonomics: A Practical Approach", John Wiley & Sons, 2016.
2	Mark A. Friend, James P. Kohn "Fundamentals of Occupational Safety and Health", 6th edition by Government Institutes Inc., 2014.

Reference Books:

1	Charles D. Reese "Occupational Health and Safety Management: A Practical Approach", Third edition, CRC Press 2015.
2	Gavriel Salvendy, "Handbook of Human Factors and Ergonomics", Fourth edition, John Wiley & Sons 2012.

Web References:

1	https://alison.com/course/workstation-ergonomics-revised

2	http://ergonomics.org/
Online Resources:	
1	http://nptel.ac.in/courses/107103004/31
2	https://ehs.mst.edu/generalsafety/ergonomics/ergonomicslinks/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C920.1	Remember	Quiz	20
C920.2	Understand	Technical Presentation/ Group Discussion	40
C920.3	Understand		
C920.4	Apply	Poster presentation	20
C920.5	Analyse		

Assessment based on Summative and End Semester Examination

Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	40	20	20
Understand	40	30	30
Apply	20	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**		
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**	
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C920.1	2	3												1	
C920.2	3	3	2											1	
C920.3	3													2	
C920.4	2	2	3											3	
C920.5	3													1	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME921	ADDITIVE MANUFACTURING	3/0/0/3
Nature of Course	Theory Application	
Pre requisites	Manufacturing Technology I &II	
Course Objectives:		
1	To develop skills, ideas and knowledge about additive manufacturing process.	
2	To demonstrate liquid, solid and powder based additive manufacturing process.	
3	To impart knowledge about additive manufacturing and its wide applications.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C921.1	Recall the fundamentals of additive manufacturing process	[R]
C921.2	summarize the basics of reverse engineering and data processing	[U]
C921.3	Use the various post processing techniques based on response	[Ap]
C921.4	Apply the various types of additive manufacturing techniques.	[Ap]
C921.5	Develop critical parts using generative design technology	[A]

Course Contents:

Introduction to Additive Manufacturing: Overview of AM - Scope andNeed- Survey of AM applications – Aerospace, automotive, defence, space and medical. Fundamentals of Prototyping and Rapid Prototyping, Classification of AM process, Rapid Prototyping Process Chain, Reverse Engineering – Basic concepts, Digitization Techniques Types,Rapid Prototyping Process Chain, **Data Processing for AM:** Conceptualization to Build model,AM Software's - **Post-Processing Techniques:** Support material removal, surface texture improvement, accuracy improvement,aesthetic improvement, property enhancements using non-thermal and thermal techniques

Liquid Based AM Process: Stereo lithography Apparatus, Digital Light Processing, Polyjet- **Solid Based AM Process:** Laminated Object Manufacturing, Fused Deposition Modeling - Principle of operation, Machine details and variants, Materials used, Process details, Process parameters effect on responses and Applications, Advantages and Disadvantages, Case studies.

Powder Based Rapid Prototyping Systems: Selective laser sintering, Selective Laser Melting, Electron Beam Melting, Laser metal Deposition - Laser Engineered Net Shaping - Principle of operation, Machine details and variants, Materials used, Process details, Process parameters effect on responses and Applications, Advantages and Disadvantages, Case studies – Generative Design technology for developing critical parts.

Self studies- Wire Arc AM, ceramic printing for core and cavities, 3D sand printing (not for exam)

Total Hours:	**45**

Text Books:	
1	Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.
2	Rafiq Noorani, "Rapid Prototyping-Principles and Applications", John Wiley & Sons, Inc., 2006.
Reference Books:	
1	Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer, 2011.
2	Andreas Gebhardt, — Rapid Prototyping‖, Hanser Gardner Publications Inc., 2003.

Web References:	
1	https://www.youtube.com/watch?v=NkC8TNts4B4
Online Resources:	
1	http://nptel.ac.in/courses/112107077/382
2	http://nptel.ac.in/courses/112107078/37
3	http://nptel.ac.in/courses/112102103/16

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C921.1	Remember	Assignment	40
C921.2	Understand		
C921.3	Apply	Hands on experience – AM process and Project Work (Print a Part and appraise the response)	40
C921.4	Apply		
C921.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	20	20
Understand	40	30	30
Apply	30	30	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C921.1	3														
C921.2	3														
C921.3	3	1	1											1	
C921.4	3	1	1											3	
C921.5	3	3	3											3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME922	LEAN SIX SIGMA	3/0/0/3
Nature of Course	Theory Application	
Pre requisites	Manufacturing Technology – I Manufacturing Technology – II	

Course Objectives:

1	To impart knowledge pertaining to lean six sigma and its importance in value-addition to products and services.
2	To understand the general guidelines for implementation of lean six sigma.
3	To enable students to minimize the cost/time and maximize quality using lean six sigma.
4	To execute various phases of lean six sigma for real time projects
5	To gain insights about the importance of lean manufacturing and six sigma practices

Course Outcomes:
Upon completion of the course, students shall have ability to

C922.1	Recall the various applications of lean six sigma tools in industries.	[R]
C922.2	Study the challenges in implementing six sigma.	[U]
C922.3	Illustrate the various principles of lean six sigma in different sectors.	[Ap]
C922.4	Reduce the process variation and improve the efficiency of the process using the tools of lean six sigma	[A]
C922.5	Evaluate the various industrial projects and to improve the performance.	[E]

Course Contents:

Introduction to Lean Six Sigma: Objectives of lean manufacturing – key principles and implications of lean manufacturing – Traditional vs Lean manufacturing. Value creation and waste elimination- Types of wastes – Push and Pull production - Continuous flow – Worker involvement – Cellular layout – Lean Six sigma defined – six sigma compared to total quality management – transactional vs. Manufacturing six sigma – common terms, Lean Six Sigma Training Plan, Project Selection.

Lean Six Sigma Phases: Define & Measure Phases**-** Project charter – Voice of the Customer, Business – High level process map – Project Tteam – Data Collection – Choosing Statistical Software .Measure tools – Process Maps, Pareto Charts, Cause And Effect Diagrams, Histograms, Control Charts – Six Sigma Measurements – Cost of Poor Quality – Measurement System Analysis – Process Capability Calculations – Quality Function Deployment (QFD). Analyse Phase - Process analysis – Failure Modes and Effects Analysis (FMEA), Design of Experiments (DOE). Improve And Control Phases– process redesign – generating improvement alternatives – Pilot Experiments – Cost/Benefit Analysis – Implementation Plan – Control Plan – Process Scorecard - SPC Charts, Final Project Report And Documentation.

Lean Six Sigma Applications: Case Studies in various sectors - Design for Six Sigma (DFSS): DMADV, DMADOV – Lean Six Sigma Audits – Factors of Lean Six Sigma – Sustainment of Lean Six Sigma – Softwares for Lean Six Sigma – Integration of Lean Six Sigma with other Strategies – Lean Six Sigma in Industry 4.0 Scenario.

Total Hours:	**45**

Text Books:

1	Betsiharris Ehrlich, “Transactional Six Sigma and Lean Servicing”, St. Lucia Press, 2019.
2	Devadasan S R, Mohan Sivakumar V, Murugesh R and Shalij P R, "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", Prentice Hall of India (PHI) Private Limited, New Delhi, India, 2016.

Reference Books:	
1	Jay Arthur, “Lean Six Sigma – Demystified”, Tata McGraw Hill Companies Inc, 2018.
2	Michael L George, David T Rowlands, and Bill Kastle, “What is Lean Six Sigma”, McGraw Hill, New York, 2014.
3	Jay Arthur, “Lean Six Sigma – Demystified”, Tata McGraw Hill Companies Inc, 2014.
Web References:	
1	https://ocw.mit.edu/courses
2	https://www.tutorialspoint.com/six_sigma/six_sigma_introduction.htm
Online Resources:	
1	http://nptel.ac.in/courses/110105039/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C922.1	Remember	Quiz	20
C922.2	Understand	Assignment	20
C922.3	Apply	Tutorial	40
C922.4	Analyze		
C922.5	Evaluate		

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	30	30
Understand	40	20	30
Apply	20	30	20
Analyse	10	10	10
Evaluate	-	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C922.1	3	3													
C922.2	3	3													
C922.3	3	3													
C922.4	3						2					3			
C922.5				3							3		1		1

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME923	THEORY OF METAL CUTTING	3/0/0/3
Nature of Course	Theory Application	
Pre-Requisites	Manufacturing Technology – I Manufacturing Technology – II	

Course Objectives:

1	To familiarize the student with tool nomenclature and cutting forces.
2	To provide knowledge about heat distribution and thermal aspects of machining.
3	To impart knowledge on tool materials, tool life and tool wear.
4	To educate the students on machining dynamics and economics.

Course Outcomes:

Upon completion of the course, students shall have ability to

C923.1	Enumerate tool materials, tool life and tool wear.	[R]
C923.2	Analyse the cutting forces in turning, drilling and milling operations.	[A]
C923.3	Identify tool information and thermal aspects of various machining process.	[Ap]
C923.4	Describe the machine dynamics during metal cutting	[U]
C923.5	Optimize machining cost and establish feasible solution	[A]

Course Contents:

Introduction: Classification of machine tools – Principle of machining- Basic mechanism of chip formation - types of Chips-Chip breaker - Orthogonal Vs Oblique cutting - force and velocity relationship and expression for shear plane angle in orthogonal cutting –. Tool Nomenclature and Cutting Forces: Nomenclature of single point tool - Systems of tool Nomenclature - Nomenclature of multi point tools like drills, milling cutters and broaches. - Modern theories in Mechanics of cutting - Merchant and Lee Shaffer Theories- Forces in drilling and milling - specific cutting pressure and energy.

Thermal Aspects of Machining: Thermodynamics of chip formation - Heat distributions in machining - Effects of various machining parameters on temperature - Method of temperature measurement in machining – Hot machining –Cutting fluids. Tool Materials, Tool Life and Tool Wear: Essential requirements of tool materials - Developments in tool materials-ISO specifications for inserts and tool holders -Tool life - Conventional and accelerated tool life tests – tool wear and wear mechanisms - Concepts of machinability and machinability index.

Machining Dynamics: Types of machine tool vibration – forced vibration – self exited vibrations (Chatter) – types of chatters - Chatter prediction – vibration control – Introduction to regenerative chatter- Wave generation. Phase shifts- Block diagram level analysis of machining dynamics - Machining stability and energy consideration-Machining economics and optimizations: Manufacturing cost – relationship between machining cost, production rate and cutting speed.

Total Hours: 45

Text Books:

1	WitGrzesik, “Advanced Machining Processes of Metallic Materials”, 2nd Edition, Elsevier,2016.
2	Shaw.M.C., “Metal cutting Principles ", Oxford Clarendon Press, 2nd Edition, 2012.
3	Juneja. B. L and Sekhon.G. S, "Fundamentals of Metal Cutting and Machine Tools", New Age International (P) Ltd., 2017.

Reference Books:

1	Stephenson, David A and Agapiou, John S, “Metal Cutting Theory and Practice (Manufacturing Engineering and Materials Processing)”. CRC Press, 2016
2	Bhattacharya, "Metal Cutting Theory and Practice ", New Central Book Agency, 2012.
3	Geoffrey Boothroyd and Knight. W.A "Fundamentals of Machining and Machine Tools", CRC Press, New York, 3rd edition 2019.

4	Machining Dynamics by T. Schmitz & K. Smith;Springer, 2019
Online Resources:	
1	https://nptel.ac.in/downloads/112105127/
2	https://nptel.ac.in/courses/112104195/43

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C923.1	Remember	Quiz	20
C923.2	Analyse	Case study/Tutorial	20
C923.3	Apply	Assignment	40
C923.4	Understand		
C923.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	30	20	20
Understand	30	30	40
Apply	40	30	20
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C923.1	3	2	2											1	
C923.2	3	3	3											2	
C923.3	3	2	2											3	
C923.4	3	2												3	
C923.5	3	2												2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME924	ENTREPRENEURSHIP DEVELOPMENT AND MANAGERIAL SKILLS	3/0/0/3
Nature of Course	Theory Skill based	
Pre Requisites	Nil	
Course Objectives:		
1	To make the students understand the scope of entrepreneurship and key areas of development.	
2	To enable the students to identify the financial assistance offered by the institutions, methods of taxation and tax benefits.	
3	To enable the students to realize the government policies for establishing small scale business entities.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C924.1	Define the basic concepts of entrepreneurship and skills needed for entrepreneurial management.	[R]
C924.2	Identify the motivational factors and techniques for evaluating business opportunities	[U]
C924.3	Examine the opportunities for launching start-ups and expansion	[Ap]
C924.4	Implement the accounting and financing skills to make sound business decisions and overcome risks.	[Ap]
C924.5	Assess the performance of a new venture	[A]

Course Contents:

Entrepreneurship: Entrepreneur, Types of Entrepreneurs, Difference between Entrepreneur and Intrapreneur, Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth, Knowledge and Skills of Entrepreneur. **Motivation:** Major Motives Influencing an Entrepreneur, Achievement Motivation Training, Self-Rating, Stress management, Entrepreneurship Development Programs, Need, Objectives.

Business: Small Enterprises, Definition, Classification, Characteristics, Ownership Structures, Project Formulation, Steps involved in setting up a Business, Identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment, Preparation of Preliminary Project Reports, Project Appraisal, Sources of Information, Classification of Needs and Agencies, Business plan preparation, MSME Schemes. **Overview of Intellectual Property:** Introduction and need for intellectual property rights.

Financing And Accounting: Need, Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Balance sheet, Break Even Analysis, Network Analysis Techniques of PERT/CPM, Taxation, Income Tax. GST-An Introduction. **Support To Entrepreneurs:** Sickness in small Business, Concept, Magnitude, causes and consequences, Corrective Measures, Business Incubators, Government Policy for Small Scale Enterprises, Growth Strategies in small industry, Expansion, Diversification, Joint Venture, Merger and Sub Contracting, Entrepreneurship Development Support, Central and State Government Industrial Policies: Atmanirbhar Bharat Abhiyaan (ABA), M-SIPS,Standup India, Government clearance and liberalization.

	Total Hours:	**45**

Text Books:

1	Hisrich R D and Peters M P, “Entrepreneurship”, 11th Edition, Mc Graw-Hill, 2020.
2	Donald F Kuratko, “Entreprenuership – Theory, Process and Practice”, 10th Edition, Cengage Learning, 2017.

Reference Books:

1	S.S.Khanka “Entrepreneurial Development” S.Chand& Co. Ltd., 2020.
2	Nuzhath Khatoon, “Entrepreneurial Development”, Himalaya Publishing House Pvt. Ltd, 2016.

Web References:	
1	https://www.shopify.in/encyclopedia/entrepreneurship
2	https://nisp.mic.gov.in/
Online Courses:	
1	http://nptel.ac.in/courses/118105009/50
2	https://www.coursera.org/specializations/wharton-entrepreneurship

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C924.1	Remember	Quiz	20
C924.2	Understand	Class Presentation/ Assignment	20
C924.3 C924.4	Apply	Group Assignment	20
C924.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	40	30	30
Understand	40	30	30
Apply	20	30	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C924.1						3	3	2			1	2			
C924.2						3	3	2			2	3			
C924.3						3	3	2			1	2			
C924.4						1	1	1			3	2			
C924.5						2	2	1			3	1			
	3 Strongly agreed | 2 Weakly agreed | 1 Moderately agreed														

21ME925	SPECIAL MANUFACTURING PROCESSES	3/0/0/3
Nature of Course	Theory technology	
Pre-Requisites	Manufacturing Technology II (with lab)	
Course Objectives:		
1	To recollect unconventional manufacturing processes and study its advantages over conventional techniques.	
2	To impart knowledge about nano manufacturing and finishing processes	
3	To impart knowledge on surface engineering process	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C925.1	Explain the various unconventional machining processes and applications.	[R]
C925.2	Elaborate the importance of process parameters	[U]
C925.3	Demonstrate the preparation of nano materials.	[Ap]
C925.4	Recognize the various nano finishing processes.	[U]
C925.5	Select appropriate surface treatment for property enhancing.	[Ap]

Course Contents:

Unconventional machining process: EDM and Wire cut EDM process – process parameters, surface finish and MRR - laser beam machining – plasma arc machining - electron beam machining – principles, equipments, beam control techniques, advantages, disadvantages and applications.

Nano manufacturing and finishing processes: General methods of preparation – bottom up, top down approach – Co precipitation – ultrasonication – mechanical milling – **finishing process -** Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations. Thermal barrier coating – laser shock peening – nano scale surface hardening

Surface engineering: Surface Cleaning - Methods of cleaning - Surface coating types – ceramic and plastic coating - economics of coating – physical vapor deposition - Chemical vapor deposition- plasma spraying - Ion implantation - diffusion coating - boriding and chromizing – cladding - laser gladding- Friction stir processing – laser hard facing - Micro Arc Oxidation process – shot peening and ultrasonic shot peening.

Total Hours	**45**

Text Books:	
1	P.C.Pandey and H.S.Shan, “Modern Machining Process”, Tata McGra Hill, Ne Delhi 2017
2	R. A. Lindburg, “Process and Materials of Manufacturing” PHI, 4th edition 2015
Reference Books:	
1	Akhlesh Lakhtakia, “The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.
2	J Paulo Davim, “Materials and Surface Engineering”, Woodhead Publishing, 2012.
3	Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015
Web References:	
1	https://nptel.ac.in/courses/112/107/112107078/
2	https://nptel.ac.in/courses/113/105/113105086/
Online Resources:	
1	https://www.udemy.com/course/non-conventional-machining-processes/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C925.1	Remember	Quiz	20
C925.2	Understand	Assignment	20
C925.3	Apply	Group Assignment and Case Study	40
C925.4	Understand		
C925.5	Apply		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	I	j	k	l	1	2	3
C925.1	3													2	
C925.2	3													2	
C925.3	3													3	
C925.4	3	2												2	
C925.5	3	2												3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME926	ENGINEERING MANAGEMENT AND FINANCIAL ACCOUNTING	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	Nil	

Course Objectives:

1	To impart the fundamental knowledge on demand and supply analysis.
2	To make the students understand the methods of calculating production cost and fix the price of a product thereof.
3	To enable the students to understand the principles, functions and practices adapted in industry for the successful management of financial accounting.
4	To provide the fundamental knowledge on capital budgeting to evaluate a project.

Course Outcomes:
Upon completion of the course, students shall have ability to

C926.1	Demonstrate the fundamental knowledge on demand and supply analysis.	[U]
C926.2	Calculate the production cost and fix price tag for a product based on the gross expenses and market scenario.	[Ap]
C926.3	Apply the basic principles, functions and practices for managing the financial accounts.	[Ap]
C926.4	Make investment decisions based on the projected return on investments.	[A]
C926.5	Interpret the importance of cost analysis and application of accounting software	[U]

Course Contents:

Introduction Managerial concepts - Relationship with other disciplines - Firms: Types, objectives and goals -- Enterprise Performance Management - Managerial decisions - Decision analysis. **Demand and Supply Analysis** Break even analysis - Demand - Supplier demand - Types of demand - Determinants of demand - Demand function - Demand elasticity -Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

Production and Cost Analysis Production function - Returns to scale - Production optimization - Least cost input – Isoquants - Managerial uses of production function, Decision making-make/buy. Cost Concepts- Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost – Pricing - Determinants of Price - Pricing under different objectives and different market structures- Price discrimination - Pricing methods in practice. Cost analysis using Software-Overview.

Financial Accounting (Elementary Treatment) Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis – Break even analysis - Cash flow analysis -Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements **Capital Budgeting (Elementary Treatment)** Investments - Risks and return evaluation of investment decision - Average rate of return- Payback Period - Net Present Value - Internal rate of return. Introduction to Accounting software packages

Total Hours:	**45**

Text Books:

1	C. M. Chang, “Engineering Management: Meeting the Global Challenges”, CRC Press , Second Edition, 2016.
2	B. Ram, “Accounting for Managers”, New Age Publications (Academic) Edition: First, 2015.

Reference Books:	
1	A.K. Gupta, “Engineering Management”, S. Chand Publication, 2016.
2	Narayanaswamy R., “Financial Accounting: A Managerial Perspective”, PHI Learning Private Limited; 6th Revised edition, 2017.
Web References:	
1	http://bookboon.com/en/accounting-basics-ebooks
2	http://bookboon.com/en/management-organisation-ebooks
Online Resources:	
1	https://nptel.ac.in/courses/110101003/
2	https://onlinecourses.nptel.ac.in/noc16_mg02/course

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C926.1& C926.5	Understand	Quiz	20
C926.2 & C926.3	Apply	Assignment	20
C926.4	Analyse	Software application practice	40

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	20	20
Understand	40	40	40
Apply	30	30	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C926.1	2	1				1	2				3	1			
C926.2	1										3				
C926.3	2										3				
C926.4		2		1							3				
C926.5	2	2		1	3						3	3			
	3 Strongly agreed					2 Moderately agreed					1 Reasonably agreed				

21ME927	ADVANCED CASTING AND WELDING PROCESSES	3/0/0/3

Nature of Course	Theory
Pre Requisites	Manufacturing technology I Industrial Metallurgy

Course Objectives:

1	To recollect the principle of casting design.
2	To study the different types of special casting process.
3	To descrive the fundamentals of the welding process.
4	To validate the welded structure.

Course Outcomes:
Upon completion of the course, students shall have ability to

C927.1	Describe the casting metallurgy.	[U]
C927.2	Elaborate the metallurgy of welded structure	[U]
C927.3	Impart the importance of design parameters governing casting and welding process.	[Ap]
C927.4	Summarize the advancement in casting processes and welding processes	[U]
C927.5	Infer the quality of casting and welding joints	[A]

Course Contents:

Casting Metallurgy and Design: Solidification of pure metal and Alloys- Shrinkage in cast metals -progressive and directional solidification - Thermal analysis of casting solidification - Heat transfer between molten metal and moulding sand -. Principles of gating, Riser and Runner systems. Casing defects and remedies. **Special Casting Processes: C**entrifugal casting, stir casting, squeeze casting, vacuum mould casting, evaporative pattern casting, ceramic shell casting – Mechanisation, automation and pollution control - smart foundry.

Welding Metallurgy and Design: Arc characteristics – current and voltage – electrode polarity - various zones and its characteristics - Heat transfer and solidification - Analysis of stresses in welded structures - pre and post welding heat treatments - weld joint design - welding defects **Recent Trends in Welding:** Hot wire GTAW, Active and keyhole TIG, high frequency induction welding, MIAB welding, cold metal transfer welding process, ultrasonic welding, electron beam welding, Laser beam welding, Plasma welding and under water welding Robot welding.

Testing of Castings and Weldments: Preparation of specimens as per ASTM standard - Surface modification techniques - heat treatment, shot and laser peening. Characterization of specimens – Optical microscope, SEM, EDS, EBSD - Macro and Micro hardness, Tensile strength, Impact strength, flexural strength, fatigue strength, wear and friction test – Electrochemical corrosion. Non-Destructive test: Radiographic test - Electromagnetic test - LASER testing methods Leak test.

Total Hours:	**45**

Text Books:

1	P L Jain, “Principles of Foundry Technology (paper back)”, Tata McGraw Hill, 2017
2	Richard L Little, “Welding and Welding Technology”, Tata McGraw Hill, 2017

Reference Books:

1	George E Dieter. “Mechanical Metallurgy”, McGraw Hill Education (India) pvt ltd.,2017.
2	Norrish, “Advanced welding process”, Wood Head Publishing in Materials, Cambridge, UK, 2006.
3	Larry Jeffus,” Welding Principles and Applications”, Cengage learning, 2011.
4	H Howard B cary, “Modern Welding Technology, Prentice Hall 2004

5	John Campbell, “Casting Practice” Elsevier Science Publishing Co., 2004.
6	“ASM Hand Book Volume 15: Casting”, ASM International 2008.
Online Resources:	
1	https://nptel.ac.in/courses/112107077/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C927.1	Understand	Assignment / Seminar	40
C927.2	Understand		
C927.3	Apply		
C927.4	Understand	Assignment / Case study	40
C927.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	40	40	30
Apply	40	20	30
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**		
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**	
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C927.1	3	3	3	2										2	
C927.2	3													2	
C927.3	3													3	
C927.4	3	2	2											3	
C927.5	3	3												3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Emerging Elective Courses

21ME007	APPLIED SOFT COMPUTING TECHNIQUES	3/0/0/3
Nature of Course	Theory	
Pre-Requisites	-	
Course Objectives:		
1	To introduce the idea of fuzzy sets, fuzzy logic and heuristics for solving problems.	
2	To become familiar with neural networks and form appropriate rules for inferring the systems.	
3	To provide the mathematical background for carrying out the optimization associated with neural network learning.	
4	To familiarize with genetic algorithms and other random search procedures useful for seeking global optimum in self-learning situations.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C007.1	Recall the basics of soft computing concepts and techniques.	[R]
C007.2	Discuss the supervised and unsupervised artificial neural networks and its applications.	[U]
C007.3	Apply various primitive operations on fuzzy sets with dynamic components.	[Ap]
C007.4	Apply genetic algorithms to combinatorial optimization problems.	[Ap]
C007.5	Analyse the process parameters of EDM and solve the travelling salesman problem	[A]
Course Contents:		
INTRODUCTION: Introduction to soft computing-Characteristics of Soft Computing-Advantages, Applications and Scope of Soft computing. Soft Computing Constituents and Conventional Artificial Intelligence introduction to: Biological and Artificial Neural Network-Fuzzy sets and Fuzzy logic systems Genetic Algorithm- Hybrid Systems. **ARTIFICIAL NEURAL NETWORK-** Basic Models and Terminologies of Artificial Neural Network- Supervised Learning Neural Networks: Perceptions-Adaptive Linear Neuron-Back propagation Multilayer Perception Applications. Learning from Reinforcement: Temporal Difference Learning-Art of Dynamic Programming-Q-Learning-Applications. Unsupervised Learning and other Neural Networks: Kohenen self-organizing Networks-Learning vector organization-Hebbian Learning-Hopfield Network-Applications. **GENETIC ALGORITHMS**- Simple GA-Classification of Genetic Algorithm- crossover and mutation- genetic algorithms in search and optimization- Applications: optimization of process parameters in advanced machining process- Electrical Discharge Machining (EDM)-Optimization of travelling salesman problem (TSP).		
	Total Hours:	**45**
Text Books:		
1	Ranjit Panigrahi, Samarjeet Borah, Applied Soft Computing Techniques and Applications, CRC Press, 2022.	
2	D. K. Pratihar, “Soft Computing: Fundamentals and Applications”, Narosa Publishing House, New Delhi, 2018.	
Reference Books:		
1	Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India, 4th edition, 2021.	
2	Millie Pant, Kanad Ray, Anirban Bandyopadhyay, Soft Computing Applications, Springer Singapore, 2018	
Web References:		
1	https://web.iiit.ac.in/~srikanth/demonstration_of_various_soft_co.htm	

Online Resources:	
1	https://nptel.ac.in/downloads/106105173/
2	https://nptel.ac.in/courses/106105173/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C007.1	Remember	Quiz	20
C007.2	Understand		
C007.3	Apply	Assignment	40
C007.4	Apply	Simple case study	20
C007.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	25	25	25
Understand	35	45	45
Apply	40	30	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C007.1	3	2			3										
C007.2	3				3							2			
C007.3	3				3							3			3
C007.4	3				3							2			3
C007.5	3	3		2	3										2

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME008	INTERNET OF THINGS FOR MECHANICAL ENGINEERS	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Basics of Electrical and Electronics Engineering	
Course Objectives:		
1	To get acquainted with the building blocks of Internet of Things (IoTs), characteristics and taxonomy of IoT levels.	
2	To impact the value creation for an industry using IoT.	
3	To gain knowledge on the real time application of IoT.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C008.1	Describe the main components used in the world of IoT.	[U]
C008.2	Select the tools and technologies to create new Internet of Things solutions.	[Ap]
C008.3	Apply M2M and IoT in value creation of manufacturing Industry	[Ap]
C008.4	Implement IoT in various fields like automobiles and transport system management	[Ap]
C008.5	Design and create IoT based systems for real time applications.	[C]
Course Contents:		
Introduction to IoT: Introduction, History of IoT, About objects/things in the IoT, Enabling technologies of IoT, About the Internet in IoT. **Technologies behind the IoT:** Challenges and Issues, Security Control Units, Components in IoT -Sensors, Communication modules, Power Sources, Communication Technologies, RFID, Bluetooth, Zigbee, Wifi, Rflinks, Mobile Internet, Wireless Communication, Arduino boards, Data Monitoring using Arduino, Rasberry Pi. **Value Creation for Industry:** Introduction to M2M, Architecture and Protocol of M2M, Smart Cards in M2M Communication, Value Creation and Challenges, Future Factory Concepts. Brownfield IoT- Technologies for Retrofitting, IoT for Oil and Gas Industry. IoT in Manufacturing supply chain **IoT for Automotive:** Vehicle Utility control, Navigation, Tracking and Self driving cars, Smart parking, Intelligent transport system, Monitoring Driving Habits using smart phones, e-Call system, Electric Toll collection, Smart signals. **Application:** Smart Factory , Smart Objects, Environment- Weather Monitoring system, Air Pollution Monitoring , Forest Fire Detection, Smart Irrigation, Smart Connected System, Design Case Study.		
	Total Hours:	**45**
Text Books:		
1	HonboZhou,"The Internet of Things in the Cloud:A Middleware Perspective", CRC Press,2016.	
2	ArshdeepBahga, Vijay Madisetti, "Internet of Things (A Hands-On-Approach)", VPT, 2014.	
Reference Books:		
1	Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things - key applications and Protocols", Wiley, 2016.	
2	Luigi Atzori, Antonio Lera, GiacomoMorabito, "The Internet of Things: A Survey", Journal on Networks, Elsevier Publications, October, 2014.	
3	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.	
Web References:		
1	http://www.theinternetofthings.eu/what-is-the-internet-of-things	
2	http://www.internet-of-things- research.eu	

Online Resources:	
1	https://www.coursera.org/specializations/Internet-of-things

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C008.1	Understand	Quiz	20
C008.2	Apply	Case Study/ Group Assignment	20
C008.3			
C008.4			
C008.5	Create	Mini Project	40

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	40	40	40
Apply	40	30	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C008.1	3	2			3										3
C008.2	3				3										3
C008.3	3				3										3
C008.4	3				3										3
C008.5	3				3									2	3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME009	DATA ANALYTICS FOR MECHANICAL ENGINEERS	3/0/0/3
Nature of Course	Theory	
Pre requisites	Probability and Numerical Methods	

Course Objectives:

1	To enable the students to learn the principles of data analytics and decision making.
2	To enable the students to understand the concept of data exploration.
3	To prepare the students to apply statistical Inference.
4	To enable the students to analyze the scenario using probability and make decisions under uncertainty.

Course Outcomes:

Upon completion of the course, students shall have ability to

C009.1	Describe the properties of normal, binomial, poisson and exponential distributions and provide suitable examples for the same.	[R]
C009.2	Classify sample data to infer the properties of the entire population and analyze data files using software.	[A]
C009.3	Determine the relationships between variables using hypothesis testing	[Ap]
C009.4	Identify decision variables that involve uncertainty and apply linear programming techniques to solve the variables	[A]
C009.5	Perform statistical analysis and apply management science techniques to make decisions.	[E]

Course Contents:

Introduction to Data Analysis & Decision Making: Introduction to Data Analysis and Decision Making, Describing the Distribution of a Single Variable, Finding Relationships among Variables, Probability and Probability Distributions, Decision Making under Uncertainty, Decsion Analysis, Decsision Support Systems, Predective Analytics

Statistical Inference: Data Description **-** Graphical presentation of data - Numerical description of data, Nature and uses of forecasts – An overview of forecasting techniques - Defining the forecasting problem – methods of forecasting, qualitative and quantitative forecasting – Time series data and model Hypothesis Testing, Regression analysis: linear regression, logistic regression, Time Series Analysis, Confidence Interval Estimation, Statistical Reporting, Advanced Data Analysis, Data Mining, Structural Equation Modeling, Cluster Analysis, Analyzing Data With Correspondence Analysis, Introduction to Machine learning

-

Applications: Importing data into excel, analysis of variance and experimental design. R tool machine learning algorithm tools: SAS Eminer, Tableau public tool – Data visualization tool: SPSS, OTA analytics, Role of Data Analytics in Product Design and Inventory and Database Management, Behavioural Data Analytics, Introduction to Big Data Analytics

Total Hours:	**45**

Text Books:	
1	Albright, S. C., Winston, W. L., Zappe, C. J., & Broadie, M. N. "Data analysis and decision making (Vol. 577)". South-Western/Cengage Learning Press, 2019
2	Hamburg, M., and P. Young. Fort Worth, "Statistical Analysis for Decision Making", TX: Dryden Press, 2021.
3	Regi Mathew., "Business Analytics for Decision Making", First Edition| By Pearson, 2020
Reference Books:	
1	S. Christian Albright , Wayne Winston , Christopher Zappe, "Data Analysis and Decision Making with Microsoft Excel (with CD-ROM, InfoTrac, and Decision Tools and Statistic Tools Suite)", South-Western College Publishing, 2020.
2	Aczel Amir, Sounder pandian, Jayvel, "Complete Business Statistics", 6th Edition, Tata McGraw Hill, 2017.
Online Resources:	
1	www.coursera.org

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C009.1	Remember	Quiz	20
C009.2	Analyze	Assignment	20
C009.3	Apply	Tutorial	20
C009.4	Analyze	Case study / Project	20
C009.5	Evaluate		

Assessment based on Summative and End Semester Examination

Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	30	20	20
Understand	30	20	30
Apply	20	40	30
Analyse	20	10	10
Evaluate	-	10	10
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C009.1	3	3			3										
C009.2	3				3								3		2
C009.3	3		2		3										1
C009.4	3				3										2
C009.5	3			2	3										

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME010	EXPERT SYSTEM AND MACHINE LEARNING	3/0/0/3
Nature of Course	Theory Application	
Pre Requisites	Probability and Statistical Applications	

Course Objectives:

1	To study the basic concepts of artificial intelligence and neural network techniques.
2	To familiarize with the various steps involved in applying Artificial Intelligence.
3	To understand the basic concepts of expert systems.
4	To understand the fundamentals of machine learning.

Course Outcomes:
Upon completion of the course, students shall have ability to

C010.1	Describe the fundamental problems in several sub-disciplines/domains of artificial intelligence, expert systems and machine learning.	[U]
C010.2	Conduct intensive problem-solving and inquiry-based efforts to formulate proto-types of AI domain constructs.	[Ap]
C010.3	Apply fundamental mathematics to formulate probabilistic models of intelligent systems such as expert systems, neural nets and Bayesian inference systems.	[Ap]
C010.4	Apply classical logic in AI context to solve complex problems.	[Ap]
C010.5	Study the fundamentals of machine learning its types and applications.	[U]

Course Contents:

EXPERT SYSTEMS: Expert Systems – Introduction – Difference between expert system and conventional programs. Basic activities of expert system-Interpretation-Prediction-Diagnosis-Design-Planning –Monitoring –Debugging-Repair-Instruction-Control-Basic Aspects of expert system – Acquisition module frames –Knowledge base, Production rules-Semantic net, Interference engine –Backward chaining and forward chaining – Explanatory interface.

INTRODUCTION TO AI AND PRODUCTION SYSTEMS: Introduction to AI-problem formulation, Problem definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system-Problem solving methods – Problem graphs, matching, Indexing and heuristic functions -Hill climbing-Depth first and breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

INTRODUCTION TO MACHINE LEARNING: Learning – Types of machine learning – Supervised learning – The brain and the neuron – Design a learning system – Perspectives and issues in machine learning – Concept learning task – Concept learning as search – Finding a maximally specific hypothesis – Version spaces and the candidate elimination algorithm.

Total Hours:	**45**

Text Books:

1	D.W. Rolston, Principles of AI & Expert System Development, TMH, New Delhi.2018
2	I. Gupta, G. Nagpal - Artificial Intelligence and Expert Systems, Mercury Learning, Dullus, 2020.
3	Hui Jiang, - “Machine Learning Fundamentals A Concise Introduction”, Cambridge University Press,2021
4	Tom M Mitchell, “Machine Learning”, First Edition, McGraw Hill Education, 6th Edition 2021.

Reference Books:

1	E. Rich & K. Knight - Artificial Intelligence, 2/e, TMH, New Delhi, 2017.
2	P.H. Winston - Artificial Intelligence, 3/e, Pearson Edition, New Delhi, 2014.
3	Jason Bell, Machine learning – Hands on for Developers and Technical Professionals, Sixth Edition, Wiley, 2017.

Web References:	
1	www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_overview.html
2	https://onlinecourses.nptel.ac.in/noc17_cs26/preview
Online Resources:	
1	https://www.coursera.org/learn/machine-learning#syllabus
2	https://nptel.ac.in/courses/106105077/25
3	https://nptel.ac.in/courses/106105077/17

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C010.1	Understand	Assignment	20
C010.2	Apply	Case study / Project	40
C010.3			
C010.4			
C010.5	Understand	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C010.1	3				3										3
C010.2	3				3										2
C010.3	3	3		2	3										3
C010.4	3	3	3	2	3										3
C010.5	3				3										3

3	Strongly agreed	2	Weakly agreed	1	Moderately agreed

21ME011	FUEL CELLS	3/0/0/3
Nature of Course	Theory and Application	
Pre Requisites	Engineering Physics, Engineering Chemistry	
Course Objectives:		
1	To enable students to understand the performance characteristics of fuel cell and its components.	
2	To outline the performance, design characteristics and operating issues of various fuel cells.	
3	To impart sufficient knowledge to students about the working of fuel cell industry.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C011.1	Describe the fundamentals of fuel cell.	[U]
C011.2	Deduce the performance of fuel cell systems.	[A]
C011.3	Describe the construction and operation of fuel cell stack and fuel cell system	[U]
C011.4	Illustrate the modelling techniques for fuel cell systems.	[Ap]
C011.5	Interpret the different methods of fuel processing for fuel cells.	[Ap]
Course Contents:		
Overview of fuel cells and fuel cell electrochemistry Fuel cell – brief history – classification – need for fuel cell – fuel cell basic chemistry and thermodynamics - heat of reaction – theoretical electrical work and potential – theoretical fuel cell efficiency – hydrogen storage – electrode kinetics – types of voltage losses –– fuel cell efficiency –- Safety issues, economic and life cycle analysis of fuel cells. **Fuel cell process design** Main PEM fuel cell components, materials, properties and processes – membrane, electrode, gas diffusion layer, bi-polar plates – fuel cell operating conditions – pressure, temperature, flow rates, humidity – main components of solid-oxide fuel cells – cell stack and design – electrode polarization – testing of electrodes – cells and short stacks – cell, stack and system modelling. **Fuel processing** Direct and indirect internal reforming – reformation of hydrocarbons by steam – CO_2 and partial oxidation – direct electro-catalytic oxidation of hydrocarbons – carbon decomposition – sulphur tolerance and removal – using renewable fuels for SOFCs.		
	Total Hours:	**45**
Text Books:		
1	Andrew L. Dicks and David A. J. Rand, “Fuel Cell Explained”, John Wiley & Sons. Inc., 2018.	
2	Revankar shrip, “Fuel Cells: Principles, Design and Analysis”, Auerbach publications, 2019.	
3	Dushyant Shekhawat, “Fuel Cells: Technologies for fuel processing”, North Holland Publishing Co., 2018.	
Reference Books:		
1	Ohayre, “Fuel Cell Fundamentals”, John Wiley & Sons Inc., 2018.	
2	F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2017.	
3	San Ping Jiang, Qingfeng Li, “Introduction to Fuel Cells Electrochemistry and Materials”, Springer, 2020	
Online Resources:		
1	https://nptel.ac.in/courses/103/102/103102015/	

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C011.1	Understand	Objective type Quiz	20
C011.3	Understand		
C011.2	Analyze	Case study / Project	40
C011.4	Apply	Tutorial	20
C011.5	Apply		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C011.1	3	2	1		3										
C011.2	3	3	3		3									3	
C011.3	3	2			3									1	
C011.4	3	2	1		3									1	
C011.5	3		1		3									1	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME012	PRODUCT LIFECYCLE MANAGEMENT	3/0/0/3
Nature of Course	Theory	
Pre requisites	CAD/CAM laboratory	
Course Objectives:		
1	To acquire knowledge on the principles, best practices, current advancements and applications of Product Life cycle Management.	
2	To study all the aspects of a product's life cycle from "design phase" to "end of life phase".	
3	To understand and experience effective integration of PLM technologies into product development process that provides competitive advantage to industries of various sectors to deliver innovative products.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C012.1	Familiarize with the fundamentals of the product lifecycle and thus acquire the capability to apply them.	[R]
C012.2	Recall the methods and technologies for adopting PLM strategies.	[R]
C012.3	Manage and analyze the challenges in different stages of product development.	[A]
C012.4	Apply the tools/techniques of product life cycle management to industrial problems.	[Ap]
C012.5	Apply digital manufacturing framework in product development process with business considerations.	[Ap]

Course Contents:

MOTIVATION AND INTRODUCTION: Product Lifecycle -Definition, Need and Overview; Elements; Stages; Corporate Challenges; E-Commerce -B To B, B ToC Forms of Business, Extended Enterprise**,** Product Data Management -CIM Data, PDM Functions, Definition And Architectures Of PDM Systems, Information Flow Model In Product Development, Engineering Bill Of Materials And Manufacturing Bill Of Materials.

PRODUCT DEVELOPMENT PROCESS & METHODOLOGIES: Integrated Product development process Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis, Concurrent engineering - work structuring and team Deployment, Product Modeling - Definition of concepts - Fundamental issues - Role of Process chains and product models, Value engineering in product design. **Introduction to product design** tools - Computer Aided Design, DFM, DFA, Ergonomics in product design, Product launch & engineering change, Sustainable design.

ENABLING TECHNOLOGIES AND RECENT ADVANCEMENTS: Business Process Reengineering; Enterprise Resource Planning; Managing a design project; Introduction to Digital Manufacturing; Applications of soft computing in product development process; PLM Softwaresover view;,Use of visuaization in several stages of lifecycle – Case studies.

Total Hours	**45**

Text Books:

1	Uthayan Elangovan, "Product Lifecycle Management (PLM): A Digital Journey Using Industrial Internet of Things (IIoT) ", CRC Press; 1st edition July 9, 2020
2	John Stark, "Product Lifecycle Management: 21 Century Paradigm for Product Realisation", 2nd Edition Springer Publisher, 2011.
3	Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006.

Reference Books:	
1	Kevin Roebuck, Product Lifecycle Management (PLM): High-impact Strategies – What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors, Emereo, 2020.
2	Ohn Stark, Product Lifecycle Management: 21st Century Paradigm for Product Realisation, Springer Publisher, 2020
3	Abele, E. et al., Environmentally-friendly Product Development Methods and Tools, Springer, 2005.
Web References:	
1	http://plmbook.com/
2	www.aberdeen.com
Online Resources:	
1	https://nptel.ac.in/courses/110104070/9
2	https://nptel.ac.in/courses/110/104/110104084/
3	https://nptel.ac.in/courses/112107217/2

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C012.1	Remember	Quiz	20
C012.2	Remember	Assignment	20
C012.3	Analyze	Project / Lab Tutorial	40
C012.4	Apply		
C012.5	Apply		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	20	20
Understand	50	50	30
Apply	20	20	40
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C012.1	3	3									3			1	
C012.2	3							2			2			2	
C012.3	3	3	3					2			2			2	
C012.4	3							2				3			
C012.5	3				3			2						3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Open Elective Courses

21ME001	INDUSTRIAL SAFETY	3/0/0/3
Nature of Course	Theory	
Pre Requisites	Nil	
Course Objectives:		
1	To enable students to understand the basic Industrial safety engineering acts and rules.	
2	To impart knowledge on OSHAS (Occupational Safety and Health Assessment Series) in engineering Industry.	
3	To enable the students to identify the causes of accidents and its preventions.	
4	To make students to identify hazard and assess the risks using suitable techniques.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C001.1	Identify the evolution of industrial safety acts, rules and health standards.	[R]
C001.2	Summarize different safety management activities in industry.	[U]
C001.3	Prepare accident, investigation report and preventive guidelines to industry.	[Ap]
C001.4	Analyse the process to avoid, prevent and control workplace hazards.	[A]
C001.5	Evaluate the role of government agencies and private consulting agencies in safety training	[E]

Course Contents:

BASICS OF SAFETY ENGINEERING & ACTS: Evolution of modern safety concept – safety audit; Acts – factories act – 1948 – statutory authorities – inspecting staff – Tamilnadu factories Rules 1950 under safety and health – environment act 1986 – air act 1981, water act 1974 – labour laws; safety in industries – general safety concepts, machine guarding, hazards in metal removing process, check list for LPG installations, safety precautions using CNG. Introduction to OHSAS 18000 and 14000, National Disaster Management Act.

SAFETY MANAGEMENT: History of Safety movement – general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling. Fire Explosion and toxicity Index. **ACCIDENT INVESTIGATION AND REPORTING:** Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents - Class exercise with case study

SAFETY PERFORMANCE MONITORING: Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate. **SAFETY EDUCATION AND TRAINING:** Importance of training - identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

Total Hours:	**45**

Text Books:	
1	Charles D. Reese “Occupational Health and Safety Management: A Practical Approach”, 3rd Edition CRC press 2015.
2	Mark A. Friend, James P. Kohn “Fundamentals of Occupational Safety and Health” 6th Edition Bernan press, 2014.
3	Krishnan N.V., “Safety Management in Industry”, Jaico Publishing House, Bombay, 2015.
Reference Books:	
1	Joel M. Haight, “Principles of Industrial Safety”, ASSE publishers, 2017
2	R.K. Mishra,“Safety Management”, AITBS publishers, 2016
3	Relevant India Acts and Rules, Government of India, 2017
4	C. Ray Asfahl, David W. Rieske “ Industrial Safety and health management”, Practice,7th Edition, Pearson, 2018
Web References:	
1	www.nptel.ac.in/courses/110105094
Online Resources:	
1	http;//nptel.ac.in/courses/112107143/40
2	http://dce.mst.edu/credit/certificates/safety engineering

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom’s Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C001.1	Remember	Quiz	20
C001.2	Understand	Assignment	20
C001.3	Apply	Technical Seminar	20
C001.4	Analyse		
C001.5	Evaluate	Case study	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	10	30
Understand	40	40	30
Apply	30	40	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs											PSOs		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C001.1	3		2			2		2				2			2
C001.2	3		2			2		3							
C001.3	3	2				3		3				3			2
C001.4	3	2				3		3				3			
C001.5	3	2				3		3				3			

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME002	FUNDAMENTALS OF MEMS/NEMS	3/0/0/3
Nature of Course	Theory	
Pre requisites	Basics of Physics and Chemistry	
Course Objectives:		
1	To make the students learn various techniques available to make micro shapes using various materials.	
2	To impart the methodologies to be followed in micro fabrication and forming.	
3	To enhance the students knowledge about MEMS / NEMS devices and their applications.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C002.1	Recall the basic concepts related to MEMS / NEMS.	[R]
C002.2	Describe the various fabrication techniques and micro machining processes for MEMS / NEMS.	[U]
C002.3	Apply various fabrication techniques to develop a MEMS / NEMS System.	[Ap]
C002.4	Analyse the characteristics of MEMS and NEMS devices.	[A]
C002.5	Discuss the principles and applications of MEOMS	[U]

Course Contents:

INTRODUCTION TO MEMS/NEMS: Introduction – MEMS vs NEMS - Evolution of Micro-sensors and MEMs Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Introduction to NEMS – Nano-mechanical Resonators, Nano-mechanical Sensors. NEMS architecture, Surface Plasmon effects. **LITHOGRAPHY:** Introduction, Photolithography- Overview Critical Dimension -Line-Width - Lithographic Sensitivity and Intrinsic Resist Sensitivity Resist Profiles- Contrast and Experimental Determination of Lithographic Sensitivity Resolution in Photolithography - Photolithography Resolution - Enhancement Technology Beyond Moore's Law Next Generation – Emerging Lithography Technologies.

ADDITIVE TECHNOLOGY: Introduction –Silicon Growth -Doping of Si - Oxidation of Silicon-Physical Vapor Deposition - Chemical Vapor Deposition- Silk-Screening or Screen-Printing - Sol-Gel Deposition Technique. Plasma Spraying - Deposition and Arraying Methods of Organic Layers in BIOMEMS and BIONEMS - Thin versus Thick Film Deposition - Selection Criteria for Deposition Method. Nanofabrication with EBL & IBL.

MINIATURIZATION TECHNIQUES Introduction - Absolute and Relative Tolerance in Manufacturing - Historical Note: Human Manufacturing - Top-Down Manufacturing Methods-Surface Micromachining, Silicon on Insulator Technology (SOI), Bottom-Up Approaches - modelling, brains, packaging, sample preparation and new MEMS materials Introduction-Modelling, Brains in Miniaturization- Packaging, Substrate Choice. **MINIATURIZATION APPLICATIONS**: Introduction - Scaling, Actuators, Fluidics- Scaling in Analytical Separation Equipment- Other Actuators - Integrated Power miniaturization applications- Introduction - Definitions and Classification Method – MOEMS – Principles and Applications to Automotive, Telecom and Biomedical.

Total Hours:	**45**

Text Books:	
1	Tai-Ran-Hsu, “MEMS & Microsystems: Design and Manufacture”, McGraw Hill, 17th Reprint, 2013.
2	Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2nd Edition, 2011.
Reference Books:	
1	V.K. Jain, “Micro manufacturing Processes”, CRC Press, 2016.
2	Marc J Madou, “Fundamentals of Microfabrication and Nanotechnology”, CRC Press, 2011.
Web References:	
1	https://youtu.be/ZcCXFrHQ7Ao/Introduction to Materials Science for MEMS and NEMS
Online Resources:	
1	MEMS and Microsystems- https://nptel.ac.in/courses/117105082/
2	https://www.coursera.org/learn/MEMS/NEMS

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C002.1	Remember	Quiz	20
C002.2	Understand	Assignment	20
C002.5			
C002.3	Apply	Technical Presentation	20
C002.4	Analyse	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	30	20
Understand	40	30	40
Apply	40	30	30
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C002.1	3				3										
C002.2	3				3										
C002.3	3				3									2	
C002.4	3	1	2	2	3										
C002.5	3				3										3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME003	TOTAL QUALITY MANAGEMENT	3/0/0/3
Nature of Course	D (Theory Application)	
Pre Requisites	Nil	
Course Objectives:		
1.	To recollect the engineering and management aspects of quality planning and control	
2.	Study the methodology of improving quality in manufacturing process / products	
3.	To implement the concepts of quality management system	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C003.1	Define the basic concepts of quality management	[U]
C003.2	Recall the fundamentals of Total Quality Management and its tools.	[R]
C003.3	Examine the role of TQM tools and techniques in elimination of wastages and reduction of defects.	[A]
C003.4	Inculcate the concepts of quality and continuous improvement as a passion and habit.	[Ap]
C003.5	Analyze and understand the industrial problem and provide the optimal solution	[A]
Course Contents:		
QUALITY CONCEPTS: Definition of quality, dimensions of quality, quality planning, quality costs. Cost estimation and principles, leadership, quality council, quality statements, strategic, Quality Guru's, Criteria for Deming's Prize. **PRODUCT DESIGN AND ANALYSIS:** Basic Design Concepts and TQM Principles, Failure Mode Effect Analysis, Fault Tree Analysis, Design for Robustness, Value Analysis. **PROCESS IMPROVEMENT AND MODERN PRODUCTION MANAGEMENT TOOLS:** Six Sigma Approach, Total Productive Maintenance, Just-In-Time, Lean Manufacturing, Paradigms, Quality Improvement Tools and Continuous Improvement. Q-7Tools, New Q-7 Tools, Quality Function Deployment, Kaizen, 5S, Poka- Yoke, SMED. **QUALITY MANAGEMENT SYSTEMS:** Quality Management Systems, Introduction to ISO9000, TS16949: 2002 and EMS 14001certifications. OHSAS 18001 Occupational Health & Safety Assessment Series.		
	Total Hours:	**45**
Text Books:		
1.	DaleH. Besterfield "Total Engineering Quality Management", 6thEdition, Pearson Education, 2019.	
2.	Sunil Sharma, "Total Engineering Quality Management", 6thEdition, Mac Millan India Limited, 2019.	
Reference Books:		
1.	Poornima M.Charantimath, "Total Quality Management", 5thEdition, Pearson Education, 2019.	
2.	James R Evans, "Quality and Performance Excellence", 8thEdition, Cengage Learning, 2019.	
Web References:		
1.	https://managementhelp.org/quality/total-quality-management.htm	
Online Courses:		
1.	https://onlinecourses.nptel.ac.in/noc17_mg18/preview	
2.	https://www.apnacourse.com/course/quality-management	

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C003.1	Understand	Quiz	20
C003.2	Remember	Assignment	20
C003.3	Analyze	Assignment	20
C003.4	Apply	Assignment/Tutorial	20
C003.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	40	40	30
Understand	40	30	40
Apply	10	10	20
Analyse	10	20	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C003.1	3											3			
C003.2	3	2				2									
C003.3	3	3	3						3						
C003.4	3	2	2			2			3						
C003.5	3					2			3						

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME004	PRODUCT DEVELOPMENT	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	Nil	

Course Objectives:

1	To describe the basic concept of product development.
2	To learn the concepts and tools that is necessary for product design and manufacturing
3	To apply the new product development process by devising a new product or service and an introductory launch plan.

Course Outcomes:
Upon completion of the course, students shall have ability to

C004.1	Identify concept generation activities and summarize the methodology involved in concept selection and testing.	[U]
C004.2	Describe the different stages involved in product development.	[U]
C004.3	Analyze the relative importance of customer needs in establishing product specifications.	[A]
C004.4	Applying the design knowledge in design for manufacturing.	[Ap]
C004.5	Devise innovative product development plan with environmental and societal consideration.	[Ap]

Course Contents:

INTRODUCTION: Importance of engineering design, New product development process, Product development Methodologies - Identifying Market Opportunities -Identifying Customer and User Needs - Concept generation- Concept selection - Pugh Matrix method – concept screening and scoring-Concept testing-Product Planning - Strategic Planning.

DESIGN THINKING TECHNIQUES: Product Specifications - Product Architecture - Industrial Design - User Interface Design – Function based design - Designing to codes and standards. TRIZ- axiomatic design - Product Development Economics.

DESIGN FOR MANUFACTURING: Design for Manufacturing –- Robust Design - Prototyping - Product Testing and Reliability - Simulation and Design Tools. **DESIGN FOR THE ENVIRONMENT:** Design for the Environment - Product Life Cycle Management. Role of PLM in Industries (Aero, Auto, Electronics), Human factors design - Sustainable Manufacturing – Product Launch.

Total Hours:	**45**

Text Books:

1	Ulrich, Karl, and Steven Eppinger. “Product Design and Development”, 7th edition. New York, Y: McGraw-Hill, 2020.
2	Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.

Reference Books:

1	Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, , Tata McGraw-Hill Education, 2015.
2	Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, 2014.
3	George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2017.

Online Resources:

1	www.nptel.ac.in/courses/112107217/
2	https://ocw.mit.edu/courses/sloan-school-of-management/15-783j-product-design-and-development-spring-2017/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C004.1	Understand	Quiz	20
C004.2	Understand		
C004.3	Analyse	Assignment	20
C004.4	Apply	Case Study	20
C004.5	Apply	Seminar	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	20	20
Understand	40	40	30
Apply	20	20	30
Analyse	10	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C004.1	3		3			2							1		
C004.2	3	3	3			2							1		
C004.3	3	3	3			2							3		
C004.4	3		3			3	3						2	3	
C004.5	2	2	2				3					1		2	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME005	FUNDAMENTALS OF ADDITIVE MANUFACTURING	3/0/0/3
Nature of Course	Theory application	
Pre requisites	-	
Course Objectives:		
1.	To provide a detailed insite on the additive manufacturing processes.	
2.	To help in understanding the need, types, application, method of operation and the future of AM system in industrial applications.	
3.	To enhance innovative thinking and solve business case studies in AM technique.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C005.1	Recall the basic concepts of Additive manufacturing technologies along with recent trends in advanced manufacturing.	[R]
C005.2	Describe the different methods used for pre-processing and post processing of additive manufactured products.	[U]
C005.3	Demonstrate the uses of additive manufacturing in automobile, aerospace and biomedical fields.	[Ap]
C005.4	Select and use the correct CAD formats in the manufacturing of 3D printed parts.	[Ap]
C005.5	Design the product using additive manufacturing techniques.	[E]

Course Contents:

INTRODUCTION TO RAPID MANUFACTURING:

Evolution, fundamental fabrication processes, CAD for AM, product design and rapid product development – Needs – Impact of AM and Rapid Tooling on Product Development – The Generalized AM Process chain – CAD Model - 3D modelling -3D solid modeling software and their role in AM – Input file formats – Generation and Conversion of STL file – File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM systems

TYPES OF ADDITIVE MANUFACTURING PROCESS:

Liquid based systems: Stereolithography – Solid Ground Curing – Polyjet printing – Applications. Solid based systems: Fusion Deposition Modeling – Laminated Object Manufacturing – Solid Deposition Manufacturing –Applications. Powder based systems: Selective Laser Sintering – 3-Dimensional Printers – Laser Engineered Net Shaping – Electron Beam Melting Process – Applications. Other Systems: Metal Additive Manufacturing (SLM, Inkjet, etc), Sand/Ceramics Printing. Advanced materials - Electronic Materials, Bio printing-Food Printing.

APPLICATIONS OF ADDITIVE MANUFACTURING:

Rapid Tooling and Applications of AM: Direct Rapid Tooling, Indirect Rapid Tooling: Soft tooling and Hard tooling – Conversion of CT / MRI scan data – Customized implant - Reverse engineering – Case studies on current application of AM – Novel Application of AM systems – Future trends of AM system. Application of AM in Medical, Automotive, Aeronautical, Space and Construction Industries. Customized design and fabrication for medical applications.

Total Hours:	**45**

Text Books:

1	C.K. Chua, K.F. Leong, C.S. Lim, “Rapid prototyping Principles & Application (3rd Edition), World Scientific Publication, 2018.
2	Additive Manufacturing Design, Methods & Processes, Steinarkilli, Taylor & Francis Publication, 2017.

Reference Books:	
1	Liou, W.F., Rapid Prototyping and Engineering Applications, A toolbox for prototype development, CRC Press, Taylor & Francis Group LLC, USA, 2018.
2	Hopkinson, N., Hague, R.J.M, and Dickens, P.M., Rapid Manufacturing, An Industrial Revolution for the Digital Age, John Wiley & Sons, Ltd, UK, 2016.
Web References:	
1	http://nptel.ac.in/courses/112107077/382.
2	http://nptel.ac.in/courses/112107078/37
3	http://nptel.ac.in/courses/112102103/16
Online Resources:	
1	https://www.technosofteng.com
2	https://schooledbyscience.com
3	https://www.metal-am.com

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C005.1	Remember	Quiz	20
C005.2	Understand	Assignment	20
C005.3	Apply	Case Study	20
C005.4	Apply	Assignment	20
C005.5	Evaluate		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	30	20	20
Understand	50	40	40
Apply	20	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C005.1	3	2												3	
C005.2	3	2			2									3	
C005.3	3													3	
C005.4	3		3		2									3	
C005.5	3	3	3	3										3	

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME006	TECHNOLOGY MANAGEMENT	3/0/0/3
Nature of Course	Theory	
Pre Requisites	Nil	

Course Objectives:

1	To expose the student to the basic concepts of management in order to make them understanding how an organization function.
2	To create awareness among the students about the impact of technology and innovation on business management.
3	To make the students understand the social issues in technology management.

Course Outcomes:
Upon completion of the course, students shall have ability to

C006.1	Recognize the role and significance of technology management	[R]
C006.2	Interpret the human issues and ethics involved in the technology usage and implementation.	[U]
C006.3	Illustrate the environmental impact of technological change.	[A]
C006.4	Relate the issues in preparation of EIA report	[Ap]
C006.5	Categorize the elements of the environmental problem	[A]

Course Contents:

Introduction to Technology Management: Concept and Meaning of Technology and Technology Management- Technology; Technology management, Evolution and Growth of Technology, Role and Significance of Technology Management, Impact of Technology on Society and Business- components of technology management -Technology and competition; Key issues in managing technological innovation, Forms of Technology- Process technology; Product technology.

Managing Technology Based Innovation: Innovation and Technology- role of technology in innovation; Technological innovation and management, Process of Technology - Based Innovation, Measures of Innovative Performance, Characteristics of Innovative Work Environment, three perspectives of technology management, Measures for Building High-Performing Innovative Technology- Based Organizations.

Social Issues in Technology Management: Social Issues, Technological Change and Industrial Relations- Implementation of rationalization and automation in India; Impact of technological change, Technology Assessment and Environmental Impact Analysis- Environmental impact analysis process- Guidelines on the scope of EIA; Issues in preparation of EIA report; Elements of the environmental problem.

Total Hours:	**45**

Text Books:

1	Sanjiva Shankar, Technology and innovation management, Dubey publisher: PHI learning, 2017.
2	Margaret A. White , Garry D. Bruton, The Management of Technology and Innovation: A Strategic Approach, 2nd Edition, 2014.

Reference Books:

1	Joe Tidd, John Bessant, Managing Innovation: Integrating Technological, Market and Organizational Change, 6th Edition 2018.
2	Hellriegel, Jackson and Slocum, Management: A Competency-Based Approach, South Western, 11th edition, 2015.
3	Koontz, Essentials of Management, Tata McGraw-Hill, 10th Edition, 2015.
4	Bateman Snell, Management: Competing in the new era, McGraw-Hill Irwin,5th Edition, 2018.

Web References:	
1	https://www.youtube.com/watch?v=ShpfL1ji-ZE
2	https://www.youtube.com/watch?v=4Vy4y7ot3HE
Online Resources:	
1	https://www.youtube.com/watch?v=TsZukmeaewc&list=PLF1DBCAC25C2BC963

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C006.1	Remember	Quiz	20
C006.2	Understand	Assignment	20
C006.4	Apply		
C006.3	Analyze	Assignment	20
C006.5	Analyze	Tutorial	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	10	10	10
Understand	10	20	20
Apply	40	40	40
Analyse	40	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C006.1	3		1										2		
C006.2	3	2	2			3		3							
C006.3	3			2											
C006.4	3			2									2		
C006.5	3	2		2											

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Mandatory Courses

21MC103	SOFT SKILLS	2/0/0/0
Nature of Course	MANDATORY COURSE	
Pre Requisites	Nil	

Course Objectives:

1	To impart the skills required for working in the corporate world
2	To study the required interpersonal and management skills
3	To develop self-confidence, positive attitude, emotional intelligence, social grace, flexibility and friendliness among the students
4	To impart the requisite Entrepreneurial Skills to the students.

Course Outcomes:
Upon completion of the course, students shall have ability to

C103.1	Identify the significance of soft skills in professional and interpersonal communications	[R]
C103.2	Understand the soft skills that helps for achieving excellence in career	[U]
C103.3	Prepare an effective resume using advanced writing skills	[Ap]
C103.4	Examine the importance of stress and time management in an organization	[Ap]

Course Contents:

Introduction to Soft skills
Soft Skills – definition – scope and importance – workplace communication, process and barriers- Interpersonal and Intra-personal communication skills

Meeting Management
Team building- emotional intelligence and Critical thinking- developing self-esteem, time and stress management- group discussions, interviews, and presentation skills

Advanced skills
Drafting an effective Resume- campus to company- Entrepreneurial Skills Development- Project Reading

Total Hours: 15

Reference Books:

1	Chauhan, G.S. and Sangeeta Sharma. Soft Skills. New Delhi: Wiley. 2016
2	Sharma, R.C. and Krishna Mohan. Business Correspondence and Report Writing. New Delhi: TMH. 2016

Web References:

1	https://nptel.ac.in/courses/109/107/109107121/
2	https://nptel.ac.in/courses/109/104/109104115/

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component	Marks
C103.1	Remember	NPTEL Swayam / MOOC / Assignments	50
C103.2	Understand		
C103.3	Apply		
C103.4	Apply		

Summative assessment based on Continuous and End Semester Examination	
Bloom's Level	**Term End Model Examination [50 marks]**
Remember	30
Understand	40
Apply	30
Analyze	-
Evaluate	-
Create	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C103.1								2		3	2				
C103.2								3	1	3	3	1			
C103.3								2		3	3				
C103.4								3		3	2				

3	Strongly agreed	2	Weakly agreed	1	Moderately agreed

21MC108	CONSTITUTION OF INDIA	2/0/0/0
Nature of Course	Mandatory Course	
Pre Requisites	NIL	

Course Objectives:

1	To explore various aspects of the Indian political and legal system from a historical perspective highlighting the events that led to the making of the Indian Constitution.
2	To survey the basic structure and operative dimensions of Indian Constitution.
3	To make students aware of the theoretical and functional aspects of the Indian parliamentary system
4	To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.
5	To make students learn about role of engineering in business organizations and e-governance.

Course Outcomes:
Upon completion of the course, students shall have ability to

C108.1	Visualize the nature of Indian Political and legal system.	[R]
C108.2	Interpret the structure of Indian Constitution.	[Ap]
C108.3	Differentiate and relate the functioning of Indian parliamentary system at the center and state level.	[U]
C108.4	Differentiate different aspects of Indian Legal System and its related bodies	[U]
C108.5	Correlate the role of engineers with different organizations and governance models	[A]

Course Contents:

Historical Perspectives
Constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Indian Constitution
Principles of the Constitution – Fundamental Rights – Directive Principles – Centre-State Relations – Division of Power.

Constitution and Structure
Legislature, Executive, Judiciary; Institutions: President, Governors, Statutory bodies – Amendments to the Constitution.

Total Hours:	**15**

Reference Books:

1	D D Basu, "Introduction to the Constitution of India", 23rd Edn.,Lexisnexis Butterworths, 2021.
2	Brij Kishore Sharma: Introduction to the Indian Constitution, 8th Edition, PHI Learning Pvt. Ltd, 2015.

Web References:

1	https://nptel.ac.in/courses/129/106/129106002/
2	https://nptel.ac.in/courses/129/106/129106003/

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C108.1	Remember	NPTEL Swayam / MOOC / Assignments	50
C108.2	Apply		
C108.3	Understand		
C108.4	Understand		
C108.5	Analyze		

Summative assessment based on Continuous and End Semester Examination	
Bloom's Level	**Term End Model Examination [50 marks]**
Remember	30
Understand	30
Apply	30
Analyze	10
Evaluate	-
Create	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C108.1						3	3								
C108.2						3	3								
C108.3						3	2	1							
C108.4						3	3								
C108.5						3	1	3							

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21MC109	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2/0/0/0
Nature of Course	Mandatory Course	
Pre Requisites	NIL	

Course Objectives:

1	To study the basic science followed in Indian tradition.
2	To enable the students to understand the importance of our surroundings and encourage the students to contribute towards sustainable development.
3	To sensitize students towards issues related to 'Indian' culture, tradition and its composite character.
4	To make the students aware of holistic life styles of Yogic-science and wisdom capsules in Sanskrit literature that are important in modern society with rapid technological advancements and societal disruptions.
5	To acquaint students with Indian knowledge system, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care system.

Course Outcomes:
Upon completion of the course, students shall have ability to

C109.1	Understand the basic science of Indian Traditional Knowledge	[U]
C109.2	Ability to understand, connect up and explain basics of Indian Traditional knowledge with modern scientific perspective.	[U]
C109.3	Apply the concept of Indian tradition towards sustainable development	[Ap]
C109.4	Explore the importance of traditional knowledge in Agriculture and Medicine.	[U]
C109.5	Conceptualize the various enactments related to the protection of traditional knowledge.	[Ap]

Course Contents:

Indian knowledge and Tradition System
Basic structure of Indian Knowledge System -Modern Science and Indian Knowledge System - Yoga and Holistic Health care – Philosophical Tradition-Indian Linguistic Tradition – Indian Artistic Tradition.

Science and Management
Astronomy in India - Chemistry in India - Mathematics in India - Physics in India - Agriculture in India - Medicine in India - Metallurgy in India – Geography – Biology-Harappan Technologies.

Cultural Heritage and Performing Arts
Indian Architect, Engineering and Architecture in Ancient India, Sculptures, Seals, coins, Pottery, Puppetry, Dance, Music, Theatre, drama, Painting, Martial Arts Traditions, Fairs and Festivals, Current developments in Arts and Cultural, Indian's Cultural Contribution to the World. Indian Cinema

Total Hours:	**15**

Reference Books:

1	V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
2	S. Baliyan, Indian Art and Culture, Oxford University Press, India. 2020

Web References:

1	https://nptel.ac.in/courses/109/104/109104102/
2	https://www.iare.ac.in/?q=courses/r18-auto-aero/essence-indian-traditional-knowledge

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C109.1	Understand	NPTEL Swayam / MOOC / Assignments	50
C109.2	Apply		
C109.3	Understand		
C109.4	Understand		
C109.5	Apply		

Summative assessment based on Continuous and End Semester Examination	
Bloom's Level	**Term End Model Examination [50 marks]**
Remember	30
Understand	50
Apply	20
Analyze	-
Evaluate	-
Create	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	Pos												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C109.1			1			3	3								
C109.2			1			3	3								
C109.3			1			3	3								
C109.4			2			3	3								
C109.5			1			3	3								

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

Service Courses

21ME103	ENGINEERING PRACTICES LABORATORY	0/0/3/1.5

Nature of Course	Practical application
Pre Requisites	Nil

Course Objectives:

1	To learn the use of basic hand tools and to know the need for safety in work place and to gain hands on experience in Carpentry, Sheet metal, Plumbing, Welding and Foundry.
2	To learn about basic electrical devices, meters and electronics devices and to gain knowledge about the fundamentals of various electrical and electronic gadgets their working and trouble shooting.

Course Outcomes:
Upon completion of the course, students shall have ability to

C103.1	Identify and solve the basic engineering problems at home and in workplace.	[Ap]
C103.2	Develop the surfaces and make simple components like tray and funnel.	[Ap]
C103.3	Make simple metal joints using welding equipment and wooden joints using carpentry tools.	[Ap]
C103.4	Prepare pipe connections and sand moulds.	[Ap]
C103.5	Understand the fundamentals of hot forging and injection moulding	[U]
C103.6	Examine and troubleshoot electrical and electronic circuits	[A]

Course Contents:

GROUP A (CIVIL & MECHANICAL)

Manufacturing Methods –Sheet metal operations - Welding - arc welding, gas welding,Study of TIG & MIG welding. Study of foundry, Demonstration of Smithy and Injection moulding - Carpentry work using power tools - Plumbing components and pipelines

List of Experiments:

S.No	List of Experiments	CO Mapping	RBT
1	Preparation of butt joints and lap joints using arc welding	C103.3	[Ap]
2	Sheet metal Forming and Bending, Model making – Trays and funnels.	C103.2	[Ap]
3	Preparation of wooden joints by sawing, planning and cutting.	C103.3	[Ap]
4	Making basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings.	C103.4	[Ap]
5	Demonstration of foundry operations like mould preparation for solid and split piece pattern.	C103.4	[U]
6	Demonstration of Smithy operations	C103.5	[Ap]
7	Demonstration of assembly of pump / Demonstration of Injection moulding	C103.1	[Ap]

GROUP B (ELECTRICAL AND ELECTRONICS ENGINEERING)

List of Experiments:

Basic Circuit Elements: Resistor, inductor, capacitor. Introduction to measuring equipments: Moving iron meter, moving coil meter, Wattmeter, Energy meter, CRO, Multi-meter. Digital logic circuits, PCB design, fuse, relay, circuit breaker, wire, Earthing, fan, fluorescent lamp, iron box, mixer grinder, study of FM radio and mobile phone.

S.No	List of Experiments	CO Mapping	RBT
1	Study and identification of electronic components with specification.	C103.6	[U]
2	Testing of CRO and Electronic components using Multimeter.	C103.6	[A]

3	Generation and measurement of signals using CRO.	C103.6	[A]
4	Familiarisation of digital basic gate IC's.	C103.6	[AP]
5	Soldering practice-components devices and circuits- using general purpose PCB.	C103.6	[AP]
6	Demonstration of meters and electrical components.	C103.6	[AP]
7	Safety precautions with electrical components.	C103.6	[AP]
8	Residential house wiring.	C103.6	[A]
9	Measurement of power and energy.	C103.6	[A]
10	Trouble shooting of electrical equipments.	C103.6	[A]
		Total Hours:	**45**

Reference Books:

1	Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson Education, Inc. 2009 (Second Indian Reprint).
2	Hajra Choudhury, "Elements of Workshop Technology", Vol. I & II, Media Promotors Pvt Ltd., 2014.
3	Suyambazhagan S, 'Engineering practices' PHI Learning private limited, New Delhi, 2012.
4	D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
5	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.

Web References:

1	www.nptel.ac.in
2	www.sme.org
3	http://www.allaboutcircuits.com/education/

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment (60%)		End Semester Examination (40%)
	FA (45 Marks)	SA (15 Marks)	Practical Examination (40 Marks)
Remember	10	10	10
Understand	10	10	10
Apply	40	40	40
Analyse	40	40	40
Evaluate	-	-	-
Create	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C103.1	3														
C103.2	3	1													
C103.3	3													3	
C103.4	3	1												3	
C103.5	3	1												3	
C103.6	3														

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

21ME111	ENGINEERING GRAPHICS	1/0/3/2.5
Nature of Course	Practical application	
Pre Requisites	Basic Drawing and Computer Knowledge	

Course Objectives:

1	To know the method to construct the conic curves used in engineering applications.
2	To develop an understanding of Isometric to orthographic views and vice versa.
3	To learn the basic projection of straight lines and plane surfaces.
4	To develop the imagination of solids inclined to one reference plane.
5	To know the development of surfaces used in various fields.

Course Outcomes:
Upon completion of the course, students shall have ability to

C111.1	Understand the basic concepts of Engineering Graphics.	[U]
C111.2	Sketch isometric, orthographic projections and projection of lines and planes	[Ap]
C111.3	Develop lateral surfaces of solids including prisms and pyramids	[Ap]
C111.4	Construct projections of lines, planes, solids and isometric views using modelling software.	[A]

Course Contents:

Conic curves and special curves – Isometric projections, Isometric to orthographic projection-Orthographic to Isometric projection-Projection of lines and plane surfaces-Projection of solids-Development of surfaces-Introduction to perspective projection.

S.No	List of Experiments	CO Mapping	RBT
1	Introduction to drafting software.	C111.1	U
2	Construction of conic curves (Ellipse, Parabola and Hyperbola)	C111.1	U
3	Construction of special curves (Cycloid and Involutes)	C111.1	U
4	Isometric to orthographic projections – manual sketches	C111.2	Ap
5	Isometric to orthographic projections – software sketches	C111.4	A
6	Projection of lines - inclined to HP, VP and Both HP & VP	C111.4	A
7	Projection of plane surfaces (Hexagon, Pentagon and circle) – inclined to any one of the principle planes	C111.4	A
8	Projection of solids (Prism and Pyramid) – inclined to HP	C111.3	Ap
9	Projection of solids (Cone and Cylinder) – inclined to VP	C111.3	Ap
10	Development of surfaces (Prism, Pyramid, Cone and Cylinder)	C111.4	A
11	Introduction to perspective projection	C111.2	U

Total Hours: 45

Reference Books:

1	Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2014.
2	K. V. Natarajan, “A Text Book of Engineering Graphics", Dhanalakshmi Publishers, 2018.
3	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2011.
4	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2013.

Web References:

1	http://nptel.ac.in/courses/112102101/
2	www.solidworks.com

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (60%)**		**End Semester Examination (40%)**
	FA (45 Marks)	**SA (15 Marks)**	**Practical Examination (40 Marks)**
Remember	30	30	30
Understand	30	30	30
Apply	20	20	20
Analyse	20	20	20
Evaluate	0	0	0
Create	0	0	0

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C111.1	3		1							3					
C111.2	3		1							3					
C111.3	3		1							3					
C111.4	3		1							3					

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed