SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution| Approved by AICTE| Affiliated to Anna University
Kuniamuthur, Coimbatore - 641008

17.4.2. EDUCATION FOR SDGS SPECIFIC COURSES ON SUSTAINABILITY

Sustainable Development Goal (SDG) Indicator 17.4.2 itself measures debt service relative to exports of goods and services, but you're bringing in an interesting dimension related to education for sustainable development (ESD) within SDG 17 specifically about courses that promote education for SDGs and sustainability. SDG 17 emphasizes partnerships, and part of that involves strengthening educational initiatives that prepare individuals and institutions to address sustainability challenges.

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF CIVIL ENGINEERING

CURRICULUM AND SYLLABI

BE CIVIL ENGINEERING

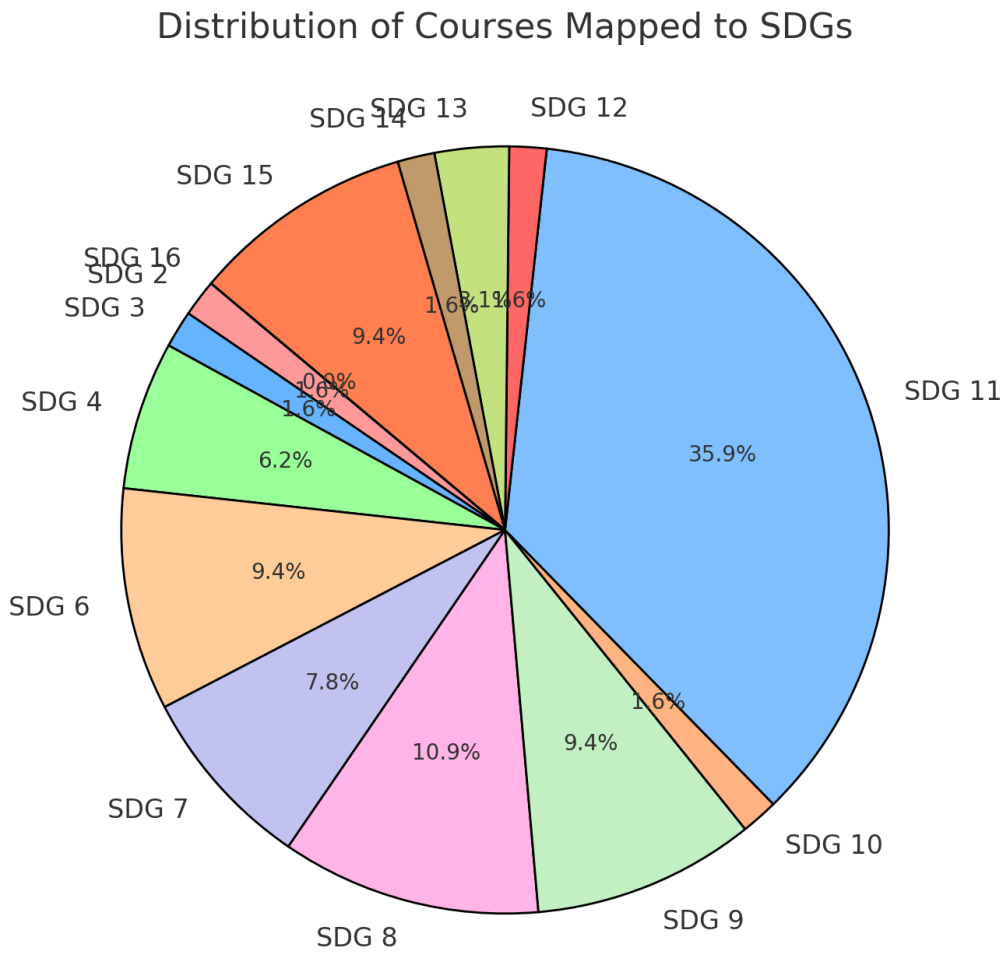
REGULATION 2022

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution| Approved by AICTE| Affiliated to Anna University

Kuniamuthur, Coimbatore - 641008

DEPARTMENT OF CIVIL ENGINEERING



BE CIVIL ENGINEERING

CURRICULUM AND SYLLABIREGULATION 2022 (B:2022-2026)

CHOICE BASED CREDIT SYSTEM

SRI KRISHNA COLLEGE OF ENGNEERING AND TECHNOLOGY

An Autonomous Institution Affiliated to Anna University

Kuniamuthur, Coimbatore - 641 008

VISION AND MISSION OF THE DEPARTMENT

Our Vision

To be a center of excellence in Civil Engineering Education through full-fledged learning experience along with research.

Our Mission

To accomplish our vision, we are committed to

M1: Faculty experts from all specialization of Civil Engineering to facilitate teaching learning process

M2: Excellent infrastructure facilities to apply Civil Engineering knowledge and perform societal based research

M3: Exposure to latest technologies in Civil Engineering through industry-institute interaction and professional bodies

M4: Environs to develop their innovative thoughts, ethics, communication, inter- and intra-personal skills

M5: Enthusiasm towards self-learning, social responsibility and entrepreneurship

Program Outcomes (POs):-

At the time of their graduation students of Civil Engineering Program should be in possession of the following Program Outcomes

PO 1. **Engineering knowledge:** Apply the knowledge of mathematics, science and engineering fundamentals for the solution of complex Civil Engineering problems.

PO 2. **Problem analysis:** Identify, formulate and analyse complex Civil Engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.

PO 3. **Design/development of solutions:** Design solutions for complex Civil Engineering problems and design system components with appropriate consideration for public health & safety, cultural, societal and environmental considerations.

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

PO 5. **Modern tool usage:** Create, select & apply appropriate techniques, resources, modern engineering and IT tools, including prediction and modeling to complex Civil Engineering activities, with an understanding of the limitations.

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

PO 7. **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.

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

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

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

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

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

Program Educational Objectives (PEOs):-

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

1. To apply knowledge of mathematics, science and engineering to solve existing problems in the area of Structural, Geotechnical, Water Resources, Environmental, Transportation, Urban Planning, Construction Materials and Management in Civil Engineering
2. To analyze, design, construct Civil Engineering traditional and modern structures

3. To perform investigation on any complicated Civil Engineering problems by conducting research using modern equipment's and software tools
4. To communicate and develop strong inter- and intra- personal skills to prepare them for placement and higher studies
5. To be self-motivated towards lifelong learning and entrepreneurship

Mapping of POs to PEOs

Program Educational Objectives	Program Outcomes											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
PEO 1	**3**	**2**	**3**	2	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**2**
PEO 2	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
PEO 3	**3**	**3**	**3**	**2**	3	**3**	**2**	**2**	**2**	**3**	**2**	**3**
PEO 4	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
PEO 5	**3**	**3**	**3**	**2**	3	**3**	**2**	**2**	**2**	**3**	**2**	**3**

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

Program Specific Outcomes (PSOs):-

At the end of the Program, Graduate shall have

PSO 1	**Analytical Knowledge and Practical Skills**	The ability to analyse, design and interpret by applying the concepts of mathematics and physical sciences in the core areas of Civil Engineering.
PSO 2	**Civil Engineer and Sustainability**	The propensity to excel in portfolio of waste management, sanitation, housing and construction management for the sustainable environment.
PSO 3	**Environment and Social Commitment**	The ability to acquire and update knowledge continuously and offer engineering solutions to meet the environmental and societal needs.

B.E. CIVIL ENGINEERING - REGULATION 2022 (B:2022-2026)

CHOICE BASED CREDIT SYSTEM
I – VIII SEMESTER CURRICULUM AND SYLLABI

SEMESTER I										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22CE101	Introduction to Civil Engineering	3	0	0	3	3	60 / 40	HSMC	6,7,12,13,11,15
2.	22MA101	Engineering Mathematics I	3	1	0	4	4	60 / 40	BSC	4,9
3.	22EE113	Fundamentals of Electrical and Electronics Engineering	3	0	0	3	3	60 / 40	ESC	4,7,8,9,12
4.	22PH104	Applied Physics	3	0	2	5	4	50 / 50	BSC	4,7,8,9,12
5.	22EN101	Technical Communication Skills	2	0	2	4	3	50 / 50	BSC	4,10
6.	22CS101	Problem solving using C++	3	0	2	5	4	50 / 50	ESC	4,9
7.	22CE102	Engineering Practices Laboratory	0	0	4	4	2	40/60	ESC	4,7,8,9,12
8.	22EE115	Fundamentals of Electrical and Electronics Engineering Laboratory	0	0	2	2	1	40/60	ESC	4,7,8,9,12
9.	22MC101	Mandatory Course I	3 WEEKS				0	0/100	MC	3,4,6,7,8,11,14,15
		Total	**17**	**1**	**12**	**30**	**24**	**900**		

SEMESTER II										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22GE201	Universal Human Values	3	0	0	3	3	60/40	HSMC	4,16,10
2.	22ME101	Engineering Mechanics	3	0	0	3	3	60/40	ESC	9,12
3.	22MA201	Engineering Mathematics II	3	1	0	4	4	60/40	BSC	4,9
4.	22CH101	Engineering Chemistry	3	0	2	5	4	50/50	BSC	4,7,8,9,12
5.	22CS201	Data Structures and Algorithms	3	0	2	5	4	50/50	ESC	4,9,11
6.	22TA101	Heritage of Tamils	1	0	0	1	1	60/40	HSMC	4,11,10
7.	22CE201	Engineering Graphics Laboratory	0	0	4	4	2	40/60	ESC	4,11,12
8.	22MCxxx	Mandatory Course II	2	0	0	2	0	0/100	MC	4,12,16
		Total	**18**	**1**	**8**	**27**	**21**	**800**		

SEMESTER III										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22CE301	Surveying and Geomatics	3	1	0	4	4	60/40	PCC	9,11,15
2.	22MA301	Probability and Numerical Methods	3	1	0	4	4	60/40	BSC	4,9
3.	22CE302	Architectural Planning and Building Drawing	3	0	3	6	4.5	50/50	ESC	11
4.	22CE303	Strength of Materials	3	0	3	6	4.5	50/50	PCC	9
5.	22IT311	Introduction to Python programming	1	0	4	5	3	50/50	ESC	8
6.	22TA201	Tamils and Technology	1	0	0	1	1	60/40	HSMC	10
7.	22CE304	Surveying and Geomatics Laboratory	0	0	3	3	1.5	40/60	PCC	15
8.	22MCxxx	Mandatory Course III	2	0	0	2	0	0/100	MC	4,15
		Total	**16**	**2**	**13**	**31**	**22.5**	**800**		

SEMESTER IV										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22CE401	Environmental Engineering	3	0	0	3	3	60/40	PCC	6
2.	22xxxxx	Open Elective I	1 or 3	0 or 0	4 or 0	5 or 3	3	50/50 or 60/40	OEC	4
3.	22CE402	Construction Materials and Technology	3	0	3	6	4.5	50/50	PCC	9
4.	22CE403	Fluid Mechanics and Hydraulic Machinery	3	0	3	6	4.5	50/50	PCC	7
5.	22CE404	Structural Analysis	3	0	3	6	4.5	50/50	PCC	11

6.	22CE405	Environmental Engineering Laboratory	0	0	3	3	1.5	40/60	PCC	13
7.	22EES101	Employability Enhancement Skills (Internship / Training – 2 weeks)					1	40/60	EES	8
8.	22MCxxx	Mandatory Course IV	2	0	0	2	0	0/100	MC	4
		Total	**15**	**0**	**16**	**31**	**22**	**800**		

SEMESTER V										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22CE501	Geotechnical Engineering	3	1	0	4	4	60/40	PCC	9,11
2.	22CExxx	Professional Elective I	3	0	0	3	3	60/40	PEC	4
3.	22xxxxx	Open Elective II	1 or 3	0 or 0	4 or 0	5 or 3	3	50/50 or 60/40	OEC	4
4.	22CE502	Design of Reinforced Concrete Structures	3	0	3	6	4.5	50/50	PCC	11
5.	22CE503	Transportation Engineering	3	0	3	6	4.5	50/50	PCC	11
6.	22CE504	Soil Mechanics Laboratory	0	0	3	3	1.5	40/60	PCC	15
7.	22EES102	Employability Enhancement Skills (Internship / Training – 2 weeks)					1	40/60	EES	8
		Total	**13**	**1**	**13**	**27**	**21.5**	**700**		

SEMESTER VI										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22CE601	Construction Planning and Management	3	1	0	4	4	60/40	PCC	11
2.	22Cexxx	Professional Elective II	3	0	0	3	3	60/40	PEC	4
3.	22Cexxx	Emerging Elective I	3	0	0	3	3	60/40	EEC	4

4.	22Cexxx	Emerging Elective II	3	0	0	3	3	60/40	EEC	4
5.	22CE602	Construction Cost Estimation and Valuation	3	0	3	6	4.5	50/50	PCC	11
6.	22CE603	Design of Steel Structures	3	0	3	6	4.5	50/50	PCC	11
7.	22CE604	Project Planning and Development Laboratory	0	0	2	2	1	40/60	PCC	8,11
		Total	**18**	**1**	**8**	**27**	**23**	**700**		

SEMESTER VII										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
1.	22Cexxx	Professional Elective III	3	0	0	3	3	60/40	PEC	4
2.	22Cexxx	Professional Elective IV	3	0	0	3	3	60/40	PEC	4
3.	22Cexxx	Professional Elective V	3	0	0	3	3	60/40	PEC	4
4.	22Cexxx	Professional Elective VI	3	0	0	3	3	60/40	PEC	4
5.	22Cexxx	Emerging Elective III	3	0	0	3	3	60/40	EEC	4
6.	22Cexxx	Emerging Elective IV	3	0	0	3	3	60/40	EEC	4
7.	22CE701	Design Comprehensive Project	0	0	4	4	2	40/60	PROJ	8
		Total	**18**	**0**	**4**	**22**	**20**	**700**		

SEMESTER VIII										
SL. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Contact hrs./wk.**	**C**	**Ext / Int**	**Cat.**	**SDG**
PROJECT WORK										
1.	22CE801	Project Work	0	0	24	24	12	40/60	PROJ	8
		Total	**0**	**0**	**24**	**24**	**12**	**100**		

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
OEC : Open Elective Courses
EEC : Emerging Elective Courses
EC : Emerging Courses

ESC : Engineering Science Courses
PCC : Professional Core Courses
PEC : Professional Elective 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

PROFESSIONAL ELECTIVE COURSES (18 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.	SDG
1.	22CE901	Bridge Engineering and Design of Special Elements	3/0/0	3	3	PEC	9
2.	22CE902	Conditional Assessment and Rehabilitation of Structures	3/0/0	3	3	PEC	11
3.	22CE903	Design of Foundations and Retaining Structures	3/0/0	3	3	PEC	11
4.	22CE904	Green Building Technology	3/0/0	3	3	PEC	7
5.	22CE905	Ground Improvement and Geosynthetics	3/0/0	3	3	PEC	15
6.	22CE906	Prefabricated Structures	3/0/0	3	3	PEC	9
7.	22CE907	Pre-stressed Concrete Structures	3/0/0	3	3	PEC	9
8.	22CE908	Soil Dynamics and Earthquake Engineering	3/0/0	3	3	PEC	11
9.	22CE909	Smart Materials and Structures	3/0/0	3	3	PEC	9
10.	22CE910	Air and Noise Pollution	3/0/0	3	3	PEC	3
11.	22CE911	Assessment of Contaminated Site and Remediation	3/0/0	3	3	PEC	15
12.	22CE912	Computing Techniques In Environmental Engineering	3/0/0	3	3	PEC	4
13.	22CE913	Groundwater and surface water pollution	3/0/0	3	3	PEC	6
14.	22CE914	Irrigation and water resources engineering	3/0/0	3	3	PEC	2
15.	22CE915	Remote Sensing and GIS for Civil Engineering	3/0/0	3	3	PEC	15
16.	22CE916	Surface Water Hydrology	3/0/0	3	3	PEC	6
17.	22CE917	Solid and Hazardous waste Management	3/0/0	3	3	PEC	12

18.	22CE918	Operation and Maintenance of Water and Wastewater Treatment Systems	3/0/0	3	3	PEC	6
19.	22CE919	Computer Simulation Applications in Transportation Engineering	3/0/0	3	3	PEC	11
20.	22CE920	Construction Personnel Management	3/0/0	3	3	PEC	11
21.	22CE921	Economics and Business Finance	3/0/0	3	3	PEC	8
22.	22CE922	Highway Construction and Management	3/0/0	3	3	PEC	11
23.	22CE923	Marketing Management	3/0/0	3	3	PEC	8
24.	22CE924	Lean Startup Management	3/0/0	3	3	PEC	11
25.	22CE925	Risk and Reliability Analysis of Civil Infrastructure Systems	3/0/0	3	3	PEC	11
26.	22CE926	Road Transport Management and Economics	3/0/0	3	3	PEC	11
27.	22CE927	Valuation of Real Properties	3/0/0	3	3	PEC	8
28.	22CE928	Finite Element Analysis	3/0/0	3	3	PEC	4
29.	22CE929	Advanced Structural Analysis	3/0/0	3	3	PEC	11
30.	22CE930	Design of Substructures	3/0/0	3	3	PEC	11
31.	22CE931	Seismic Design of Structures	3/0/0	3	3	PEC	11
32.	22CE932	Coastal Engineering	3/0/0	3	3	PEC	14
33.	22CE933	Supply Chain Management and Logistics in Construction	3/0/0	3	3	PEC	8
34.	22CE934	Formwork Engineering	3/0/0	3	3	PEC	8
35.	22CE935	Intelligent transportation system	3/0/0	3	3	PEC	11
36.	22CE936	Building Services and Management	3/0/0	3	3	PEC	11

EMERGING ELECTIVE COURSES (12 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.	SDG
1.	22CE007	Applications of Sensors and IoT in Civil Engineering	3/0/0	3	3	EEC	11
2.	22CE008	Building and Town Planning	3/0/0	3	3	EEC	11
3.	22CE009	Environmental Ethics and Management	3/0/0	3	3	EEC	6,7
4.	22CE010	Environmental Geotechnics	3/0/0	3	3	EEC	15
5.	22CE011	Low carbon Building Materials and Systems	3/0/0	3	3	EEC	11,15
6.	22CE012	Metro Rail Engineering and Infrastructure	3/0/0	3	3	EEC	11
7.	22CE013	Nanotechnology in Civil and Environmental Engineering	3/0/0	3	3	EEC	11
8.	22CE014	Project Formulation and Implementation	3/0/0	3	3	EEC	8
9.	22CE015	Rural Water Supply and Onsite Sanitation Systems	3/0/0	3	3	EEC	6
10.	22CE016	Smart City Planning and Development	3/0/0	3	3	EEC	11
11.	22CE017	Sustainable Construction Materials and Methods	3/0/0	3	3	EEC	11
12	22CE018	Waste to Energy	3/0/0	3	3	EEC	7

OPEN ELECTIVE COURSES (6 Credits) [Offered to Other Branches]

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.	SDG
1.	22CE001	Disaster Management	3/0/0	3	3	OEC	13,15
2.	22CE002	Engineering Risk and Uncertainty	3/0/0	3	3	OEC	8,15
3.	22CE003	Environmental Pollution and Global issues	3/0/0	3	3	OEC	6,7
4.	22CE004	Project Management	3/0/0	3	3	OEC	8
5.	22CE005	Industrial Safety	3/0/0	3	3	OEC	9
6.	22CE006	Research Methodology and IPR	3/0/0	3	3	OEC	9

MANDATORY COURSES (Non-credit)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.	SDG
1.	22MC101	Induction Programme	3 WEEKS		0	MC	4
2.	22MC102	Environmental Sciences	2/0/0	2	0	MC	6,7,13,15
3.	22MC103	Soft Skills	2/0/0	2	0	MC	4
4.	22MC104	Management Organizational Behavior	2/0/0	2	0	MC	8
5.	22MC105	General Aptitude	2/0/0	2	0	MC	4

VALUE ADDED COURSES (Additional credit courses)

SL. No.	Course Code	Course Title	Course Credits	SDG
1.	22VA130	Effective Communication Skills	2	4
2.	22VA101	Building Function Design using AutoCAD	1	11
3.	22VA102	Total Station and GPS Surveying	1	11
4.	22VA103	Arc GIS for Civil Engineers	1	11
5.	22VA104	Structural Analysis and Design Using STAAD.Pro	1	11
6.	22VA105	Project Management Using Primavera	1	8
7.	22VA106	3DBuilding Modeling Using Revit Architecture	1	9

Sri Krishna College of Engineering and Technology

An Autonomous Institution, Affiliated to Anna University Coimbatore – 641 008

REGULATION 2022

CURRICULUM AND SYLLABI

B.E. MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING
SRI KRISHNA COLLEGE OF ENGINEERING 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 it envisions 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

1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2.	**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.
3.	**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.
4.	**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.
5.	**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.
6.	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7.	**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.
8.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9.	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
10.	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11.	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12.	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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.

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.

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

Programme Educational Objectives	**Programme Outcomes**												**Programme Specific Outcomes**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**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 2022
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**	**Cat.**	**SDG**
1.	22ME101	Engineering Mechanics	3/0/0	3	3	-	PCC	9,11,12
2.	22ME102	Engineering Drawing	2/1/0	3	3	-	ESC	4,9,12,13
3.	22MA105	Matrices and Calculus I	3/1/0	4	4	-	BSC	3,4,9
4.	22EE113	Fundamentals of Electrical and Electronics Engineering	2/1/0	3	3	-	ESC	7,9,11,12
5.	22PH104	Applied Physics	3/0/2	5	4	-	BSC	7,9,12
6.	22CS101	Problem Solving using C++	3/0/2	5	4	-	ESC	4,9
7.	22EE115	Fundamentals of Electrical and Electronics Engineering Laboratory	0/0/2	2	1	-	ESC	4,7,9
8.	22MC101	Induction Programme	3 WEEKS		0	-	MC	4,8
		Total	**18/3/6**	**27**	**22**	**-**		

SEMESTER II								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME201	Industrial Metallurgy	3/0/0	3	3	-	PCC	9,12
2.	22MA204	Calculus II and Transforms	3/1/0	4	4	-	BSC	4,9
3.	22TA101	Heritage of Tamils	1/0/0	1	1	-	HSMC	4,8,11,15,16
4.	22ME202	Manufacturing Technology I (with lab)	3/0/2	5	4	-	PCC	8,9,12
5.	22CH101	Engineering Chemistry	3/0/2	5	4	-	BSC	6,7,9
6.	22EN101	Technical Communication Skills	2/0/2	4	3	-	HSMC	4,9
7.	22CS201	Data Structures and Algorithms	3/0/2	5	4	-	ESC	4,9
8.	22MC102	Environmental Sciences	2/0/0	2	0	-	MC	3,6,7,12,13,15
		Total	**20/1/8**	**29**	**23**	**-**		

SEMESTER III								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME301	Engineering Thermodynamics	3/0/0	3	3	-	PCC	7,9,13
2.	22ME302	Solid Mechanics	3/0/0	3	3	-	PCC	9,13
3.	22MA305	Fourier Series and Partial Differential Equations	3/1/0	4	4	-	BSC	4,9,13
4.	22GE201	Universal Human Values	3/0/0	3	3	-	HSMC	3,4,10,11,12,13
5.	22TA201	Tamils and Technology	1/0/0	1	1	-	HSMC	4,8,9,10,11,12,13,14
6.	22ME303	Manufacturing Technology- II (with Lab)	3/0/2	5	4	-	PCC	8,9,12
7.	22IT311	Introduction to Python Programming	1/0/4	5	3	-	ESC	4,9
8.	22ME304	Strength of Materials Laboratory	0/0/3	3	1.5	-	PCC	9,12,15
9.	22ME305	Computer Aided Machine Drawing	0/0/3	3	1.5	-	PCC	9
		Total	**19/1/12**	**32**	**24**	**-**		

SEMESTER IV								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME401	Automobile Engineering	3/0/0	3	3	-	PCC	7,9
2.	22ME402	Mechanics of Machines	3/0/0	3	3	-	PCC	9
3.	22ME403	Fluid Mechanics and Machinery	3/0/0	3	3	-	PCC	6,9
4.	22ME404	Thermal Engineering	3/0/0	3	3	-	PCC	7,9,11,13
5.	22MA402	Probability and Computational Methods	3/1/0	4	4	-	BSC	4,8,9
6.	22XXZZZ	Open Elective – I	1/0/4 (or) 3/0/0	5 (or) 3	3 (or) 3	-	OEC	
7.	22ME405	Thermal and Fluid Mechanics Laboratory	0/0/3	3	1.5	-	PCC	7,9,12,13
8.	22ME406	Dynamics Laboratory	0/0/3	3	1.5	-	PCC	9
		Total	**18/1/10**	**29**	**22**	**-**		

SEMESTER V								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME501	Design of Machine Elements	3/0/0	3	3	-	PCC	9
2.	22ME502	CAD/CAM/CIM	3/0/0	3	3	-	PCC	9
3.	22ME503	Smart Factory	3/0/0	3	3	-	PCC	9
4.	22ME504	Heat and Mass Transfer	3/0/0	3	3	-	PCC	6,7,9
5.	22ME505	Metrology and Instrumentation (with Lab)	3/0/2	5	4	-	PCC	9,12
6.	22XXZZZ	Open Elective – II	1/0/4 (or) 3/0/0	5 (or) 3	3 (or) 3	-	OEC	
7.	22ME506	CAD/CAM Laboratory	0/0/3	3	1.5	-	PCC	9
8.	22ME507	Heat Transfer Laboratory	0/0/3	3	1.5	-	PCC	2,7,9
		Total	**18/0/12**	**30**	**22**	**-**		

SEMESTER VI								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME601	Design of Transmission Systems	3/0/0	3	3	-	PCC	9,11
2.	22ME602	Computational Mechanics	3/0/0	3	3	-	PCC	9,13
3.	22ME603	Simulation and Analysis Laboratory	0/0/3	3	1.5	-	PCC	9,11
4.	22ME604	Design Thinking and Mini Project	0/0/2	2	1	-	PROJ	9,17
5.	22EES01	Employability Enhancement Skills	-	-	2	-	EES	4,9,17
		Total	**18/0/5**	**23**	**20.5**	**-**		

SEMESTER VII								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME701	Industrial Engineering and Operations Management	3/0/0	3	3	-	HSMC	9,11
2.	22ME702	Mechatronics	3/0/0	3	3	-	ESC	9,13
		Total	**18/0/5**	**23**	**20.5**	**-**		

PROFESSIONAL ELECTIVE								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME901	ELECTRIC AND HYBRID VEHICLE TECHNOLOGY	3/0/0	3	3	-	PEC	7,9,11,13
2.	22ME902	AUTOTRONICS	3/0/0	3	3	-	PEC	3,7,9,11,13
3.	22ME903	ALTERNATE ENERGY SOURCE FOR AUTOMOBILES	3/0/0	3	3	-	PEC	7,9,13
4.	22ME904	AUTOMOTIVE COMPONENT MANUFACTURING	3/0/0	3	3	-	PEC	7,9,13
5.	22ME905	SMART AND INTELLIGENT MOBILITY	3/0/0	3	3	-	PEC	9,11,13
6.	22ME906	DRONE TECHNOLOGIES	3/0/0	3	3	-	PEC	9,11,12,13,15,16
7.	22ME907	DIGITAL MANUFACTURING	3/0/0	3	3	-	PEC	4,8,9,12
8.	22ME908	MODERN ROBOTICS	3/0/0	3	3	-	PEC	2,3,8,9,12,14,15
9.	22ME909	APPLIED HYDRAULICS AND PNEUMATICS	3/0/0	3	3	-	PEC	4,8,9,12
10.	22ME910	PLC SCADA	3/0/0	3	3	-	PEC	4,8,9
11.	22ME911	IMMERSIVE TECHNOLOGIES	3/0/0	3	3	-	PEC	4,8,9
12.	22ME912	COMPUTER INTEGRATED MANUFACTURING	3/0/0	3	3	-	PEC	8,9,12
13.	22ME913	COMPOSITE AND SMART MATERIALS	3/0/0	3	3	-	PEC	9,12
14.	22ME914	ADVANCED MANUFACTURING TECHNIQUES	3/0/0	3	3	-	PEC	9,12
15.	22ME915	FAILURE ANALYSIS AND NON-DESTRUCTIVE TESTING	3/0/0	3	3	-	PEC	9,12
16.	22ME916	GREEN AND SUSTAINABLE MANUFACTURING	3/0/0	3	3	-	PEC	3,11,12,13
17.	22ME917	ADDITIVE MANUFACTURING	3/0/0	3	3	-	PEC	9,12
18.	22ME918	DESIGN FOR MANUFACTURING AND ASSEMBLY	3/0/0	3	3	-	PEC	9,12
19.	22ME919	LEAN SIX SIGMA	3/0/0	3	3	-	PEC	9,12
20.	22ME920	INDUSTRIAL LAYOUT, SAFETY AND PRODUCTION MANAGEMENT	3/0/0	3	3	-	PEC	3,8,9,11,12

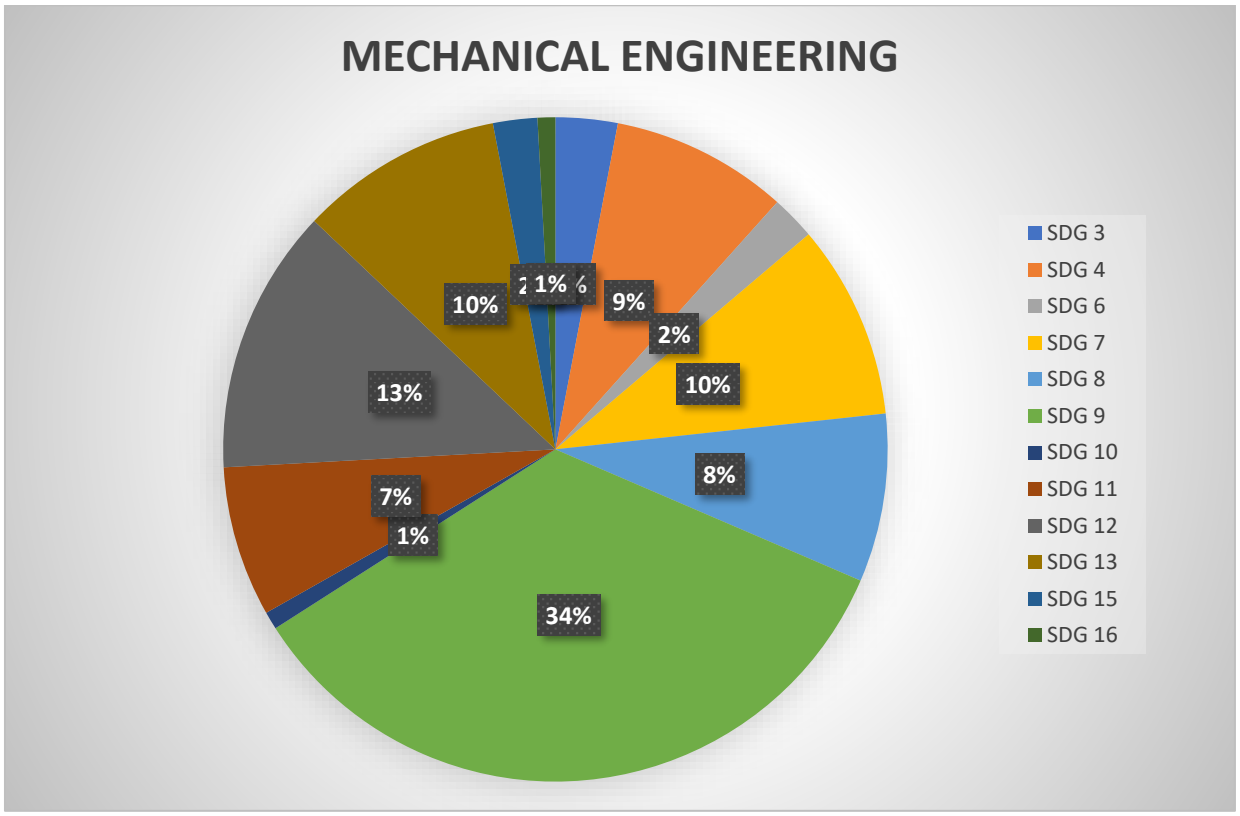
21.	22ME921	PRODUCT DESIGN AND DEVELOPMENT	3/0/0	3	3	-	PEC	8,9,12
22.	22ME922	ENTREPRENEURSHIP MANAGEMENT	3/0/0	3	3	-	PEC	4,8,9
23.	22ME923	SUPPLY CHAIN MANAGEMENT	3/0/0	3	3	-	PEC	9,12,13
24.	22ME924	SUSTAINABLE MANUFACTURING	3/0/0	3	3	-	PEC	8,9,12,13
25.	22ME925	POWER PLANT ENGINEERING	3/0/0	3	3	-	PEC	3,6,7,9
26.	22ME926	BIOENERGY CONVERSION TECHNOLOGIES	3/0/0	3	3	-	PEC	7,9,12,13
27.	22ME927	GAS DYNAMICS AND JET PROPULSION	3/0/0	3	3	-	PEC	7,9
28.	22ME928	HEATING, VENTILATION AND AIR-CONDITIONING SYSTEMS	3/0/0	3	3	-	PEC	7,9
29.	22ME929	RENEWABLE ENERGY TECHNOLOGIES	3/0/0	3	3	-	PEC	7,13
30.	22ME930	ENERGY STORAGE DEVICES AND THERMAL MANAGEMENT OF BATTERIES	3/0/0	3	3	-	PEC	7,9

OPEN ELECTIVE								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME001	INDUSTRIAL SAFETY	3/0/0	3	3	-	OEC	3,7,8,11,12
2.	22ME002	FUNDAMENTALS OF MEMS/NEMS	3/0/0	3	3	-	OEC	9
3.	22ME003	TOTAL QUALITY MANAGEMENT	3/0/0	3	3	-	OEC	9
4.	22ME004	PRODUCT DEVELOPMENT	3/0/0	3	3	-	OEC	9,12
5.	22ME005	FUNDAMENTALS OF ADDITIVE MANUFACTURING	3/0/0	3	3	-	OEC	9
6.	22ME006	TECHNOLOGY MANAGEMENT	3/0/0	3	3	-	OEC	8,9,12

EMERGING ELECTIVE								
SL. No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs./wk.**	**C**	**O**	**Cat.**	**SDG**
1.	22ME007	APPLIED SOFT COMPUTING TECHNIQUES	3/0/0	3	3	-	EEC	9
2.	22ME008	INTERNET OF THINGS FOR MECHANICAL ENGINEERS	3/0/0	3	3	-	EEC	9,11,13
3.	22ME009	DATA ANALYTICS FOR MECHANICAL ENGINEERS	3/0/0	3	3	-	EEC	9,12
4.	22ME010	EXPERT SYSTEM AND MACHINE LEARNING	3/0/0	3	3	-	EEC	9
5.	22ME011	PRODUCT LIFECYCLE MANAGEMENT	3/0/0	3	3	-	EEC	8,9,12

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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SDG 13
SDG 15
SDG 16

Semester – 01

22ME101	ENGINEERING MECHANICS	3/0/0/3

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

C101.1	Define and illustrate the basic concepts of force system	[U]
C101.2	Calculate the resultant force, moment and geometrical properties of 2D, objects	[Ap]
C101.3	Analyse the resistance force of objects for impending motion	[A]
C101.4	Determine the displacement, velocity and acceleration of particles and objects.	[Ap]
C101.5	Determine the dynamic forces exerted in various mechanisms of planar motion	[Ap]

Course Contents:

Equilibrium of Particles and Rigid Bodies : Force Systems – Basic concepts, Laws of Mechanics, Principle of Transmissibility, System of Forces, Coplanar Concurrent Forces, Resolution and resultant of several concurrent forces, Equilibrium of particles in 2D. Statics of
Rigid bodies in two dimensions- Varignon's theorem; Couples and Resultant of Force System, Equations of equilibrium of rigid bodies in 2D. Beams - 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, Parallel Axis theorem and perpendicular axis theorem, Moment of inertia of standard sections and composite sections (problems only); Introduction to Mass moment of inertia.
Friction: Types of friction, Limiting friction, Laws of friction – Static Friction-simple contact friction in blocks only.

Dynamics of Particles: Kinematics of Particles: Displacements, Velocity and acceleration, their relationship in linear motion (Horizontal only), projectile motion.
Kinetics of Particles: D'Alembert's principle and its applications; Work-kinetic energy, Impulsemomentum.

Total Hours:	**45**

Text Books:

1	Beer F.P, and Johnston ER, Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill Education, New Delhi, 2017.
2	Dhiman A.K, Dhiman P, Kulshreshtha D.C, Engineering Mechanics-Statics and Dynamics, McGraw Hill Education, 2017.

Reference Books:

1	Kottiswaran N, Engineering Mechanics - Statics and Dynamics, Sri Balaji Publications-2017.

2	R.S.Khurmi , A Textbook Of Engineering Mechanics, S Chand publications ,2018.
3	Meriam JL and Craige, “Engineering Mechanics statics and dynamics”, John Willey and Son’s publication, 9th edition.2021
4	Sanju Unadkat, “Engineering Mechanics”, Tech-Neo Publications-2020.
5	Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2016.
6	Timoshenko.S, “Engineering Mechanics”, McGraw Hill Education, 2017.
Web References:	
1	http://nptel.ac.in/courses/122104015/
2	http://nptel.ac.in/courses/112103109/
Online Resources:	
1	https://ocw.mit.edu/courses

22ME102	ENGINEERING DRAWING	2/1/0/3
Nature of Course	Practical Application	
Pre-Requisites	General Drawing skill	
Course Objectives:		
1	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**		
C102.1	Interpret and sketch the basic and intermediate geometries.	[U]
C102.2	Visualize and sketch the 2D diagram from 3D diagrams.	[A]
C102.3	Imagine the parametric features of solids.	[A]
C102.4	Envisage the sectional and lateral geometrical properties of solids.	[E]
C102.5	Interpret the isometric to orthographic projection and vice versa.	[C]
Course Contents:		
Concepts and conventions: Drafting instruments, BIS conventions, drawing sheets, general principles of projection: First angle projection - Layout of views. **(Not for examination)** **Manual drafting of the following using mini-drafter** **General Plane Curves:** Conic curves: ellipse and parabola by eccentricity method. Drawing normal and tangents to these curves, Involutes- Square and Circle, Simple Cycloid. **Orthographic projection**- Conversion of isometric/pictorial into orthographic views. **Projection of solids** (Solid axis inclined to any one reference plane)**:** Drawing front and top views of Prisms- Square, Pentagonal, hexagonal and circular prisms. Drawing front and top views of Pyramids - Square, Pentagonal, hexagonal and circular pyramids. **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 and Perspective projection basics. Introduction to CAD:** Basics of 2D and 3D modeling, Drafting of simple geometrics: Line, planes and simple 2D drawings. **(Not for examination).**		
	Total Hours:	**45**
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., 3e-2019.	
3	Parthasarathy N.S and Veera Murali, “Engineering Drawing”, Oxford University Press, 2015.	
4	Basant Agarwal and C M Agarwal., “Engineering Drawing”, 2e, McGraw Hill Education, 2019.	
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

22MA105	MATRICES AND CALCULUS I (COMMON TO MECH, MCT)	3/1/0/4

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

Course Objectives:

1.	To develop the skill to use matrix algebra techniques that are 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 the concepts of differential calculus which are 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.
5.	To make the student acquire sound knowledge of numerical techniques in solving ordinary differential equations that model engineering problems.

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

C105.1	Use the matrix algebra methods for solving practical problems	[R]
C105.2	Solve systems of linear equations and differential equations in numerical way.	[U]
C105.3	Implement the concepts of eigenvalues and eigenvectors in various Engineering problems.	[AP]
C105.4	Apply the concepts and principles of differential calculus to find the curvature of different curves.	[AP]
C105.5	Find the solution to second and higher order differential equations and to apply numerical techniques to analyse and visualize data to solve basic engineering-related problems.	[AP]

Course Contents

MODULE I - MATRICES **(20 Hrs)**

Definition – Types of matrices – Characteristic equation – Eigenvalues and Eigenvectors of a real matrices and their properties (excluding proofs) – Orthogonal transformation of a real symmetric matrix to diagonal form – Quadratic form– Reduction of quadratic form to canonical form by Orthogonal transformation– Nature of Quadratic forms – Cayley Hamilton Theorem(excluding proof) – Applications of Cayley Hamilton theorem in finding inverse and higher powers - Solution of linear system by Gauss Elimination method – Gauss Seidel iterative method – Eigenvalue of a matrix by Power method.

MODULE II - APPLICATIONS OF DIFFERENTIAL CALCULUS **(20 Hrs)**

Curvature, Centre, Radius and Circle of curvature in cartesian co-ordinates – Evolutes – Envelopes – Evolute as envelope of normals.

MODULE III - ORDINARY DIFFERENTIAL EQUATIONS **(20 Hrs)**

Second and Higher order linear differential equations with constant coefficients – Second and Higher order linear differential equations with variable coefficients – Euler Cauchy's and Legendre's linear equations – Numerical solutions for ordinary differential equations: Taylor series method – Euler's method – Modified Euler's method – Fourth order Runge Kutta method for solving first order equations–Milne's and Adams's predictor and corrector methods.

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 2020.
3.	Grewal. B.S, “Higher Engineering Mathematics”, 44rd edition, Khanna Publications, Delhi, 2021.
4.	Grewal. B. S, “Numerical methods in Engineering and Science”, Khanna Publications, Delhi, 2016.
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, 5th edition, 2018.
3.	N.P. Bali and Dr. Manish Goyal,” A Text book of Engineering Mathematics” 10th edition, Laxmi publications ltd, 2020.
Web References:	
1.	https://nptel.ac.in/courses/111105121
2.	https://nptel.ac.in/courses/111106100
3.	https://nptel.ac.in/courses/111107106
4.	https://nptel.ac.in/courses/111107107
Online Resources:	
1.	https://www.coursera.org/learn/matrix-algebra-engineers
2.	https://www.coursera.org/learn/differentiation-calculus
3.	https://www.coursera.org/lecture/discrete-calculus/numerical-o-d-e-s-cre5Q
4.	https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/

22EE113	Fundamentals of Electrical and Electronics Engineering (Common to MECH and CIVIL)	2/1/0/3

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

Course Objectives:

1	To import the students with a basic understanding of Electrical circuits.
2	To learn the working principle of static machine.
3	To understand the rotating Machines 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.

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

C113.1	Analyze the concepts in AC circuit and DC circuits.	[A]
C113.2	Examine the working principle of Static machines.	[A]
C113.3	Demonstrate the working principle of Rotating machines.	[U]
C113.4	Utilize the basic components for Electrical installations.	[AP]
C113.5	Interpret the basic devices in Electronics and Instrumentation.	[A]

Course Contents:

Course Contents:

Module I: DC Circuits and AC Circuits **15 Hrs**

DC Circuits - Electrical circuit elements (R, L and C) - Voltage and Current Sources - Kirchoff's current and voltage law - analysis of simple circuits with DC excitation - Mesh and Nodal Analysis. **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 and RC. Three phase balanced circuits - Voltage and Current relations in star and delta connections.

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

Static machines: BH characteristics, construction & working principle of single-phase and three phase transformers. Rotating machines: Generation of rotating magnetic fields, construction and working principle of DC machines, three-phase induction motor and synchronous motor. Components of LT Switchgear - Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Domestic wiring, Types of Wires and Cables, Earthing.

Module III: Fundamentals of semiconductor devices and Instrumentation **15 Hrs**

Semiconductor - PN junction diode - Zener diode - Bipolar Junction Transistor Introduction - Field Effect Transistor Introduction - Construction and characteristics of JFETs - MOSFET - Depletion type MOSFET, Enhancement type MOSFET, Transfer characteristics. Sensors, Solenoids, Pneumatic controls with electrical actuator, Mechatronics, types of valves and its applications, Electro-Pneumatic systems, Proximity sensors, Limit switches.

Total Hours	**45**

Text Books:

1	Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 7th edition, 2020.
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 Graw Hill, 2013.

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, Revised 1st edition 2017,
3	Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, ‘Electronic Devices and Circuits’, Pearson Education, 6th edition, 2013.
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	http://www.electrical-knowhow.com/
2	https://www.edx.org/course/electricity-magnetism-part-1-ricex-phys102-1x-1
3	https://www.mooc-list.com/course/fundamentals-electrical-engineering-coursera
4	https://nptel.ac.in/course.php

22PH104	APPLIED PHYSICS (Common to MECH. MCT and CIVIL)	3/0/2/4

Nature of Course	: E (Theory skill based)
Prerequisites	: Nil

Course Objectives:

1	To enable the students to understand the basics of harmonic oscillator and Laser.
2	To learn the basic concepts of Electromagnetic waves
3	To familiarize the principle of Quantum mechanics and crystallography.

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

C104.1	Understand the physical characteristics of Simple harmonic oscillation	[U]
C104.2	Recall the basic concept and applications of laser.	[R]
C104.3	Describe the basic principles of Electromagnetic waves, sensors and transducers.	[U]
C104.4	Interpret the central concepts and principles in quantum mechanics, such as the Schrödinger equation and the wave function.	[AP]
C104.5	Estimate the Atomic packing, acquire the basic knowledge about Crystal Lattice and Unit cell.	[AP]

Course Contents:

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 considerations, comparison with un-damped harmonic oscillator, logarithmic decrement, relaxation time, quality factor. **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: CO_2 laser - Semiconductor Laser (Homo-junction and Heterojunction), – Qualitative industrial applications of lasers: welding, drilling and cutting.

Electromagnetic waves: ***15 Hours***

Concept of Del operator, gradient, divergence and curl operators and their physical significances - Gauss divergence theorem, Stokes theorem.

Laws of Electromagnetism: Gauss law of electricity, Gauss law of magnetism, Faraday' law of electromagnetic induction, Ampere's circuital law- (Derivation only) – Dielectrics: Concept of different charge and current densities - free charges, bound charges; Maxwell's equations in free space and dielectric medium (equations only). **Sensors and Transducers:** Introduction, Classification of Transducers - Transducers Actuating Mechanisms - Resistance Transducers - Piezoelectric Transducers, Thermoelectric Transducers - Photoelectric Transducers.

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 – Problems - Crystal imperfections: point & line - burger vector. Basic concepts of band theory and classification of materials into conductor, semiconductor and insulator.

45 Hours

Lab Component ***30 Hours***

1	Determination of frequency of transverse and longitudinal wave modes – Melde's experiment.	[E]

2	Determination of characteristics of Simple harmonic motion – Simulation lab.	[E]
3	Determination of laser parameter	[E]
4	Determination of optical fiber parameters.	[E]
5	Determination of characteristics of LCR circuits.	[E]
6	Determination of characteristics of RC circuit to find the time constant	[E]
7	Determination of Magnetic field along the axis of current carrying coil- Stewart and Gee method.	[E]
8	Determination of Planck's Constant.	[E]
9	Determination of Stefan's Constant.	[E]
10	Determination of lattice constant of cubic crystal structure.	[E]
	Life Skills Experiments	
11	Determination of pressure required to shut off the fuel pump nozzle.	[E]
12	Determination of capacitance required to shut off the circuit in a circuit breaker.	[E]
13	Determination of earth, neutral and phase line in a circuit.	[E]
	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
4	David J. Griffiths, "Introduction to Quantum Mechanics", 2nd edition, Cambridge university press, 2017.
5	Chris Bernhardt, "Quantum Computing for Everyone" The MIT press, 2019
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

22CS101	Problem Solving using C++	3/0/2/4
Nature of Course	C (Theory Concept), K (Problem Programming)	
Pre requisites	NIL	

Course Objectives:

1	To learn the fundamental programming concepts and methodologies which are essential to build good C++ programs.
2	To gain knowledge on control structures and functions in C++.
3	To provide the basic object-oriented programming concepts and apply them in problem solving.
4	To introduce file streams and operations for storing data permanently.
5	To know generic programming paradigm.

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

C101.1	Solve problems using operators and control Statements.	[AP]
C101.2	Write C++ programs for processing strings and arrays.	[AP]
C101.3	Apply the concepts of pointers and functions in programs.	[AP]
C101.4	Develop C++ programs using various object-oriented concepts to solve real world problems.	[A]
C101.5	Implement the concepts on file streams and operations.	[AP]

Course Contents:

Module I C++ Programming Fundamentals **15 Hours**

C vs C++, Basic of OOPS, the main () function, Header files, Basic Input and Output (I/O) using cin and cout, Variable, Constant. **Operators:** Arithmetic Operators, Assignment Operators, Relational Operators, Logical Operators, Bitwise Operators, Other Operators, Operator Precedence. Control Statements: if, if...else and Nested if...else, switch..case, break and continue, Loops - for loop, while loop, do while loop, goto. **Arrays and Strings:** 1D array, 2D array, Strings, String functions. **Function:** Basics, call by value, call by reference & return by reference, Inline function, overloading Functions, inline Functions, Recursive Functions. **Pointers:** Pointer, Dynamic Memory Allocation.

Module II Object Oriented Concepts **15 Hours**

Classes and Objects, public, private, protected. **Constructors and destructors**: Overloaded Constructor, Copy Constructor, Shallow Copying Deep Copying. **Overloading:** this' Pointer, structs vs Classes, Friends of a class, Operator Overloading, Inheritance, Overloading vs Overriding, Polymorphism, Virtual Functions, Pure Virtual Functions and Abstract Classes.

Module III Files and Generic Programming **15 Hours**

Abstract Classes as Interfaces, Exception, Files, Streams and I/O, STL, Generic Programming, Lambda Expression.

Total Hours (Theory)	**45 Hours**

Lab Component

S.No.	Lab Exercise
1.	Practice of C Programming using Branching and Iterative constructs.
2.	Programs using arrays and strings
3.	Programs using Functions
4.	Programs using Structures and Pointers.
5.	Programs using classes and objects
6.	Programs using constructor and destructor
7.	Programs using method overloading, operator overloading and polymorphism concepts.
8.	Programs using friend class
9.	Programs using virtual functions and abstract class.

10.	Programs using inheritance concepts
11.	Programs using exception handling concept
12.	Programs using Files.
13.	Mini project
Total Hours (Lab)	**30 Hours**
Total Hours (45+30)	**75 Hours**
Text Books:	
1.	E Balagurusamy,"Object Oriented Programming With C++", 4th Edition, Tata McGraw-Hill Education, 2008.
2.	YashavantP. Kanetkar, "Let us C++", BPB Publications, 2020.
3.	M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2011.
Reference Books:	
1.	Herbert Schildt, "The Complete Reference C++", 4th edition,MH, 2015.
2.	John Hubbard, "Schaum's Outline of Programming with C++", MH, 2016.
Web References:	
1.	https://www.geeksforgeeks.org/c-plus-plus/
2.	http://web.stanford.edu/class/cs106l/
Online Resources:	
1.	https://nptel.ac.in/courses/106101208
2.	https://www.hackerrank.com/domains/cpp
3.	https://codeforces.com/blog/entry/74684
4.	https://www.hackerearth.com/practice/notes/tricky-and-fun-programming-in-c/

22EE115	Fundamentals of Electrical and Electronics Engineering Laboratory (Common to MECH and CIVIL)	0/0/2/1
Nature of Course	: M (Practical application)	
Pre-requisites	: Nil	

Course Objectives:

1	To learn the safety precautions and troubleshooting in using Electricity.
2	To estimate the current flow and voltage across the circuit elements under different loading conditions.
3	To understand the basic components for electrical installations.

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

C115.1	Illustrate Electrical and Electronic components and its specifications.	[U]
C115.2	Verify the current flow and voltage across the circuit elements using different analysis method.	[A]
C115.3	Measure power and power factor of single and three phase AC circuits.	[AP]
C115.4	Comprehend the cut-out sections of DC Motor and Induction Motor.	[U]
C115.5	Utilize the basic components for electrical installations.	[AP]

Course Contents:

S.No	Listof Experiments	CO Mapping	RBT
1	Demonstration of meters, electrical and electronic components with specification.	C115.1	[U]
2	Safety precautions with electrical components.	C115.1	[U]
3	Troubleshooting of electrical equipment.	C115.1	[A]
4	Testing of CRO and Electronic components using Multimeter.	C115.2	[A]
5	Determination of mesh current by Mesh Analysis.	C115.2	[A]
6	Estimation of Voltage and Current in star and delta connections.	C115.2	[A]
7	Measurement of power and energy.	C115.3	[A]
8	Soldering practice - Components devices and Circuits using general purpose PCB.	C115.5	[A]
9	Residential house wiring.	C115.4	[A]
10	Demonstration of cut-out sections of DC Motor and Induction Motor.	C115.3	[U]
11	Demonstration of components of LT Switch Gears.	C115.5	[U]
12	Familiarization of digital basic gate ICs.	C115.5	[U]
	Total Hours	**30**	

Text Books:

1	Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 7th edition, 2020.
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 Graw Hill, 2013.

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, Revised 1st edition 2017,
3	Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, 'Electronic Devices and Circuits', Pearson Education, 6th edition, 2013.

22VA130	EFFECTIVE COMMUNICATION SKILLS (MECH/MCT/AI&DS/CIVIL/CYBER)	2/0/0/0
Nature of Course	E (Theory skill based)	
Pre-Requisites	Basics of English Language	

Course Objectives:

1	To become self-confident individuals by mastering interpersonal skills, team management skills, and leadership skills.
2	To develop effective communication skills.
3	To train students to use the language with confidence and without committing errors.
4	To improve the fluency of the students when speaking English.
5	To focus on pronunciation, dialect, intonation, interaction, practice and communication.

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

C101.1	Remember correct usage of English grammar in speaking.	[U]
C101.2	Apply and improve their speaking ability in English both in terms of fluency and comprehensibility.	[AP]
C101.3	Understand and communicate effectively in personal and professional situations.	[U]
C101.4	Understand and analyzeoral presentations and receive feedback on their performance.	[U]
C101.5	Apply reading fluency skills through extensive reading.	[AP]

Course Contents:

Module I **10 Hours**

Pre-Test - Vocabulary Building- Connecting Phrases- Exercises and **Activities-Conversation Practices-** Greetings-exchanging ideas - Asking for information - questioning techniques / answering techniques - Getting people to do things - requesting/agreeing/refusing – **Activity Common Expressions** (Individual)- Talking about Favorites - Talk Show **Activity** - **Impromptu Speaking-** Personal Interest - Talking about Past Events and Future/Talking about Everyday Life (Family, Hobbies, Work, Travel and Current Events) – **Activity.**

Module II **10 Hours**

Listening- Trials of a Good Listener- Listening to Texts, Listening for Specific Purpose- **Activity-21st Century Skills**– Communication with Critical Thinking and Creativity-Role Play-**ActivityPersonality Development**- Manners and Etiquettes. Building Confidence and Developing Presentation Skills-**Activity**- **Singing a Song (Group)**- **Activity**.

Module III **10 Hours**

Story Telling- Use of Charts and Graphs-**Activity -Persuasive Speech**- Handling CriticismJustifying Opinions-Conflict-Resolution-Situational Role Play **Activity--News reading and Pronunciation**- **Activity** -**Satori**- Intuitive Approach-**Activity**-**Post Test.**

30 Hours

Total Hours:	**30**

Text Books:

1	English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel) 2010
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	Busch, B., & Oakley, B. (2017). Emotional intelligence: why it matters and how to teach it. Retrieved from https://www.theguardian.com/teachernetwork/2017/nov/03/emotional-intelligence-why-it-matters-and-how-to-teach-it.
3	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
Web References:	
1	https://www.udemy.com/course/english-speaking-complete/
2	https://www.cambridgeenglish.org/exams-and-tests/linguaskill/
Online Resources:	
1	https://www.lingoda.com/en/linguaskill-from-cambridge/
2	https://www.icd.org.pk/linguaskill/

Semester – 02

22ME201	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		
C201.1	Recall the different types of materials, bonding of materials and their properties.	[R]
C201.2	Discuss the crystallization mechanisms	[U]
C201.3	Understand the phase diagrams and the use of phase diagrams.	[U]
C201.4	Identify and apply the heat treatment processes and coatings to modify the properties of materials.	[Ap]
C201.5	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 and scanning electron 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

22TA101	HERITAGE OF TAMILS	1/0/0/1
Nature of Course:	C (Theory Concept)	
Pre requisites:	NIL	

Course Objectives:

1	To know various concepts of Tamil Language families.
2	To know about the essentialities of Heritage.
3	To understand the Aram concepts of Tamils and the cultural influence.

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

C101.1	Know about the language families in India, impact of religions and the contribution of Bharathiyar and Bharathidhasan.	[U]
C101.2	Observe the growth of sculpture, making of musical instruments and the role of temples in socio and economic lives.	[U]
C101.3	Understand the significance of folklore and martial arts.	[U]
C101.4	Learn the sangam literature, sangam age and overseas conquest of Cholas.	[U]
C101.5	Understand the contribution of Tamils to Indian Freedom Struggle, role of Siddha medicine and print history of Tamil Books.	[U]

Course Contents:

Language and Literature: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

Heritage - Rock Art Paintings to Modern Art – Sculpture: Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils. **Folk And Martial Arts:** Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

Thinai Concept Of Tamils - Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas. Contribution of Tamils to Indian national movement and indian culture: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

Total Hours:	**15**

Text-cum-Reference Books:

1	தமிழக வரலாறு – மக்களும் பண் பாடும் – கே. கே. பிள்ளள (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் – முனனெர் இல. சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – னெனக நதிக்கனரயில் சங்ககால நகர நாகரிகம் (வதால்லியல் துனற வெளியீடு)
4	வபாருனந – ஆற்றங்கனர நாகரிகம். (வதால்லியல் துனற வெளியீடு)

5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22ME202	MANUFACTURING TECHNOLOGY – I (WITH LAB)	3/0/2/4
Nature of Course	Theory concepts and lab	
Pre Requisites	Nil	
Course Objectives:		
1	To make the students understand the various manufacturing processes available to produce the desired components	
2	To impart the methodologies to be followed in casting, fabrication and forming of engineering materials	
3	To enable the students to select a particular 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	Determine the appropriate casting techniques for various materials and components	[Ap]
C202.3	Recommend the suitable welding process for an application	[E]
C202.4	Apply a suitable metal forming processes or other manufacturing processes for making an industrial component	[Ap]
C202.5	Explore the possible defects and its causes in various manufacturing processes.	[A]

Course Contents:

METAL CASTING AND PLASTIC MOULDING PROCESSES: Metal casting processes: 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 - Casting techniques - shell moulding, Investment casting, pressure die casting processes, centrifugal casting. **Plastic moulding processes** - 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 – 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 MANUFACTURING TECHNIQUES:** Powder metallurgy - compaction, sintering, introduction to additive manufacturing.

22MA204	CALCULUS II AND TRANSFORMS (COMMON TO MECH, MCT)	3/1/0/4

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

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 familiarize with the concepts of vector calculus needed for problems in all engineering disciplines.
4	To investigate the purpose of using transforms to create a new domain in which it is easier to handle problems.
5	To impart the knowledge of Laplace transform, to find solutions of initial value problems for linear ordinary differential equations.

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

C204.1	Determine the area and volume by applying the techniques of double and triple integrals.	[R]
C204.2	Develop the understanding of integration techniques needed for problems in engineering disciplines.	[U]
C204.3	Apply multiple integral ideas in solving areas, volumes and other practical problems.	[AP]
C204.4	Differentiate and integrate a vector-valued functions to solve real world applications	[AP]
C204.5	Apply Laplace transform methods for solving linear differential equations.	[AP]

Course Contents

MODULE I - MULTIPLE INTEGRALS **(20 Hrs)**

Definite integrals: Evaluation of definite integrals using Bernoulli's formula –Beta and Gamma function – Double integration in Cartesian coordinates – Area as double integral – Triple integration in Cartesian coordinates –changing the order of integration in Cartesian coordinates - Volume as triple integral – Numerical integration: Trapezoidal rule and Simpson's rule for single and double integrals.

MODULE II - VECTOR CALCULUS **(20 Hrs)**

Vector differential operator – Gradient and Directional derivatives – Angle between the surfaces – Divergence and Curl – Scalar potential – Equation of the tangent plane and normal line – Irrotational and Solenoidal vector fields –Vector integration: Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

MODULE III - LAPLACE TRANSFORMS **(20 Hrs)**

Convergence of Laplace transform – Transform of some standard functions (concepts of Ramp signal, Sinusoidal signal and Exponential signal)-Unit step function – Unit Impulse function – Properties – Shifting theorem –Transforms of derivatives and integrals –Initial and final value theorem – Transform of periodic functions – Inverse Laplace transform – Partial fraction method – Convolution theorem – Solution of second order linear ordinary differential equations using Laplace Transform.

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 2020.
3.	Grewal. B.S, “Higher Engineering Mathematics”, 44th edition, Khanna Publications, Delhi, 2021.
4.	Grewal. B. S, “Numerical methods in Engineering and Science”, Khanna Publications, Delhi, 2016.
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, 5th edition, 2018.
3.	N.P.Bali and Dr.ManishGoyal,”A Text book of Engineering Mathematics” 10th edition, Laxmi publications ltd, 2020.
Web References:	
1.	https://ocw.mit.edu/courses/18-02sc-multivariable-calculus-fall-2010/
2.	https://archive.nptel.ac.in/courses/111/107/111107108/
3.	https://archive.nptel.ac.in/courses/111/106/111106139/
Online Resources:	
1.	https://www.coursera.org/learn/integration-calculus
2.	https://www.coursera.org/learn/vector-calculus-engineers
3.	https://www.coursera.org/learn/differential-equations-engineers

22CH101	ENGINEERING CHEMISTRY Common for all B.E/ B.Tech Engineering Courses (Except CSBS & M.Tech CSE)	3 /0 /2 /4

Nature of Course	: E (Theory Skill based)
Pre requisites	: NIL

Course Objectives:

1	To understand the principles and applications of electrochemistry and to learn electroanalytical methods.
2	To learn the effect of corrosion in materials and the methods for prevention of corrosion.
3	To understand the basic concepts, synthesis, and applications of nanomaterials. To
4	explore the synthesis and properties of important engineering plastics and energy sources.
5	To understand the concepts of photophysical and photochemical processes in spectroscopy.

Course Contents

Electrochemistry and Corrosion: Electrochemistry-Introduction***,*** Oxidation and reduction potentials-Free energy and emf, cell potentials, Nernst equation and applications. Reference electrodes-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Electrochemical cells-electrolytic cell-reversible and irreversible cells. Water treatment-characteristics of water-hardness-types and estimation of hardness by EDTA method with numerical problems. Importance of corrosion-types–mechanism of dry and wet corrosiongalvanic corrosion-differential aeration corrosion. Corrosion protection-electroplating of Chromiumelectroless plating of Nickel.

15 hours

Nano-Chemistry and Energy sources: Nano Chemistry-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-Solid oxide and polymer electrolytes in H_2-O_2 fuel cell. Storage Devices-Batteries- Alkaline-Lead acid, Nickel cadmium and Lithium-ion batteries.

15 hours

Polymer chemistry and Spectroscopic techniques: Introduction-monomers and polymersclassification of polymers-Degree of Polymerization (Simple problems). 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).

15 hours

Field work:
Industrial visit- Moulding and spectroscopic techniques

Theory: **45 hours**

Lab Components: **30 hours**

1	Determination of total, temporary, calcium and magnesium hardness of water sample by EDTA method.	[E]
2	Estimation of alkalinity of water sample.	[E]
3	Estimation of dissolved oxygen in water.	[E]
4	Potentiometry- determination of redox potentials and emf's.	[E]
5	Conductometric titration-mixture of acids vs NaOH.	[E]
6	Determination of strength of strong acid by pH-metry.	[E]

7	Determination of corrosion rate of mild steel in acid medium.	[E]
8	Electroplating of nickel over copper.	[E]
9	Spectrophotometry-Estimation of iron in water.	[E]
10	Determination of single electrode potential of Zinc and Copper by given solution.	[E]
	Total Hours:	**75**
Understanding the concepts by simple Demonstrations/Experiments:		
11	To detect the chlorine content in tap water using simple chemical method.	
12	To know the presence of dissolved oxygen in given water sample using glucose by redox principle.	
13	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, DhanpatRai 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	Nanochemistry, 2nd Edition by K. Klabunde, G. Sergeev Springer Publisher, 2013.	
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	Introduction to Nano: basics to Nanoscience and Nanotechnology, by Sengupta, Amretashis, Sarkar, Chandan Kumar, Springer Publisher, 2015.	
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	www.edx.org/	
5	https://www.ntnu.edu/studies/courses	
6	www.corrosionsource.com/	

22EN101	TECHNICAL COMMUNICATION SKILLS (MCT/CIVIL/IT/EEE/ECE/AI&DS/CYBER/CSE/CSD) (SEMESTER I) (MECH- SEMESTER II)	2/0/2/3

Nature of Course	Theory Skill Based
Pre requisites	Basics of English Language

Course Objectives:

1	To enhance learners' LSRW skills.
2	To develop students' ability to understand the process of communicating and interpreting ideas and human experiences.
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.	[R]
C101.2	Apply communication skills in a corporate environment.	[AP]
C101.3	Understand and communicate effectively in personal and professional situations.	[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]

Course Contents:

Module I **10 Hours**

Introduction-Listening: - Listening to News in NDTV and Times Now Channels. **Speaking**: Introduction to Effective Communication - Barriers to Effective Communication- Tips to develop Communication Skills - Self Introduction - Overview of Business Communication-Short Talk on Business Topics -Impromptu Speaking (Public Speaking) - Non-Verbal Communication-SATORISharing Personal Information-**Reading**: Reading Comprehension- Values and its Importance. **Writing**: SWOT Analysis -Book Review - Movie Review-Vocabulary Building.

Module II **10 Hours**

Listening: Listening to Specific Information. **Speaking**: Speaking on Specific Information. **Reading**: Skimming and Scanning-Reading Short Texts - Comparing Facts and Figures - Short Stories and Scientific Articles. **Writing**: Good and Bad Writing- Note Making - Writing Formal Letters (Inviting, Accepting and Declining Invitations)- Writing Business Letters (Calling for Quotations, Seeking Clarifications, Placing an Order and Complaint Letter)- Transcoding (Bar chart, Flowchart. Pie chart and Table)-Job Application Letter- Resume Writing.

Module III **10 Hours**

Listening: Listening to Narrations and Persuasive speech and identifying narrative and persuasive techniques. **Speaking**: 21st Century Skills- Narrative Skills- Leadership- Conflict ResolutionPersuasive Speaking-How to Tell a Story with Charts and Graphs **Reading:**Product Description and Product Review. **Writing**: Email Writing –Advantages and Disadvantages- Circular – Agenda and Minutes of the Meeting - Proofreading- Subject Verb Agreement-Tenses-Active Voice-Passive Voice- Impersonal Passive Voice-Report Phrases – Report Writing.

(**30 Hours)**

Lab Components		
1	Listening Comprehension 1.News in NDTV and Times Now Channels 2.Listening to Specific Information	[AP]
2	Impromptu Speaking	[AP]
3	Reading Comprehension related to Competitive Exams	[U]
4	Immersion Activity and Presentation	[AP]
5	Group Discussion	[AP]
6	Group Assignment – Form an NGO	[AP]
		15 Hours
	Total Hours:	**30+30=60 Hours**
Text Books:		
1	Basic Communication Skills for Technology, by Andrea J Rutherford, Pearson Publishers.2000	
2	Remedial English Grammar. F.T. Wood. Macmillan.2007	
3	Oxford Guide to Effective Writing & Speaking by John Seely, Oxford University Press.2005	
4	Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.	
Reference Books:		
1	Touchstone Student's Book 1 by Michael McCarthy, Jeanne McCarten, Helen Sandiford, Cambridge University Press.2005	
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.	
3	Touchstone Student's Book 2 by Michael McCarthy, Jeanne McCarten, Helen Sandiford, Cambridge University Press.2015	
Web References:		
1	http://www.academiccourses.com/Courses/English/Business-English	
2	https://www.liveworksheets.com/worksheets/en/English_as_a_Second_Language_(ESL)/Technical_English	
Online Resources:		
1	https://www.coursera.org/specializations/business-english	
2	https://www.businessenglishresources.com/learn-english-for-business/studentsection/practice-exercises-new/	

22CS201	DATA STRUCTURES AND ALGORITHMS	3/0/2/4
Nature of Course:	F(Theory Programming)	
Pre requisites:	Problem Solving using C++	

Course Objectives:

1.	To introduce list data structure and its applications.
2.	To impart the importance of stacks and queues in problem solving.
3.	To provide knowledge on Tree and Graph data structures.
4.	To discuss the role of hashing in information storage and retrieval.

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

C201.1	Demonstrate the knowledge of basic data structures such as array and Linked List.	[AP]
C201.2	Solve real world problems efficiently by applying stack and queue data structures.	[AP]
C201.3	Illustrate the applications of tree and trie data structures.	[AP]
C201.4	Evaluate the performance of hashing algorithms in information storage and retrieval.	[A]
C201.5	Employ graph algorithms for solving real time computing problems and analyze them.	[A]

Course Contents:

Module I Linear data structures **15 Hours**

Linked List: Array vs Linked list - Types of linked list - Singly, Doubly and Circular Linked list - Applications of linked list. **Stack:** Array and Linked list implementation of Stack –Applications of Stack - Infix, Prefix and Postfix expressions - Expression Evaluation. **Queue:** Array and Linked list implementation of Queue -Priority Queue - Applications of Queue.

Module II Trees and hashing **15 Hours**

Trees: Binary Tree - Binary Search Tree - Insertion, Deletion, Traversal - Inorder, Preorder, Postorder, Level order traversal. **Tries:** Introduction to Tries, making a trie node, Insert, Search and Remove operation in Tries. **Hashing:**Direct Address Table, open hashing-separate chaining, closed hashing - linear probing, quadratic probing, double hashing- Collision handling.

Module III Graph data structures **15 Hours**

Graphs: Weighted and Directed graphs - Adjacency matrix and list implementation - Traversal – Breadth First Search& Depth First Search. **Graph Algorithms:** Minimum spanning Tree – Prim's and Kruskal's algorithms, Dijkstra's Shortest path algorithm.

Total Hours (Theory): 45 Hours

Lab Component

S. No.	Lab Exercises
1	Implementation of Singly, Doubly and Circular Linked List.
2	Implementation of Stack using Arrays and Linked List.
3	Implementation of Stack applications
4	Implementation of Queue using Arrays and Linked List.
5	Implementation of Priority Queue.
6	Implementation of Queue applications.
7	Implementation of Hashing techniques
8	Implementation of Binary Search Tree.
9	Implementation of Graph Traversal algorithms
10	Implementation of Minimum spanning tree algorithms
11	Implementation of Dijkstra's Shortest path Algorithms.

12	Implementation of Trie data structure	
	Total Hours (Lab):	**30 Hours**
	Total Hours: (45+30)	**75 Hours**
Text Books:		
1	Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, Silicon paper publications, 2004.	
2	Anany Levitin, Introduction to the design & analysis of algorithms , 3rd Edition, Pearson Education, 2021.	
3	Michael T. Goodrich, “Data Structures and Algorithms in C++”, 2nd Edition, Wiley Publication, 2011.	
Reference Books:		
1	Seymour Lipschutz, “Data Structures by Schaum Series”,2nd edition, Tata McGraw Hill, 2013.	
2	Narasimha Karumanchi, “Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles”,5th Edition, Career Monk,2016.	
3	Debasis Samanta, “Classicdatastructures”, Prentice Hall of India,2nd edition,2014.	
Web References:		
1	https://www.codingninjas.com/courses/c-plus-plus-data-structures-and-algorithms	
2	https://www.edx.org/course/data-structures-algorithms-using-c	
Online Resources:		
1	https://www.programiz.com/dsa l	
2	https://freevideolectures.com/course/2519/c-programming-and-data-structures	
3	https://www.cprogramming.com/algorithms-and-data-structures.html	

22MC102	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

C201.1	Recall and play an important role in transferring a healthy environment for future generation.	[R]
C201.2	Illustrate the importance of natural resources and conservation of biodiversity.	[U]
C201.3	Interpret and analyze the impact of engineering solutions in a global and societal context.	[U]
C201.4	Apply the gained knowledge to overcome pollution problems.	[AP]
C201.5	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. Soil pollution - Solid waste management-Recycling of plastics-Pyrolysis method- causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazards-case studyChernobyl 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.

Total Hours:	**30**

Text Books:

1	AnubhaKaushik and C P Kaushik “Perspectives in Environmental Studies”4th Edition, Newage 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

Semester – 03

22GE201	UNIVERSAL HUMAN VALUES (Common to all branches)	3/0/0/3

Nature of Course	Descriptive
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 and take responsibilities in life and handle problems to attain sustainable solutions while keeping human relationships and human nature in mind.	[U]
C201.2	Apply responsibilities towards their commitments (human values, human relationship and human society).	[AP]
C201.3	Apply what they have learnt to their own self indifferent day-to-day settings in real life, atleast a beginning would be made in this direction.	[AP]
C201.4	Analyze ethical and unethical practices, and formulate strategies to actualize a harmonious environment wherever they work.	[AN]
C201.5	Understand the harmony in nature and existence, and work out mutually on fulfilling participation in nature.	[U]

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education, Understanding Harmony in the Human Being-Harmony in Myself!

15 Hours

Self-evaluation of the students- Pre-test of UHV- Purpose and motivation for the course.SelfExploration–Its content and process- A look at basic Human Aspirations. Understanding Happiness and Prosperity correctly-Understanding the needs of Self('I') and 'Body'Understanding the Body as an instrument of 'I'(being the doer, seer and enjoyer)-Understanding the characteristics and activities of 'I' and harmony in 'I' - Understanding theharmony of'I' with the Body- Social activities – Waste Management - Water Conservation-Soil Pollution - Physical Health and related activities - Lectures by eminent persons- Literary activities.

Module 2: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship, Understanding Harmony in the Nature and Existence- Whole existence as Coexistence

15 Hours

Understanding values in human relationship - Understanding the harmony in the society (society being an extension of family): - Visualizing a universal harmonious order in society-Understanding the harmony in Nature -Understanding Existence as Coexistence of mutually Interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence-Buddy program-

Relationships-Homesickness- Managing peer pressure-ProjectsSocially responsible engineers- Visit to local areas (orphanages, special children)- Physical activities(games).

Module 3: Implications of the above Holistic Understanding of Harmony on Professional Ethics

15 Hours

Natural acceptance of human values- Definitiveness of Ethical Human Conduct- Basis for Humanistic Education-Humanistic Constitution and Humanistic Universal Order-Competence in professional ethics-Case studies of typical holistic technologies, management models and eco-friendly production systems - Strategy for transition from the present state to Universal Human Order-Sum up: Self-evaluation of the students-Post test of UHV.

tal Hours: 45

TextBooks:	
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.
ReferenceBooks:	
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	IndiaWins Freedom-MaulanaAbdulKalamAzad.
WebReferences:	
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
OnlineResources:	
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

22ME301	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**		
C301.1	Paraphrase about the thermodynamic properties, work, heat and entropy.	[U]
C301.2	Apply laws of thermodynamics to open and closed systems.	[Ap]
C301.3	Examine the properties of pure substances and analyse the vapor power cycle used in steam power plants.	[A]
C301.4	Devise simple thermodynamic relations of ideal and real gases	[A]
C301.5	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 of thermodynamics and Entropy:** 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	https://www.grc.nasa.gov/www/k-12/airplane/thermo.html
2	https://www.livescience.com/50776-thermodynamics.html

22ME302	Solid Mechanics	3/0/0/3
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**		
C302.1	Identify the strength of various structural elements subjected to axial loading.	[U]
C302.2	Interpret the principal stress and strain energy.	[U]
C302.3	Compute graphically the shear force and bending moment for different types of beams and interpret the effect of transverse loading on beams.	[Ap]
C302.4	Determine the influence of torque on circular shafts.	[Ap]
C302.5	Examine the stability of columns.	[A]
C302.6	Analyze the stresses involved in thin cylinders.	[A]

Course Contents:

Simple Stresses and Strain- Introduction, Definition of stresses and strains, Hooke's law, Stress-Strain diagram for brittle and ductile materials, factor of safety, Deformation of simple, compound bars and uniformly varying circular rod due to axial force, Thermal stresses, Compound section subjected to thermal stresses. Elastic constants - relationship between elastic constants and Poisson's ratio. Strain Energy- Analysis of strain energy under gradual, sudden and impact loading conditions, Stresses on inclined planes - Principal stresses and principal planes - Analytical method - Mohr's circle method.

Transverse loading on beams - supports and loadings. Definition of bending moment and shear force, Sign conventions, Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to concentrated loads, uniformly distributed loads and combination of these loads. Stresses in Beams- bending equation, section modulus, flexural rigidity. Analysis of bending stress in the circular, rectangular, 'I' sections. Deflection of Beams **-** Slope and deflection of cantilever and simply supported beams by Double Integration method and Macaulay's method.

Torsion - stresses and deformation in solid and hollow circular 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 cylinders and spherical shells subjected to internal pressure.

	Total Hours:	**45**

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, 2017.
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

22MA305	FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS MECH / MCT	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

C305.1	Recall the basic integration concepts, partial derivatives and transform techniques	[R]
C305.2	Understand and apply the Fourier series to solve engineering problems	[U]
C305.3	Develop and solve the partial differential equations	[AP]
C305.4	Apply transform techniques in signal processing	[AP]
C305.5	Apply continuous transforms techniques to evaluate definite integrals	[AP]

Course Contents:

MODULE I - FOURIER SERIES **(20 Hrs)**

Dirichlet's conditions – General Fourier Series (0,2π) and (0,2l) – Odd and Even Functions (- π, π) and (- l, l) – Half range sine series and cosine series (0, π) and (0, l) – Applications of Fourier Series – One Dimensional Wave Equation.

MODULE II - PARTIAL DIFFERENTIAL EQUATIONS **(20 Hrs)**

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 Equations – Elliptic equations – Laplace equation – Liebmann's Iterative 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).

MODULE III- TRANSFORMS **(20 Hrs)**

Complex form of Fourier Transforms – Fourier sine and cosine transforms – Properties – Transforms of simple functions – 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 – Solving difference equation– Inverse Z-transform–Convolution theorem (Excluding proof) – Partial fraction method.

Total Hours:	**60 Hrs**

Text Books:

1	Erwin E., "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.
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/

22TA201	TAMILS AND TECHNOLOGY	1/0/0/1
Nature of Course:	C (Theory Concept)	
Pre requisites:	NIL	

Course Objectives:

1	To know about weaving, ceramic, design and construction technologies in sangam age.
2	To know the significance of technologies such as manufacturing, agriculture and irrigation.
3	To understand the development of Scientific Tamils and Tamil Computing.

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

C201.1	Describe about the weaving industry in sangam age and ceramic technology.	[U]
C201.2	Observe the design of houses, sculptures and construction of temples.	[U]
C201.3	Relate the various manufacturing materials and stone types in Silappathikaram.	[U]
C201.4	Understand the significance of agriculture and irrigation technology in ancient period.	[U]
C201.5	Explain the growth of scientific Tamil, Tamil computing and digitization of Tamil books.	[U]

Course Contents:

Weaving and Ceramic Technology: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries. **Design and Construction Technology:** Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

Manufacturing Technology: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel - Copper and gold - Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads - Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. **Agriculture and Irrigation Technology:** Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

Scientific Tamil & Tamil Computing: Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Total Hours: 15

Text-cum-Reference Books:

1	தமிழக வரலாறு – மக்களும் பண் பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் – முனைனர் இல. சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – னைனக நதிக்கனரயில் சங்ககால நகர நாகரிகம் (வதால்லியல் துனற வெளியீடு)

4	வபாருனந – ஆற்றங்கனர நாகரிகம். (வதால்லியல் துனற வெளியீடு)

5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22ME303	MANUFACTURING TECHNOLOGY – II (WITH LAB)	3/0/2/4
Nature of Course	Theory concepts and lab	
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

C303.1	Comprehend the basics of metal cutting processes and various machining operations.	[U]
C303.2	Discuss the working principle of special purpose machines and various mechanisms involved.	[U]
C303.3	Analyze the cutting forces involved in the machining process using Merchant circle	[A]
C303.4	Categorize the various Un-conventional Manufacturing processes and Additive Manufacturing processes and determine its applications.	[Ap]
C303.5	Demonstrate knowledge on the working of CNC machine tools and different additive manufacturing techniques and capable of operating the machine and producing finished product.	[Ap]

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. **Lathe:** Centre Lathe, Turret and Capstan lathes constructional features, Operations, work and tool holding devices– Semi Automatic lathe and Automats types.

Special Purpose Machines and Abrasive processes: Shaper, Planer, Slotter machines. Milling machines, Drilling machines, Grinding machines, Broaching machines - Tools and cutters, Various operations. **Gear manufacturing and finishing** process: Gear cutting: forming, generation, shaping. Sustainable Manufacturing of Gears–Heat treatment of gears overview - Finishing processes: Honing, lapping, polishing and buffing.

Un-conventional Manufacturing Process: Abrasive water Jet machining, Electro chemical machining (ECM), Electrical discharge machining (EDM), **Additive Manufacturing processes:** Stereolithography, Fused deposition modeling, Selective Laser Melting. Metal additive Manufacturing Process - **CNC machines:** Introduction, turning and machining center - machine structure components and drives, feedback devices, Automatic tool changers and pallet systems, and Part programming fundamentals. Industrial Internet of CNC Machines.

Total Number of Theory Hours	**45**

Laboratory Components

S. No	List of Experiments	CO Mapping	RBT
1	Step turning and external thread cutting using center lathe	C303.5	[Ap]
3	Measurement of cutting forces in Turning process and determine the tool wear.	C303.5	[A]
4	External dovetail and internal dovetail using shaping machine	C303.5	[Ap]
5	Contour milling and keyway cutting using milling machine	C303.5	[Ap]
6	Fasten the two different plates using drilling, reaming and tapping processes	C303.5	[Ap]

7	Improve the surface finish of the given component using Surface grinding process	C303.4	[Ap]
8	Make a spur gear / helical gear using hobbing machine.	C303.5	[Ap]
9	Perform a step turning operation using CNC turning centre.	C303.5	[Ap]
10	Development of prototype model by using FDM process	C303.5	[Ap]
11	Every student must undergo minimum of 3 industrial visits during the activity day.	C303.1	[U]
Text Books:			
1	Serope Kalpakjian, “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, 2018.		
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		
Online Resources:			
1	https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-me05/		
2	https://archive.nptel.ac.in/noc/courses/noc16/SEM2/noc16-me17/		

2IT311	INTRODUCTION TO PYTHON PROGRAMMING	1/0/4/3
Nature of Course	F (Theory Programming)	
Prerequisites	Nil	

Course Objectives:

1.	To understand and execute Python script using types and expressions.
2.	To understand the difference between expressions & statements and to understand the concept of assignment semantics.
3.	To utilize high level data types such as lists and dictionaries.
4.	To import and utilize a module and to perform read & write operations on files.

Course Outcomes

Upon completion of the course, students shall have ability to

C311.1	Demonstrate programs using simple python statements and expressions.	[U]
C311.2	Build control flow and string concept in python for solving problems.	[AP]
C311.3	Develop python programs using functions.	[AP]
C311.4	Analyze compound data using python lists, tuples and dictionaries.	[A]
C311.5	Apply python programs using files, exception, modules and packages.	[AP]

COURSE CONTENTS:

DATA, EXPRESSIONS, STATEMENTS: 15 Hours

Data Types, Variables and Identifiers, Operators and Expression, Conditional Branching Statements, Iterative statements- Nested Loops, Break, Continue, Pass statements, Function - definition and function call, arguments, return statements, Lambda Function and Recursive Function.

STRING, LISTS, FUNCTIONS: 15 Hours

Strings – Concatenation, Append, Comparing Strings, Iterating Strings, Strings Modules and Functions, Modules – NumPy, Math, List: Operations, Nested list, Cloning, Methods, Looping, Tuple: Operations, Nested Tuple, Tuple assignments, Checking the index, Dictionary: Operations, looping over and Nested Dictionary, Built in functions and Methods.

FILES, INHERITANCE: 15 Hours

Classes and Objects, Inheritance, Polymorphism, File Handling and Exception Handling.

Total Hours	**45**

Laboratory Component:

S. No	List of Experiments
1.	Compute the GCD of two numbers.
2.	Find the square root of a number (Newton's method).
3.	Exponentiation (power of a number).
4.	Find the maximum of a list of numbers.
5.	Linear search and Binary search.
6.	Selection sort, Insertion sort.
7.	Merge sort.
8.	First n prime numbers.
9.	Multiply matrices.
10.	Programs that take command line arguments (word count).

11.	Plotting datasets.
12.	File handling and plotting.
Total Hours	**30**
Text Books:	
1.	Allen B. Downey, “Think Python: How to Think Like a Computer Scientist’’, 2nd Edition, Updated for Python 3, Shroff/O’Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/).
2.	Tony Gaddis, “Starting out with Python’’, 4th Edition, Addison Wesley, Pearson 2017.
Reference Books:	
1.	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2.	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3.	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, 3rd Edition, MIT Press, 2021.
Web References:	
1.	http://nptel.ac.in/courses/106106145/
2.	https://www.codecademy.com/learn/learn-python
3.	https://www.coursera.org/learn/python-data-analysis#syllabus
Online Resources:	
1.	https://www.programiz.com/python-programming
2.	https://www.fullstackpython.com/best-python-resources
3.	https://www.udemy.com/course/easy-way-to-learn-python-for-beginners-2021/
4.	https://stackify.com/learn-python-tutorials/

22ME304	STRENGTH OF MATERIALS LABORATORY	0/0/3/1.5
Nature of Course	Practical application	
Pre Requisites	Industrial Metallurgy	

Course Objectives:

1	To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads.
2	This would enable the student to have a clear understanding of the design for strength and stiffness

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

C304.1	Determine the Tensile, Compression, Shear, Impact, fatigue and Hardness properties of the materials.	Ap
C304.2	Analyze the Deflection of Beams	A
C304.3	Determine the Stiffness of Springs	Ap
C304.4	Demonstrate the Usage of strain Gauges	U
C304.5	Analyze the Effect of Heat Treatment on Hardness	A
C304.6	Compare the Microstructure of various specimens	Ap

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Tension test on a mild steel rod to determine the percentage of elongation, yield, ultimate and breaking stress on mild steel rod	C304.1	Ap
2	Compression test on wood to determine the compression strength	C304.1	Ap
3	Double shear test on Mild steel / Aluminium rods to determine the shear strength.	C304.1.	Ap
4	Torsion test on mild steel rod to determine the modulus of rigidity	C304.1	Ap
5	Impact test on metal specimen to determine the impact strength and toughness -Izod's and Charpy's test	C304.1	Ap
6	Hardness test on metals to determine Brinnell and Rockwell Hardness Number of Aluminium, Brass and Mild Steel	C304.1	Ap
7	Conduct the fatigue test on the given specimen	C304.1	Ap
8	Deflection test on beams to determine the young's modulus of the given beam (Steel & Aluminium)	C304.2	A
9	Compression test on open coil helical springs to determine the deflection and stiffness	C304.3	Ap
10	Compare the theoretical and experimental strain of mild steel using digital strain indicator	C304.4	U
11	Effect of hardening- Improvement in hardness and impact resistance of steels. a. Unhardened specimen b. Hardened specimen and c. Quenched Specimen	C304.5	A
12	Study of Microstructure of (i)Hardened samples and (ii) Hardened and tempered samples	C304.6	Ap
	Total Hours:		**45**

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	S.S. Rattan "Strength of Materials", McGraw Hill Education (India) Pvt. Ltd., 3rd Edition, 2017.
Web References:	
1	https://sm-nitk.vlabs.ac.in/
2	https://www.vlab.co.in/participating-institute-nitk-surathkal

22ME305	COMPUTER AIDED MACHINE DRAWING	0/0/3/1.5

Nature of Course	Practical application
Pre Requisites	Engineering Drawing

Course Objectives:

1	To impart the knowledge of drawing practices followed for common machine components.
2	To enable the students to understand the 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

C305.1	Apply standard drawing practices for representation of mechanical components.	[Ap]
C305.2	Apply limits and tolerances to the assemblies and choose appropriate fits.	[Ap]
C305.3	Sketch the various machine elements using modeling software.	[Ap]
C305.4	Model the assembled views of machine parts using modeling software.	[C]
C305.5	Formulate the detailed drawing of the given component.	[C]

Course Contents:

Machine Drawing Conventions –Welding symbols, riveted joints, keys, fasteners, bolts, nuts screws and keys-Limits, Fits and Tolerances- Geometric dimensioning and tolerancingmethod of indicating geometric tolerances on part drawings- Introduction to production drawing- Design of jigs and fixtures.

S.No	List of Experiments	CO Mapping	RBT
1	Draw hexagonal nut and square nut, hexagonal headed bolt, square headed bolt and washer.	C305. 1 C305. 3	[Ap]
2	Draw single riveted lap joint, double riveted (chain) lap joint, double riveted (zigzag) lap joint, single riveted butt joint, double riveted butt joint	C305. 1 C305. 3	[Ap]
3	Draw the assembly of Gib & Cotter Joint.	C305. 2 C305. 4	[C]
4	Draw the assembly of Universal joint.	C305. 2 C305. 4	[C]
5	Draw the assembly of Foot step bearing.	C305. 2 C305. 4	[C]
6	Draw the assembly of Non return valve	C305. 2 C305. 4	[C]
7	Draw the assembly of Oldham coupling.	C305. 2 C305. 4	[C]
8	Draw the assembly of Connecting rod.	C305. 2 C305. 4	[C]
9	Draw the assembly of Screw Jack.	C305. 2 C305. 4	[C]
10	Draw the assembly of Machine Vice.	C305. 2 C305. 4	[C]
	Total Hours:		**45**

Reference Books:

1	N. D. Bhatt, “Machine Drawing” Charotar Publishing House. 2016.
2	K.L. Narayana, P.Kannaiah, & K.Venkata Reddy, “Machine Drawing-Multi Color Edition”, New Age International Publishers, 2019.

Web References:	
1	http://www.nptel.ac.in
2	https://www.machinedesignonline.com
3	http://www.sigmetrix.com

Semester – 04

22ME401	AUTOMOBILE ENGINEERING	3/0/0/3

Nature of Course	Theory
Pre-Requisites	Engineering 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 basic concepts of automobiles and engine architecture	[R]
C401.2	Discuss the various autotronics systems involved in automobiles	[U]
C401.3	Explore the emission control methods used in current vehicles.	[Ap]
C401.4	Survey the various alternate energy vehicles	[Ap]
C401.5	Discuss the transmission and vehicle control systems.	[U]

Course Contents:

AUTOMOBILE AND ENGINE ARCHITECTURE: Automobile - types, components, subsystems and their positions - Power required for automobile - resistance and force – chassis, frame and body -concepts of vehicle body aerodynamics – 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, VI engine technology, supercharging and turbo charging. **AUTOTRONICS:** Overview of basic automobile electrical components and circuits in an automobile - Overview of various sensors, actuators 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: EGR, SCR, catalytic converter (description only) – alternative energy source overview – CNG, electric 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 - torque converter, CVT, overdrive – transfer box - gear changing mechanism types. **Drive Line:** Universal joints and propeller shaft types, **Rear axle:** types of rear axle, **Final Drive**: Differential unit, 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: Introduction to additive manufacturing and its automobile applications. (Not for exam)

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,13th edition, 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.
3	Er.R.K.Rajput, “A Textbook of Automobile Engineering”, Laxmi Publications, New Delhi, 2020
Web References:	
1	https://alison.com/tag/automotive-engineering
2	https://www.youtube.com/watch?v=zy_zipMEH7g
Online Resources:	
1	https://archive.nptel.ac.in/courses/107/106/107106088/
2	https://www.careers360.com/courses-certifications/coursera-automobileengineering-courses-brp-org
3	https://www.udemy.com/course/overview-of-automotive-performance-engineering/

22ME402	MECHANICS OF MACHINES	3/0/0/3
Nature of Course	Theory Analytical	
Pre-Requisites	Engineering Mechanics	

Course Objectives:

1	To impart knowledge about various machine elements.
2	To facilitate students to understand the functions of cam and gear.
3	To enable students to get an insight into the concepts of vibration.
4	To provide perception to the undesirable effects on balancing of rotating and reciprocating masses.

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

C402.1	Study the basic principles of mechanisms and their kinematics.	[U]
C402.2	Compute velocity and acceleration of various mechanisms.	[Ap]
C402.3	Construct cam profile for various types of followers.	[Ap]
C402.4	Discriminate the gear terminologies and velocity ratio of gear trains.	[A]
C402.5	Categorize and analyze free vibrations of mechanical systems.	[A]
C402.6	Determine the balancing masses and gyroscopic couple on dynamic systems.	[A]

Course Contents:

Introduction of mechanisms and machines: Mechanisms – terminology and definitions – concepts of kinematic pairs, kinematic chain, degrees of freedom, Kutzbach, Grubler's and Grashof's criterion -kinematics inversions of 4 bar and slide crank chain. Velocity and acceleration analysis by relative velocity method.

Cams: Classification of cam and follower - displacement diagrams - graphical layouts of cam profiles for reciprocating followers. **Gears:** Fundamental law of gearing, spur gear- contact ratio and interference/undercutting, **Gear trains:** Simple, compound, reverted and epicyclic gear trains – speed ration analysis by tabular method.

Vibrations: Basic features of vibratory systems, single degree of freedom free vibration equations of motion - natural frequency - torsional vibration of shaft - critical speeds of shafts. **Balancing** - Static and dynamic balancing of revolving and reciprocating masses in single and two-cylinder engines. **Gyroscopes** - Basic concepts - gyroscopic law, effect of gyroscopic couple on aircrafts.

Total Hours:	**45**

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	F. B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2020.

Reference Books:

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

Web References:

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

Online Resources:

1	https://archive.nptel.ac.in/courses/112/105/112105268/
2	https://archive.nptel.ac.in/courses/112/104/112104114/

22ME403	FLUID MECHANICS AND MACHINERY	3/0/0/3

Nature of Course	G (Theory and Practical)
Pre-Requisites	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 for flow through pipes.

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

C403.1	Describe the fundamental properties of the fluids	[U]
C403.2	Analyze the nature of fluid flow and its energy losses.	[A]
C403.3	Determine the behaviour of fluid flow in series and parallel configuration	[Ap]
C403.4	Examine the dependent and independent dimensionless parameters.	[Ap]
C403.5	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 - **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 fundamentals.

Dimensional Analysis - Dimension and units – Buckingham π theorem – similitude – dimensionless numbers. 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 – Introduction to CFD.

Total Hours:	45

Text Books:

1	Frank M. White, Henry Xue., "Fluid Mechanics", McGraw-Hill Education,9th edition, 2022.
2	Rajput, R.K., "Fluid Mechanics and Hydraulic Machines", S.Chand Publishers,6th edition 2022.
3	Yunus Cengel and John Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi 2019

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, Tenth edition, 2020.

Web References:

1	https://nptel.ac.in/courses/112104118
2	https://nptel.ac.in/courses/105103192

Online Resources:	
1	https://www.britannica.com/science/fluid-mechanics/Hydrodynamics
2	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/fluidmechanics

22ME404	THERMAL ENGINEERING	3/0/0/3

Nature of Course	Theory, Analytical
Pre-Requisites	Engineering thermodynamics and Mathematics.

Course Objectives:

1	To understand the various thermodynamic cycles and study the performance of I.C Engines.
2	To understand the performance of air compressors.
3	To impart knowledge on psychrometric processes and air conditioning systems.

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

C404.1	Identify and describe the air standard cycles for air standard efficiencies.	[U]
C404.2	Differentiate and analyze the working of different types of engines.	[A]
C404.3	Analyze and calculate the performance of SI and CI engines.	[Ap]
C404.4	Estimate the performance of reciprocating and rotary equipment.	[Ap]
C404.5	Classify, solve and calculate the performance of psychrometry processes and air conditioning systems.	[Ap]

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 (with and without clearance) - 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	Mahesh M, Rathore, “Thermal Engineering”, Mc Draw Hill Education private limited, Reprint 2016.
2	Kothandaraman C.P, Domkundwar S, “A course in Thermal Engineering”,Dhanpat Rai & Co. pvt ltd, 2017.

Reference Books:

1	Ganesan V, Internal Combustion Engine; Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2016.
2	Rudramoorthy R, “Thermal Engineering”, Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2016.
3	R.K. Rajput, “Thermal Engineering”, Laxmi Publication, 2020.

Web References:

1	https://www.thermal-engineering.org/
2	https://ocw.mit.edu/courses/mechanical-engineering/

Online Resources:

1	http://nptel.ac.in/courses/112105128/
2	https://www.thermal-engineering.org/

22MA402	PROBABILITY AND COMPUTATIONAL METHODS (MECH, MCT & EEE)	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.
5.	To study the various numerical methods to fit the polynomial by interpolation formulas.

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

C402.1	Recall the concept of probability.	[R]
C402.2	Understand to handle situations involving random variables and Standard distributions.	[U]
C402.3	Apply measures of central tendency to analyze statistical data and to find the correlation and regression between the given data.	[AP]
C402.4	Develop the inferences for engineering problems using testing of hypothesis.	[AP]
C402.5	Apply numerical methods to fit the polynomial by interpolation formulas.	[AP]

Course Contents

MODULE I - PROBABILITY **(20 Hrs)**

Sample space – Axioms of Probability – Events – Conditional probability – Total Probability – Baye's Theorem (Statement only). One dimensional Random Variable – Discrete random variable Probability mass function – Discrete distributions – Binomial distribution – Poisson distribution – Continuous Random Variable – Probability density function – Continuous distribution: Uniform distribution – Normal distribution.

MODULE II - STATISTICS **(20 Hrs)**

Measures of Central tendency: Mean Median and Mode. Correlation (Karl Pearson's) – Rank correlation (Spearman's) – Linear regression. Testing of Hypothesis – Small Samples– Student's t-Test for single mean, difference of means – F test – Chi square test for goodness of fit and independence of attributes – Analysis of Variance – One way classification.

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.

Total hours	**60**

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.
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/3-1random-variables-and-probability-distributions-Y3bCF
3.	https://www.codewithc.com/newtons-interpolation-in-matlab/

22ME405	THERMAL AND FLUID MECHANICS LABORATORY	0/0/3/1.5

Nature of Course	Practical
Pre Requisites	Fluid Mechanics &Thermal Engineering

Course Objectives:

1	Ability to understand the properties of fluids & working principle of Internal combustion engines
2	Ability to apply the knowledge of fluid Mechanics and Thermal Engineering in calculating the performance of various machines.
3	Ability to function on multi-disciplinary teams in the area of fluid and thermal Sciences.
4	Ability to use the techniques, skills and modern engineering tools necessary for engineering.

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

C405.1	Calculate the coefficient of discharge of the fluid flow using an apparatus	A
C405.2	Estimate the friction factor for flow through pipes	A
C405.3	Determine the performance of pump through tests at different conditions	Ap
C405.4	Evaluate the performance of engines and compare their performance characteristics	E
C405.5	Calculate and compare the performance of reciprocating and rotary equipment	A
C405.6	Conduct test and calculate the properties of fuels and lubricants	A
C405.7	Classify, solve and calculate the psychrometric processes and air conditioning systems performance	Ap

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Determination of the coefficient of discharge of given orifice meter.	C405.1	Ap
2	Determination of the coefficient of discharge of given venturimeter.	C405.1	Ap
3	Determination of the rate of flow using rotameter.	C405.1	Ap
4	Calculation of friction factor for a given set of pipes	C405.2	A
5	Conduct a test on centrifugal pump / Gear pump / Submersible pump/ Reciprocating pump and compare the performance characteristics.	C405.3	A
6	Experimental study on valve timing diagram in 4-stroke engine cut model and port timing diagram in 2-stroke engine cut model.	C405.4	A
7	Performance and combustion test on computerized Kirloskar TV1 engine with eddy current dynamometer. (In diesel mode).	C405.4	E
8	Performance and Heat balance test on a twin cylinder diesel engine with electrical dynamometer (Alternator).	C405.4	A
9	Determination of performance of an air compressor test rig (Two stage).	C405.5	Ap
10	Determination of flash point, fire point and viscosity of the engine oil.	C405.6	Ap
11	Study on air conditioning and refrigeration system.	C405.7	U
	Total Hours:		**45**

Reference Books:	
1	Bansal, R.K. “Fluid Mechanics and hydraulic Machines”, Laxmi Publications (P) Ltd., New Delhi, 2018
2	R S Khurmi, “Thermal Engineering”, Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2022.
3	Ganesan V, Internal Combustion Engine; Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2016.
4	Kothandaraman C.P, Domkundwar S, “A course in Thermal Engineering”, DhanpatRai& Co. pvt ltd, 2016.
Web References:	
1	https://fm-nitk.vlabs.ac.in
2	http://nptel.ac.in/courses/112104033/
3	http://nptel.ac.in/courses/112105128/

22ME406	DYNAMICS LABORATORY	0/0/3/1.5

Nature of Course	Practical application
Pre Requisites	Engineering mechanics

Course Objectives:

1	To enable the students to understand the principles of static force analysis and dynamic force analysis of mechanisms.
2	To provide an insight about the undesirable effects of unbalanced masses in rotors and engines.
3	To introduce the concept of vibratory systems and damping methods.

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

C406.1	Determine the Mass Moment of Inertia of given machinery part.	[A]
C406.2	Determine the gyroscopic couple on motorized gyroscope	[A]
C406.3	Evaluate the various types of vibrations and to calculate natural frequency of the system.	[Ap]
C406.4	Perform static and dynamic balancing calculations for rotating parts of the machinery.	[Ap]
C406.5	Analyze the various types of governors and their efficiency and	[A]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Determination the moment of inertia of turn table apparatus.	C406.1	[A]
2	Determination the moment of inertia using bifilar suspension.	C406.1	[A]
3	Determination of gyroscopic couple using motorized gyroscope.	C406.2	[A]
4	Determination of transmissibility ratio using vibrating table.	C406.3	[Ap]
5	Determination of transverse frequency of beam.	C406.3	[Ap]
6	Balancing of rotating and reciprocating masses.	C406.4	[A]
7	Determination of natural frequency of free longitudinal vibration.	C406.3	[Ap]
8	Determination of critical speed of shaft.	C406.3	[Ap]
9	Determination the moment of inertia using flywheel axle system.	C406.1	[A]
10	Determination the moment of inertia using flywheel and connecting rod by compound pendulum method.	C406.1	[A]
11	Determination of characteristics for Watt / Porter / Proell / Hartnell governors.	C406.5	[A]

Total Hours: 45

Reference Books:

1	Rattan S.S., "Theory of Machines", 5th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2019.
2	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/

Semester – 05

22ME501	DESIGN OF MACHINE ELEMENTS	3/0/0/3
Nature of Course	Concept and Analytical	
Pre Requisites	Engineering Mechanics, Solid Mechanics, Mechanics of Machines	
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, Springs and Flywheel:** Design of Solid and Hollow Shafts – Design of Keys and Couplings – Design of Helical and Leaf springs – Design of flywheel. **Design of Fasteners, Bearings**: – Threaded Fasteners – Design of Welded Joints – Design of riveted joints (Various types of failures alone) –-- Selection of Bearings, Sliding Contact and Rolling Contact bearing.		
	Total Hours:	**45**
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-machinedesign-fall-2001/	
Online Resources:		
1	https://www.machinedesignonline.com/	

22ME502	CAD/CAM/CIM	3/0/0/3
Nature of Course	Theory	
Pre-Requisites	Engineering Drawing, Computer Aided Machine Drawing	
Course Objectives:		
1	To design products and processes at the continuum scale, addressing both the theoretical and practical aspects of engineering challenges	
2	To convert complex physical problems into well-defined engineering problems by means of geometric modeling and numerical modelling capabilities.	
3	To impart knowledge of recent advancement in computer aided manufacturing and automation.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C502.1	Transform a conceptual idea into a detailed CAD model using geometric modelling techniques.	[U]
C502.2	Generate mathematical representation of curves, surfaces and solids using interpolation and approximation concepts.	[C]
C502.3	Apply suitable product data exchange techniques to convert geometric model into numerical model	[Ap]
C502.4	Apply CAM software tools for solving real time component machining and Develop CNC part programs.	[Ap]
C502.5	Analyze the automated flow lines through FMS and visualize the concepts of future automated factory environments to digital transformation	[A]

Course Contents:

Introduction: Design process - sequential and concurrent engineering - Computer aided design - CAD system architecture - Computer graphics - co-ordinate systems - 2D and 3D transformations- homogeneous coordinates - Line drawing – Clipping - viewing transformation - **GEOMETRIC MODELING:** Representation of curves - Hermite curve- Bezier curve - Bspline curves - Techniques for surface modelling - surface patch - Coons and bicubic patches - Bezier and B-spline surfaces. Solid modelling techniques - CSG and B-rep. CAD STANDARDS: Standards for computer graphics - Graphical Kernel System (GKS) - standards for exchange images - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

Introduction to CAM - Manufacturing Planning, Manufacturing control - CAD/CAM concepts - Types of production - Manufacturing models and Metrics - Mathematical models of Production Performance **FUNDAMENTAL OF CNC AND PART PROGRAMING:** Introduction to NC systems and CNC - Machine axis and Co-ordinate system - CNC machine tools - Principle of operation CNC - Construction features including structure - Drives and CNC controllers - 2D and 3D machining on CNC - Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes - Introduction of CAM software package.

CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS): Group Technology (GT), Part Families - Parts Classification and coding - Simple Problems in Opitz Part Coding system - Production flow Analysis - Cellular Manufacturing - Composite part concept - Types of Flexibility - FMS - FMS Components - FMS Application & Benefits - FMS Planning and Control - Quantitative analysis in FMS.

Total Hours:	**45**

Text Books:

1	Ibrahim Zeid, “Mastering CAD/CAM”, McGraw Hill Education (India) P Ltd., SIE, 2022.
2	E Zimmer, M Groover, “CAD/CAM: Computer-aided Design and Manufacturing”, Pearson Education Ltd., 2023.
Reference Books:	
1	CAD/CAM/CIM, “Radhakrishnan and Subramanian”, New Age Publishers, 2020.
2	CAD/CAM: Principles and Application, “P N Rao”, McGraw Hill Education (India) P Ltd., SIE, 2022.
Web References:	
1	https://www.autodesk.in/solutions/cad-cam
2	https://www.ptc.com/en/technologies/cad
Online Resources:	
1	https://onlinecourses.swayam2.ac.in/nou24_me04/preview

22ME503	Smart Factory	3/0/0/3
Nature of Course	Theory Application	
Pre-Requisites	Manufacturing Technology-I (with lab), Manufacturing Technology-II (with lab) and Fundamentals of Electrical and Electronics Engineering	

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

C503.1	Describe the drivers and enablers of Industry 4.0.	[U]
C503.2	Interpret the smartness in smart factories, smart cities, smart products and smart services.	[U]
C503.3	Study the applications of Industry 4.0	[U]
C503.4	Implement the various systems and technologies used in Industry 4.0.	[Ap]
C503.5	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 and Sustainable Production System, Digital Twin, basic concepts of AR& VR, Connected factory.

Total Hours:	**45**

Text Books:

1	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, 2019.
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”, Study lab, 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-asuper-easy-explanation-for-anyone/#53b174589788.

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

22ME504	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 various modes of heat transfer.	
2	To enable the students to apply various laws of heat and mass transfer in engineering applications.	
3	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**		
C504.1	Summarize the basics of different modes and laws of heat transfer.	[U]
C504.2	Compute heat transfer and temperature distribution in composite systems and extended surfaces.	[Ap]
C504.3	Interpret and analyze forced and free convection heat transfer.	[A]
C504.4	Appraise the heat exchangers performance using LMTD and NTU methods.	[A]
C504.5	Classify and appraise the different modes of mass transfer.	[A]
C504.6	Compute the radiative properties of a surface.	[Ap]
Course Contents:		
Conduction Heat Transfer: Fourier Law of Conduction, General Differential equation of Heat Conduct ion- Cartesian Coordinates, 1-D Steady State Heat Conduction (Plane Wall, Cylinder s) 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, 2017.	
2	Incropera, F. P. and De Witt, D. P., "Fundamentals of Heat and Mass Transfer", 8th Edition, John Wiley and Sons, New York, 2018.	
3	Nag P.K, "Heat and Mass Transfer", McGraw-Hill, 2019.	
4	Rk Rajput, "Heat and Mass Transfer", S Chand, Seventh Edition, 2019.	
Web References:		
1	www.academia.edu/.../Frank_P_Incropera_Fundamentals_of_heat_and mass_transfer.	
2	https://www.accessscience.com/content/article/a311100	

Online Resources:	
1	https://archive.nptel.ac.in/courses/112/108/112108149/
2	https://archive.nptel.ac.in/courses/103/101/103101137/

22ME505	METROLOGY AND INSTRUMENTATION (With Lab)	3/0/2/4
Nature of Course	Theory applications	
Pre-Requisites	Manufacturing Technology- II (with Lab)	

Course Objectives:

1	To familiarize the students with basic and advanced metrology concepts.
2	To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
3	To expose the students in the measurement of linear dimensions, angular dimensions, surface roughness, Parameters of threads and gears
4	To expose students to force, torque and flow measurement techniques

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

C505.1	Describe the concepts of measurements and study the various metrological instruments	[U]
C505.2	Outline the principles of linear and angular measurement tools used for industrial applications	[U]
C505.3	Demonstrate the techniques of form measurement used for industrial components	[Ap]
C505.4	Measure the force, torque, power, flow based on the industrial standards.	[Ap]
C505.5	Determine the temperature through appropriate electrical instruments.	[Ap]

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 Equipments - 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- Nanotechnology in measurement of mechanical properties.

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 – Basics of Virtual Instrumentation

Total Number of Theory Hours	**45**

Laboratory Components

S.No	List of Experiments	CO Mapping	RBT
1	Study the linear and angular measuring instruments for the measurement of engineering components	C505.1	[U]

2	Measure the outer diameters of a stepped cylindrical body using Micrometer.	C505.2	[Ap]
3	Measure the outer diameter, Inner diameter and thickness of an Engineering product using Vernier caliper.	C505.2	[Ap]
4	Determine the height of the component for assembly using Vernier height gauge.	C505.2	[Ap]
5	Analyze the tolerance of the manufactured component using mechanical and optical comparator	C505.2	[Ap]
6	Determine the unknown angle of the given component using Sine bar.	C505.2	[Ap]
7	Determine the Gear tool depth and thickness using Gear tooth vernier caliper	C505.3	[Ap]
8	Non-contact (Optical) measurement of tool parameters using Tool makers microscope	C505.3	[Ap]
9	Study of Virtual instrumentation (VI) for simple applications	C505.1	[U]
10	Simulate the basic arithmetic and logic operations using VI.	C505.1	[Ap]
11	Measure the real time temperature Using DAQ	C505.5	[Ap]
Text Books:			
1	R.K Jain, 'Engineering Metrology', 22nd edition, Khanna Publishers, 2022.		
2	Gupta I C , "A text book of Engineering Metrology", Dhanpat Rai Publications, New Delhi, 2018.		
Reference Books:			
1	Alan S Morris, Reza Langari , "Measurement and Instrumentation: Theory and Application", Academic Press,Third edition, 2020		
2	Venkateshan S P , "Mechanical Measurements", John Wiley & Sons, 2015.		
3	Raghavendra , Krishnamurthy "Engineering Metrology & Measurements", Oxford Univ.Press, 2016.		
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		

22ME507	HEAT TRANSFER LABORATORY	0/0/3/1.5

Nature of Course	Practical application
Pre Requisites	Nil

Course Objectives:

1	To impart knowledge on applying the theoretical concepts to analyze the 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

C507.1	Compute heat transfer and temperature distribution in steady-state and unsteady - state heat conduction.	[Ap]
C507.2	Assess the heat transfer performance of the extended surfaces.	[E]
C507.3	Appraise the forced and free convection heat transfer in practical applications.	[E]
C507.4	Assess the heat exchangers performance using LMTD and NTU methods.	[E]
C507.5	Evaluate the radiative properties of a surface.	[E]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Determination of Heat Transfer Rate through a given Composite Wall using Composite Wall Apparatus.	C507.1	[Ap]
2	Determination of thermal conductivity of pipe insulation by using lagged pipe apparatus.	C507.1	[Ap]
3	Determination of Thermal Conductivity of given specimen by two slab guarded hot plate method.	C507.1	[Ap]
4	Experimental determination of Heat Transfer from pin-fin (Forced convection mode).	C507.2	[Ap]
5	Determination of heat transfer coefficient of Natural convection heat transfer from a vertical cylinder.	C507.3	[Ap]
6	Determination of heat transfer coefficient of Forced convection inside tube.	C507.3	[A]
7	Prediction of temperature distribution and change in humidity of food crops using Solar drier in forced convection mode.	C507.3	[E]
8	Determination of Overall Heat Transfer Co-Efficient and Effectiveness of a Parallel Flow Heat Exchanger.	C507.4	[E]
9	Determination of Overall Heat Transfer Co-Efficient and Effectiveness of a Counter Flow Heat Exchanger.	C507.4	[E]
10	Determination of Emissivity of a grey surface.	C507.5	[E]
11	Determination of Stefan-Boltzmann Constant using Stefan-Boltzmann Apparatus.	C507.5	[E]
	Total Hours:		**45**

Reference Books:

1	Holman J.P “Heat and Mass Transfer”, McGraw-Hill, 2019.
2	Incropera, F. P. and De Witt, D. P., “Fundamentals of Heat and Mass Transfer”, 8th Edition, John Wiley and Sons, New York, 2018.
3	Nag P.K, “Heat and Mass Transfer”, McGraw-Hill, 2019.
4	Rk Rajput, “Heat and Mass Transfer”, S Chand, Seventh Edition, 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/

Semester – 06

22ME601	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 for engineering applications.	[Ap]
C601.5	Design and analysis the forces in clutch and brake systems for varies transmission system.	[A]
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-machinedesign-fall-2001/index.htm

22ME602	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.	[U]
C602.2	Solve the engineering problems using functional approximation methods.	[Ap]
C602.3	Calculate the stiffness matrix, stresses and strains for 1D and 2D structural problems subjected to axial load, transverse load and bending.	[A]
C602.4	Determine the shape functions and Jacobian matrix for isoparametric and serendipity element.	[A]
C602.5	Derive and apply the appropriate governing equations for fluid dynamics.	[Ap]

Course Contents:

Introduction: Historical background, application to the continuum, governing equations for continuum, discretization, matrix algebra – Gaussian Elimination, 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, Numerical integration (Gauss quadrature method) - one dimensional problems. Two Dimensional Element: Triangular Element (CST) - shape functions, element stiffness matrix and force vector, application of plane stress and plane strain conditions in stress-strain relationship matrix.

Isoparametric Formulation: Isoparametric elements-four node quadrilateral element, shape functions, element stiffness matrix and force vector, Serendipity element (8 node rectangular element) – only shape function derivation. **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).

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, 2023.

2	John D. Anderson, Jr, “Computational fluid dynamics,” Indian Edition, McGraw Hill Education, 2017.

Reference Books:	
1	Tirupathi R. Chandrupatla and Ashok D. Belugundu, “Introduction to Finite Elements in Engineering”, Fifth Edition by Cambridge University, 2022.
2	Muralidhar.K, Sundararajan.T, “Computational fluid flow and heat transfer”, Second edition, Narosa publishers, 2016.
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

22ME603	SIMULATION AND ANALYSIS LABORATORY	0/0/3/1.5

Nature of Course	Practical
Pre-Requisites	CAD/CAM, Computer Aided Machine Drawing

Course Objectives:

1	To gain exposure on software tools required to analyze engineering problems.
2	To expose the students to different applications of simulation and analysis tools.
3	To enable the students to simulate and analyze engineering components under different loading conditions.

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

C603.1	Solve the simple structural problems under different material constraints	[A]
C603.2	Analyze the natural frequency and mode shapes of beam subjected to different loading conditions	[A]
C603.3	Analyze and evaluate the given component under thermal conditions.	[A]
C603.4	Validate simple flow problem through CFD analysis.	[E]
C603.5	Develop programs to simulate mechanical system.	[C]

Course Contents:

S.No	List of Experiments	CO Mapping	RBT
1	Stress analysis of L bracket/ Plate with Hole.	C603.1	A
2	Stress analysis of axisymmetric component.	C603.1	A
3	Stress analysis in Beam under different loading conditions (Point load and UDL)	C603.1	A
4	Modal analysis of Beam.	C603.2	A
5	Thermal stress analysis in 2D components.	C603.3	A
6	Conductive and convective heat transfer analysis.	C603.3	E
7	Flow analysis for velocity and pressure distribution in simple 2D flow over flat plate.	C603.4	E
8	Flow and heat transfer analysis of fluid flowing in a circular pipe.	C603.4	E
9	Simulation of hydraulic / pneumatic cylinder.	C603.5	C
10	Simulation of cam and follower mechanism.	C603.5	C
11	Structural analysis of automobile rollbar	C603.1	A
	Total Hours:		**45**

Reference Books:

1	Xiaolin Chen, Y. Yujin Liu, “Finite Element Modelling and Simulation using ANSYS Workbench”, CRC Press, 2023.
2	K.Muralidhar, T.Sundarajan, “Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2021.

Web References:

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

22ME604	Design Thinking and Mini Project	0/0/2/1
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. Introduction and need for intellectual property rights.

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	

22EES01	Employability Enhancement Skills	0/0/0/2
Nature of Course	Hands on Practice	
Pre Requisites	-	
Course Objectives:		
1	Will expose technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry	
2	Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.	
3	Understand the importance of industry internship.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C01.1	Collect a list of manufacturing and service industries for doing an intern.	[U]
C01.2	Communicate with company HR to get intern offer.	[U]
C01.3	Develop technical skill, presentation skill and interpersonal behavior.	[Ap]
C01.4	Demonstrate interdisciplinary skill, ethical values and team work.	[Ap]

Course Guidelines:

Step 1: Request Letter/ Email from the office of Training & Placement cell of the college and a student's request letter/profile/ interest areas may be submitted to industries for their willingness for providing the training.
Step 2: Industry will confirm the training slots and the number of seats allocated for internships via Confirmation Letter/ Email.
Step 3: Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.
Step 4: Students undergo industrial training at the concerned Industry for 21 days (minimum). In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers.
Step 5: Students will submit training report after completion of internship.
Step 6: Training Certificate to be obtained from industry.
Step 7: List of students who have completed their internship successfully will be issued by Training and Placement Cell.

Summative assessment based on Continuous and End Semester Examination

Activity	Month	Continuous Assessment [100 marks]
Intern Presentation	April / May	100

PROFESSIONAL ELECTIVE

22ME901	ELECTRIC AND HYBRID VEHICLE TECHNOLOGY	3/0/0/3

Nature of Course	Theory Skill based
Pre-Requisites	NIL

Course Objectives:

1	To enable the students to understand the working of different configurations of electric and hybrid vehicles.
2	To expose the students to the recent propulsion technologies used in automotive industries.
3	To enable the students to realize the technical characteristics of energy storage system.

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

C901.1	Describe the need, concept and types of EV/HEV.	[U]
C901.2	Report the basic components of hybrid and electric vehicles.	[U]
C901.3	Choose suitable electric propulsion and control systems for EV/HEV.	[Ap]
C901.4	Evaluate the performance of electric vehicles.	[A]
C901.5	Employ proper energy storage systems for vehicle applications.	[Ap]

Course Contents:

Introduction to Electric Vehicle and Hybrid Electric Vehicle: Environmental impact of conventional vehicle, overview of air pollution, need for electric vehicle, history of electric vehicles & hybrid electric vehicles, social and environmental importance of electric vehicles and hybrid electric vehicles. **Types of Electric Vehicles:** Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), plug-in hybrid electric vehicle, fuel cell electric vehicle, solar powered vehicle. **Types of Hybrid Vehicle:** Hybridization – micro hybrid, mild hybrid, fully hybrid – advantages, disadvantages & its applications.

Electric Vehicle Propulsion Systems: Types of EV motors - DC motor drives, induction motor drives, permanent magnetic brushless DC motor drives, hub motor drive system, configurations of electric vehicle, performance of electric vehicle – tractive effort in driving conditions – energy consumption. **Hybrid Electric Vehicle Drive Trains:** IC engine, electric motor, controller, DC/DC converter, transmission unit, batteries. **Drive train Configuration:** Parallel hybrids, series hybrids, and power-split hybrids **–** control strategies.

energy storage systems: batteries – lead acid batteries, nickel-based batteries, and lithiumbased batteries, battery charging techniques, battery characterization – capacity, discharge rate, state of charge, state of discharge, depth of discharge, technical characteristics, battery pack design, smart battery management system. fuel cell-based energy storage, hybridization of various energy storage devices. **Control Systems for EV/HEV**: Electronics power steering – torque sensor – EPS motor, suspension system – semi trailing arm type, trailing arm, air suspension, regenerative suspension system, regenerative braking system for EV/HEV.

Total Hours:	45

Text Books:

1	M. Ehsani, Y. Gao and A. Emadi, 'Modern electric, hybrid electric and fuel cell vehicles: Fundamentals, Theory and design', 3rd edition, CRC press, 2018.
2	T. Denton, "Electric and Hybrid Vehicles", Second Edition, Routledge, 2020.

Reference Books:

1	K. T. Chau, 'Electric vehicle machines and drives: Design, analysis and application', first edition, John Willey and Sons Singapore Pvt. ltd., 2015.
2	Electric Vehicle Battery Systems" - Sandeep Dhameja, Butterworth Heinemann, 2002.

3	Iqbal Hussain, “Electric & Hybrid Vehicles – Design Fundamentals”, Second Edition, CRC Press, 2018.

22ME902	AUTOTRONICS	3/0/0/3

Nature of Course	Theory
Pre-Requisites	Automobile Engineering

Course Objectives:

1	To enable the students to understand the evolution of electronics in automobiles and impart them the basics of charging and starting system
2	To impart the knowledge on ignition and injection systems
3	To acquaint students with various sensors and actuators for controlling engine parameters

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

C902.1	Recall the basic electrical and electronics systems used in automotive electronics.	[U]
C902.2	Classify the different types of batteries used in the automotives	[U]
C902.3	Select the suitable sensors for various applications used in automotives.	[Ap]
C902.4	Recall the principles and applications of vehicle control and safety systems used in the automotives	[R]
C902.5	Design and develop the components for automotives	[C]

Course Contents:

Autotronics Systems: Introduction to electrical systems in automobiles - charging system - working of charging circuit diagram - alternators - regulator - battery - types of batteries - lead acid battery and lithium-based batteries - construction and working principle - battery rating - battery testings – battery charging methods, starting system - working of starter circuit diagram - starter motor - types of starter drive - bendix drive - over running clutch type. **Ignition System** - Types of ignition system - battery coil ignition system and its components - electronic ignition system and its components. **Lighting System** - Circuits and various components. auxiliary systems/accessories in automobiles.

Sensors, Actuators and Engine Management System: Sensors - types of automotive sensors - working principle of various sensors - crankshaft position sensors - throttle position sensor - oxygen sensor - manifold pressure sensor - mass air flow sensor - engine coolant temperature sensors - vehicle speed sensors - exhaust gas oxygen sensors - knock sensors. **Actuators** - Types of actuators - idle speed actuator - unit injector - Exhaust Gas Recirculation (EGR) valve and control. Engine management system - block diagram and working principle - ECUs used in the engine management - On Board Diagnosis (OBD) Purpose of On Board Diagnostic second generation - OBD II concept - SAE J2012 standard diagnostic trouble code (DTC).

Vehicle Control and Safety Systems: Automatic Transmission System - electronic clutch - active suspension system - electronic suspension system - traction control system - electronic power steering control – electronic differential - Advanced Driver Assistance Systems (ADAS) - adaptive cruise control system - anti-lock braking system - vehicle and artificial intelligence - autonomous vehicles - object detection - collision warning and avoidance systems - airbags. Case studies - Technological development in modern automotives.

Total Hours:	45

Text Books:

1	Tom Denton, “Automobile Electrical and Electronic Systems” 5th edition, Routledge, United Kingdom, 2018.
2	William.B.Ribbens, “Understanding Automotive Electronics” 8th edition Butterworth-Heinemann publications, 2017.

Reference Books:	
1	Robert Bosch Gmbh, “Bosch Automotive Electric and Electronics” 5th edition Springer-Vieweg.2013
2	Barry Hollembeak, “Automotive Electricity and Electronics” Cengage Learning, 2017.
3	Tom Denton, “Electric and Hybrid Vehicles” 2nd edition, Routledge, United Kingdom, 2020.
Web References:	
1	https://www.udemy.com/course/basics-of-automotive-electronics/
2	https://archive.nptel.ac.in/courses/107/106/107106088/
Online Resources:	
1	https://www.youtube.com/watch?v=BOP8qLQzhDc
2	https://elearn.nptel.ac.in/shop/iit-workshops/completed/emobility-and-electricvehicle-engineering-cohort-2/

22ME903	ALTERNATE ENERGY SOURCE FOR AUTOMOBILES	3/0/0/3

Nature of Course	Theory technology
Pre-Requisites	Engineering Thermodynamics, Thermal Engineering, Automobile Engineering

Course Objectives:

1	To expose the students to the available alternate energy resources.
2	To provide insights about new energy sources like CNG, Renewable oils, and Hydrogen.
3	To recognize the ways of utilizing the energy resources in conventional vehicles.

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

C903.1	Study the need, availability and difficulty in using alternate fuels.	[U]
C903.2	Analyze properties of alternate fuels and know the standards followed.	[A]
C903.3	Analyze the performance and emission characteristics of engines using alternate fuels.	[A]
C903.4	Discover the developments in hybrid energy and fuel cells.	[Ap]
C903.5	Analyze the technology behind developing of electric, hybrid and fuel cell vehicles.	[A]

Course Contents:

Introduction: Need for alternate fuels, Properties of alternate fuels, general use of alcohols, LPG, hydrogen, CNG, LNG. **Alcohols:** Properties of engine fuel, alcohols andgasoline blends, Performance, combustion characteristics and Emission characteristics in SI and CI engine.

Natural Gas, LPG, Hydrogen and Biogas: CNG vehicles, availability of CNG, properties, modifications required to use in engines, performance and emission characteristics of CNG and LPG in SI and CI engines, hydrogen storage and handling, performance and safety aspects. **Renewable Oils:** Esterification, Performance and emission characteristics in engines. Hybrid oils in engines. Renewable Fuel Standard (RFS)

Electric, Hybrid, Fuel Cell and Solar Cars: Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, series and parallel hybrid vehicle, fuel cell vehicles, solar powered vehicle.

Total Hours:	45

Text Books:

1	Amit Sarin, “Biodiesel- Production and Properties”- RSC Publishing - ISBN:978-1-84973-470-7, 2019.
2	Sunggyu Lee, James G. Speight, Sudarshan K. Loyalku- “Handbook ofAlternative Fuel Technologies”- CRC Press- 2015

Reference Books:

1	James D. Halderman, “Hybrid and Alternative Fuel Vehicles”- Pearsonpublication2015
2	Curtis D. Anderson and Judy Anderson, “Electric and Hybrid Cars- A History”McFarlad& Company, Inc, Publishers- 2013.

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/

22ME904	AUTOMOTIVE COMPONENT MANUFACTURING	3/0/0/3

Nature of Course	Theory
Pre-Requisites	Automobile engineering, Manufacturing Technology.

Course Objectives:

1	To impart knowledge on various processes involved in the manufacturing of automotive components.
2	To address the underlying concepts and methods behind automobile engine component manufacturing.
3	To understand the fundamentals of modern manufacturing methods in automotive industry.

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

C904.1	Describe the various manufacturing processes employed for producing engine components	R
C904.2	Illustrate the appropriate manufacturing process for manufacturing transmission system components.	U
C904.3	Select the relevant heat and surface treatment methods for engine and transmission Components	AP
C904.4	Outline the automotive body components manufacturing methods	AP
C904.5	Choose a suitable material and process for manufacturing of automobile components like chassis, wheel, brake and tyres	AP

Course Contents:

Engine Components: Casting of engine block - conventional and expendable pattern, casting of cylinder heads, cylinder liners, crankshaft, connecting rod and gudgeon pins-forging and casting, machining and heat treatment. Casting of piston - gravity casting, squeeze casting, machining and finishing and piston ring manufacturing. Upset forging of valves - heat treatment and surface improvement. Engine bearing manufacturing.

Transmission Components: Manufacturing of friction plates using conventional blanking and fine blanking. Manufacture of composite friction lining, composite moulding of phenol formaldehyde lining. Casting of gear box casing, precision forging of gears, gear hobbing, shaping, powder metallurgy, orbital forming of spur, helical, and bevel gears, hypoid gears, heat treatment and finishing. Propeller shaft – continuous casting, extrusion, heat treatment and surface hardening, composite propeller shaft manufacturing. Forging of rear axles, casting of rear axle casing, manufacturing of wheels and brake drums.

Chassis Components, Tyres and Advanced Manufacturing: Selection of material and manufacturing methods for vehicle frame manufacturing, steering systems, shock absorbers, dead axle – casting, forging, machining and finishing operation- Heat treatment procedures for chassis components. Tyre and tube manufacturing, prototype manufacturing -RPT,3-D Printing, chemical vapour deposition, physical vapour deposition, cryogenic grinding of powders, sealants, sound proof materials, structural adhesives, MMC liners

Total Hours:	45

Text Books:

1	Philip F. Ostwald & Jairo Munuz, “Manufacturing Processes and Systems”, John Wiley & Sons, New York, 2018
2	Degarmo E.P., “Materials and process in Manufacturing”, Macmillan Publishing Co, 2019.

Reference Books:

1	Kalpakjian, “Manufacturing Engineering and Technology”, Publisher: Pearson, 2013.
2	Sanjay K Mazumdar, “Composites Manufacturing”, CRC Press, NY, 2014.

Web References:	
1	https://www.youtube.com/watch?v=hs7bABMtOMI&t=71s
2	https://www.youtube.com/watch?v=H_RgFXjg-5s
Online Resources:	
1	https://www.youtube.com/watch?v=hs7bABMtOMI&t=41s

22ME905	SMART AND INTELLIGENT MOBILITY	3/0/0/3
Nature of Course	Theory	
Pre-Requisites	Automobile Engineering	

Course Objectives:

1	To understand the basics of autonomous and connected vehicle
2	To elaborate various technologies used in autonomous vehicle
3	To understand the impact of automating various driving functions, connecting the automobile to sources of information that assist the task

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

C905.1	Summarize the concept of fully autonomous vehicles.	U
C905.2	Recall the concept of remote sensing and the types of sensor technology needed to implement remote sensing.	R
C905.3	Apply the technologies of cyber physical control systems to avoid collision in autonomous vehicles.	Ap
C905.4	Apply various decision and control technologies in intelligent vehicles.	Ap
C905.5	Analyze the concept of the connected vehicle and its role in automated vehicles.	A

Course Contents:

Introduction to Autonomous and Connected vehicles:
Concept of automotive electronics, history & evolution, body, chassis and powertrain electronics. Introduction to automated, connected, intelligent vehicles, unmanned aerial vehicle and drones, case studies. Fundamentals of connectivity, navigation and other applications, multimedia communication in vehicles, vehicle-to-vehicle technology and applications, vehicle-to-roadside and vehicle-to-infrastructure applications, challenges and issues.

Technologies for Smart Mobility: Overview of technologies in autonomous cars, basics of radar technology and systems, ultrasonic sonar systems, lidar sensor technology and systems, camera technology, night vision technology, other sensors, integration of sensor data to on-board control systems, overview of the operation of ECUs, basic cyber-physical system theory, role of surroundings sensing systems and wireless data networks.

Intelligent Vehicle Decision and Control Techniques: Adaptive control system techniques, system model for adaptive control. Design of self-tuning controllers. Fuzzy control systems. Fuzzy control of distance and tracking. Sharp control and decisional architecture for autonomous vehicles. Motion planning for vehicles. Trajectory planning and state time space, nonholonomic path planning.

Total Hours:	45

Text Books:

1	Radovan Miucic, “Connected Vehicles: Intelligent Transportation Systems”, Springer, 2019.
2	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, ‘Autonomous Vehicles – Technologies, Regulations and Societal Impacts, Elsevier, 2021.

Reference Books:

1	Alaa Khamis, ‘Smart Mobility – Exploring Foundational Technologies and wider impacts’, Apress, Canada, 2021.
2	Hussein T. Mouftah, Melike Erol-Kantarci, Sameh Sorour, ‘Connected and Autonomous Vehicles in Smart Cities’ CRC Press, 2021.
3	Tom Denton, “Automobile Electrical and Electronic systems, Roultedge”, Taylor & Francis Group, 2018.

Web References:	
1	https://intellias.com/smart-mobility-ecosystem/
2	https://www.lslidar.com/solution/smart-mobility/
Online Resources:	
1	https://www.coursera.org/learn/electric-vehicles-mobility
2	https://www.coursera.org/learn/people-technology-and-the-future-of-mobility

22ME906	DRONE TECHNOLOGIES	3/0/0/3
Nature of Course	Theory	
Pre-Requisites	Fundamentals of Electrical and Electronics Engineering	

Course Objectives:	
1	To understand the basics concepts, fabrication and programming of drone.
2	To impart the knowledge of a flying and operation of drone
3	To understand the applications of drones in various industries

Course Outcomes: **Upon completion of the course, students shall have ability to**		
C906.1	Recall the various types of drones and its components.	[U]
C906.2	Select appropriate sensors required and operating principles of the drones.	[Ap]
C906.3	Describe various testing methods and applications for drones.	[Ap]
C906.4	Execute the of drone control systems and programming.	[U]
C906.5	Design and development of a drones for specific applications.	[C]

Course Contents:

Introduction to Drones: Introduction to Unmanned Aerial Vehicles - History of UAV, drone technology – Classification of UAV - Types of drones based on propulsion and applications – Drone Components and Systems - Drone construction components and configurations - Frames and propellers – Batteries, Motor and power systems - Sensors and payloads - Flight controllers - Drone Flight Principles. Internet of Thinks Systems and Controls - Intelligence Systems in Drones.

Drone Design, Development and Control Systems: Aerodynamics effects of drones - UAV Material Selection – Design and Fabrication for Balancing of Gliders, Aspect Ratio, Tail and Winglets Design Configuration, Controls Deflection and Mixing. Basic flight maneuvers - Flight planning and navigation. Drone Control Systems – Transmitter, Remote control systems - Autopilot systems - Telemetry systems - Methods of drone programming.

Drone Testing Methods and Applications – Thrust Calculation, Weight Calculation, CG Balancing, Roll Balancing, Servo Testing, LiPo Balancer and Tester, Propeller Balancing, Payloads, Range Testing, Vibration Testing. Drone Maintenance - Troubleshooting common problems. Drone Regulations and Safety - Drone License. Overview of Drone Applications, localization and mapping.

Total Hours:	45

Text Books:	
1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, Inc., 2021.
2	Garg, P. K, “Unmanned Aerial Vehicles: An Introduction”, Stylus Publishing, LLC., 2021.

Reference Books:	
1	Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016.
2	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
3	Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

Web References:	
1	https://nptel.ac.in/courses/101104073
2	http://www.jetaero.in/internship/page-11564021

Online Resources:	
1	https://www.youtube.com/watch?v=P9adBgSz--g
2	https://www.youtube.com/watch?v=qBx-uCaAltM

22ME907	DIGITAL MANUFACTURING	3/0/0/3

Nature of Course	Theory
Pre-Requisites	Manufacturing Technology I and II

Course Objectives:

1	To study the various aspects of digital manufacturing and understand the importance of digital manufacturing in product lifecycle management and supply chain management.
2	To elaborate the significance of digital twin.
3	To formulate smart manufacturing systems in the digital work environment.

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

C907.1	Describe the fundamental concepts of digital manufacturing.	U
C907.2	Select tools and technologies used in implementation of digital manufacturing.	U
C907.3	Apply digital technologies in various manufacturing and process industry.	Ap
C907.4	Analyze and optimize various practical manufacturing process through digital twin.	A
C907.5	Implement digital environment in product life cycle and supply chain management.	Ap

Course Contents:

Introduction to Digital Manufacturing: Introduction – need – overview of digital manufacturing. technologies behind digital manufacturing – benefits of digital manufacturing. **Smart Factory:** Smart factory – levels of smart factories, key principles of a smart factory – creating a smart factory – smart factories and cyber security.

IoT and Industry 4.0: Industry 4.0 – internet of things – industrial internet of things, monitoring manufacturing processes, intelligent machining – cloud computing – big data analytics – cyber physical systems - collaborative robots. Artificial Intelligence and Machine Learning in Manufacturing. Augmented Reality and Virtual Reality in Manufacturing. Case Study.

Digital Twin: Digital twin concept, digital twin in manufacturing, digital twin platform ecosystem, digital twin implementation and guidelines, business advantages of digital twin, challenges and risk. case study. **Digital Product Life Cycle & Supply Chain Management:** Phases of digital life cycle, digital technologies in product life cycle, collaborative product development, case study. Overview of digital supply chain – effective digital transformation - scope & challenges in digital supply chain – case study.

Total Hours:	45

Text Books:

1	Kaushik Kumar, Divya Zindani, J. Paulo Davim, 'Digital Manufacturing and Assembly in Industry 4.0, Taylor & Francis Ld., 2020.
2	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2018.

Reference Books:

1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2019.
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
3	Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017

Web References:	
1	https://www.plm.automation.siemens.com/global/en/our-story/glossary/digitalmanufacturing/13157
2	https://www.twi-global.com/technical-knowledge/faqs/what-is-digital-manufacturing
Online Resources:	
1	https://www.coursera.org/specializations/digital-manufacturing-design-technology
2	https://www.udemy.com/course/digital-manufacturing-and-industry-40-trainingcourse/

22ME908	MODERN ROBOTICS	3/0/0/3

Nature of Course	Concept and Theory
Pre-Requisites	Engineering Mechanics, Mechanics of Machinery

Course Objectives:

1	To introduce the history of robotics and robot anatomy.
2	To impart knowledge on robot end effectors, arm and their design.
3	To understand the simulation of robot kinematics.
4	To study the mobile robots and its manipulation.
5	To study the application of robots in various sectors.

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

C908.1	Discuss the definition, history of robotics and robot anatomy.	R
C908.2	Elaborate the types of robotic manipulators and gripper configuration based on kinematics and dynamics of robot.	U
C908.3	Develop the simulation of robot kinematics.	Ap
C908.4	Analyze the drive mechanism and power transmission methods used in robots.	A
C908.5	Describe the mobile robot and the application of robots in various sectors.	U

Course Contents:

INTRODUCTION TO ROBOT, SIMULATION OF ROBOT KINEMATICS
Robot: Definition, history of robotics, robot anatomy, co-ordinate systems, types and classification, configuration space and degrees of freedom of rigid bodies and robots, configuration space topology and representation; configuration and velocity constraints; task space and workspace, rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, homogeneous transformation matrices. robot kinematics, forward and inverse kinematics (two three four degrees of freedom), homogeneous transformation matrices.

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.

MOBILE ROBOTS AND APPLICATIONS OF ROBOTS
Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and nonholonomic wheeled mobile robots, controllability, motion planning, feedback control of nonholonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference trajectory generation, feed forward control. applications of robots: industrial robots, service robots, domestic and house hold robots, medical robots, military robots, agricultural robots, space robots, aerial robotics role of robots in inspection, assembly, material handling, underwater, space and healthcare.

Total Hours:	45

Text Books:

1	Julian Evans, “Modern Robotics: Mechanics, Systems and Control”, Larsen and Keller Education, 2019
2	Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill Education, 2nd Edition, 2018.

Reference Books:	
1	Jared Kroff, “Modern Robotics: Designs, Systems and Control”, Willford Press, 2019.
2	Chenguang Yang, Hongbin Ma, Mengyin Fu, “Advanced Technologies in Modern Robotic Applications”, Springer, 2018.
3	Harry Henderson, “Modern Robotics: Building Versatile Machines”, Facts on File Inc; Illustrated edition, 2006.
4	Francis X. Govers, “Artificial Intelligence for Robotics”, Packt Publishing Limited; Standard Edition, 2018.
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

22ME909	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 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 andsequencing 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

C909.1	Recall the fundamentals of hydraulic and pneumatic systems	[U]
C909.2	Select the components and control elements required for hydraulic and pneumatic systems as per the application.	[Ap]
C909.3	Analyze the scenario and provide suitable solution to the problems usinghydraulic and pneumatic systems.	[A]
C909.4	Design customized circuits in hydraulic systems for various industrialneeds	[C]
C909.5	Design customized circuits in pneumatic 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. 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 and KV map method **Design of Fluid Power Circuits**: Servo systems, hydro mechanical servo systems, electro hydraulic servo system and proportional valves, introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC and SCADA applications in fluid power control. Fluid power circuits, failure and troubleshooting.

Total Hours:	45

Text Books:

1	Ilango Sivaraman, “Introduction to Hydraulics and Pneumatics”, PHI Learning, 2019.
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

22ME910	PLC SCADA	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 PLC & SCADA, characteristics and taxonomy of industrial automation and control levels.
2	To study the value creation for an industry through PLC & SCADA.
3	To gain knowledge on the real time application of PLC & SCADA.

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

C910.1	Recall the main components used in the world of PLC &SCADA.	[R]
C910.2	Describe the applications of PLC and SCADA systems along with their design, installation, and operation.	[U]
C910.3	Programming and configuring PLC and SCADA systems,using industrystandard programming languages and software tools.	[Ap]
C910.4	Integrate PLC and SCADA systems with other automation systems and devices, such as sensors, actuators, and controllers.	[Ap]
C910.5	Design PLC and SCADA based systems for real time applications.	[A]

Course Contents:

INTRODUCTION
Basic Of electronics, electrical, instrumentation-understanding for automation & control system-job opportunity for PLC / SCADA- history of PLC / SCADA-basic components of automation-hardware / software classification of automation. **Introduction to PLC Systems-** Basic principles and architecture of PLCs- introduction to PLC- need of PLC in designing advantages and limitations of PLCs-types of PLC systems.

PLC (PROGRAMMABLE LOGIC CONTROLLER)
Automation concept and basic design-PLC programming-introduction of ladder logic- basic ladder logic symbols and operations-ladder logic programming rules and techniques- ladder logic programming examples and exercises-introduction of SFC- introduction of instruction list -creating & editing ladder logic program-different types of sensors-sinking, sourcing, NPN, PNP NO/ NC concept. **Troubleshooting and maintenance -** Fault identification and diagnosis - component replacement and repair - maintenance practices and procedures - **Design and implementation of simple PLC systems -** Process control and automation-monitoring and reporting systems - safety systems.

SCADA (Supervisory Control and Data Acquisition)
Introduction to SCADA systems- Basic principles and architecture of SCADA systemsadvantages and limitations of SCADA systems- types of SCADA systems. **SCADA software tools-** Introduction to industry - standard SCADA software tools - SCADA system configuration and design- HMI design and configuration. **Alarm management-**Basic principles of alarm management- alarm design and configuration. **Design and implementation of simple SCADA systems**-Process control and automation.

Total Hours:	45

Text Books:

1	Stephen P Tubbs, “Programmable Logic Controller (Plc) Tutorial, Siemens Simatic S7-200", 2007.
2	Kevin Collins, "PLC Programming for Industrial Automation", 2016.
3	Ronald L. Krutz and Russell Dean Vines, "Industrial Automation and Control System Security Principles", 2022.

Reference Books:	
1	Frank Petruzella, "Programmable Logic Controllers", 2016.
2	Francis G. L , “SCADA: Beginner's Guide”, 2016.
3	Stuart A Boyer, “SCADA: Supervisory Control and Data Acquisition”, Fourth Edition 4th Edition, 2016.
4	PLC Handbook,Practical Guide to Programmable Logic Controllers.
Web References:	
1	https://electrical-engineering-portal.com/scada-systems
2	https://www.automationdirect.com/plc-training/
Online Resources:	
1	https://www.coursera.org/lecture/intelligent-machining/programmable-logiccontrollers-plc-fGz3r
2	https://www.plcacademy.com/
3	https://www.coursera.org/lecture/electrical-power-distribution/introduction-to-scada4bqDt

22ME911	IMMERSIVE TECHNOLOGIES	3/0/0/3
Nature of Course	Theory	
Pre-Requisites	Introduction to computer graphics	
Course Objectives:		
1	To understand various immersive technologies via VR, AR and MR.	
2	To learn software related to immersive technologies.	
3	To understand the logic of developing AR applications, VR and unreal engine	
Course Outcomes: Upon completion of the course, students shall have ability to		
C911.1	Elucidate the fundamentals of immersive technologies.	U
C911.2	Analyse the different types of tools and devices used in immersive technology.	A
C911.3	Use the features of unity and unreal engine.	A
C911.4	Discuss about haptics in immersive technologies.	U
C911.5	Developing the applications related to AR/VR systems.	C
Course Contents:		
INTRODUCTION TO IMMERSIVE TECHNOLOGIES Introduction on virtual reality – augmented reality – mixed reality – extended reality – VR devices – AR devices – applications. **SOFTWARE TOOLS -** Intro to unity – unity editor workspace – intro to C# and visual studio - programming in unity – intro to unreal engine – UE4 Editor workspace – intro to blueprint programming – programming in Ue4. **BUILDING AR APPLICATION WITH UNITY** - AR SDKs for unity and unreal engine – working with SDKs for unity – developing AR application in unity - building AR application. **BUILDING VR APPLICATION WITH UNREAL ENGINE -** VR SDKs for unity and unreal engine – developing VR application in Ue4 – building VR application.		
	Total Hours:	45
Text Books:		
1	Steve Aukstakalnis, “Practical Augmented Reality”, Addison-Wesley Professional; 2nd edition 2017.	
2	Simon Moore, “Strategic Communication and AI”, Roland Hübscher, Routledge; 1st edition 2022.	
Reference Books:		
1	Kim Marriott, “Immersive Analytics”, Falk Schreiber, Springer; 1st ed. 2018 edition, 2018.	
2	Gerardus Blokdyk, “Immersive Analytics a Clear and Concise Reference”, 5STARCooks, 2018.	
Web References:		
1	Kelly S. Hale, Kay M. Stanney, “Handbook of Virtual Environments: Design, Implementation, and Applications”, Second Edition (Human Factors and Ergonomics), 2014.	
Online Resources:		
1	Michael Heim. 1994. The Metaphysics of Virtual Reality. http://doi.org/10.1093/acprof:oso/9780195092585.001.0001	
2	Anton Nijholt. 2014. Playful User Interfaces. https://doi.org/10.1007/978-981-4560-96-2	

22ME912	COMPUTER INTEGRATED MANUFACTURING	3/0/0/3
Nature of Course	Theory	
Pre-Requisites	Manufacturing Technology	

Course Objectives:

1	To understand the evolution of automation, CIM and its principles.
2	To elaborate on the automation tools and material handling system.
3	To familiarize students with group technology and FMS

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

C912.1	Describe the application of computer aided tools in manufacturing.	U
C912.2	Apply computer integrated manufacturing in future automated industry.	Ap
C912.3	Recall the tools and component in material handling systems.	R
C912.4	Apply appropriate automotive tools and material handling systems.	Ap
C912.5	Discuss the overview of group technology and FMS.	U

Course Contents:

Introduction to Computer Integrated Manufacturing:
Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – production concepts and mathematical models – simple problems in production models – CIM hardware and software – major elements of CIM system – three step process for implementation of CIM – computers in CIM – computer networks for manufacturing – the future automated factory – management of CIM – safety aspects of CIM– advances in CIM.

Automated Manufacturing Systems:
Automated production line – system configurations, work part transfer mechanisms – fundamentals of automated assembly system – system configuration, part delivery at workstations – overview of material handling equipment – consideration in material handling system design – the 10 principles of material handling. automated guided vehicle system – types &applications – vehicle guidance technology – vehicle management and safety. storage system performance – storage location strategies – conventional storage methods and equipment – automated storage/retrieval system and carousel storage system deadlocks in automated manufacturing systems.

Group Technology And FMS: Part families – visual – parts classification and coding – production flow analysis – grouping of parts and machines by rank order clustering method – benefits of GT – case studies. FMS – components – workstations – FMS layout configurations – computer control systems – FMS planning and implementation issues – architecture of FMS – flow chart showing various operations in FMS – machine cell design – composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – simple and complicated problems – extended bottleneck model - sizing the FMS – FMS applications, benefits.

Total Hours:	45

Text Books:

1	Shivanand H K, Benal M M and Koti V, “Flexible Manufacturing System”, New Age, 2018.
2	R. Panneerselvam, P. Senthilkumar, P. Sivasankaran, “Computer Integrated Manufacturing: Automation in Manufacturing”, Cengage India, 2020

Reference Books:

1	Vajpayee S Kant, “Principles of Computer Integrated Manufacturing”, PHI Learning, 2018
2	A W Scheer, “Computer Integrated Manufacturing: Towards the factory of the future”, Springer, 2019
3	V D Hunt, “Computer Integrated Manufacturing: Handbook”, Springer, 2016

Web References:	
1	https://www.armagard.com/ip54/computer-integrated-manufacturing-explainedclearly.html
2	https://www.britannica.com/technology/computer-integrated-manufacturing
Online Resources:	
1	https://www.coursera.org/specializations/autodesk-cad-cam-manufacturing
2	https://www.edx.org/micromasters/mitx-principles-manufacturing

22ME913	COMPOSITE AND SMART MATERIALS	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 equip the students with knowledge on fabrication and testing of composites.
2	To enable them to understand the different types of composite materials, their properties and applications.
3	To understand the fundamentals of smart materials.

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

C913.1	Recall the types of composite materials and their characteristic features.	[R]
C913.2	Identify the suitable technique for manufacturing different types of composite materials.	[U]
C913.3	Predict the advances in composite materials and their applications in automotive, aerospace and industrial sectors.	[Ap]
C913.4	Examine the mechanical properties of composites.	[Ap]
C913.5	Discover the principle concepts of smart materials, characteristics 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, merits, demerits and applications of MMC. **Processing of MMC** – Powder metallurgy process - diffusion bonding, stir casting – squeeze casting, friction stir processing, **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 - testing of composites as per ASTM standard.

SMART MATERIALS: Electro rheological and magneto rheological Fluids. **Piezoelectric**, Magneto strictive materials, active smart polymer and shape-memory alloy. Material characteristics of smart materials, applications. **Vibration Absorbers** - Parallel damped vibration absorber, gyroscopic vibration absorbers.

Total Hours:	**45**

Text Books:

1	Ronald, F. Gibson, “Principles of Composite Material Mechanics”, Fourth Edition, CRC Press, 2020.
2	Daniel Gay “Composite Materials: Design and Applications”, Third Edition, CRC Press, 2015.
3	Srinivasan A V and Michael McFarland, “Smart Structures: Analysis and Design”, Cambridge University Press, UK, 2016.

Reference Books:

1	Deborah D.L. Chung, “Composite Materials”, Second Edition, Springer, 2020.
2	Nikhilesh Chawla, Krishan K. Chawla, “Metal Matrix Composites”, Second Edition, Springer, 2018.

3	Ricky Peyret, “Smart Materials: Advanced Concepts and Research”, NY Research Press ,2015.

Web References:	
1	https://www.youtube.com/watch?v=VMH6qbED7pg
2	https://www.pnas.org/doi/10.1073/pnas.96.15.8330
Online Resources:	
1	https://nptel.ac.in/courses/112104168/
2	http://nptel.ac.in/courses/101104010/

22ME914	ADVANCED MANUFACTURING TECHNIQUES	3/0/0/3

Nature of Course	Theory
Pre-Requisites	Manufacturing Technology II (with lab)

Course Objectives:

1	To acquaint the basic concepts and applications of micro and nanomanufacturing processes.
2	To encourage the students for developing the models of micro and nano machining processes.
3	To select an appropriate surface modification technique depending on the need.

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

C914.1	Recognize the fundamental micro and nano machining processes and their process parameters.	[R]
C914.2	Examine the appropriate machining process based on tool-workpiece interaction and source of energy for the end product.	[A]
C914.3	Discover the advanced finishing processes.	[Ap]
C914.4	Describe the process of surface cleaning techniques, coating methods and property enhancement methods.	[U]
C914.5	Select and use an appropriate deposition technique for various materials.	[Ap]

Course Contents:

Introduction: Fundamentals of micro and nano machining processes - theory of micromachining, micromilling, micro-grinding. operating principles and process parameters, applications and limitations. EDM and wire cut EDM process – process parameters, surface finish and MRR. **Advanced High Energy processes:** Laser beam machining – plasma arc machining - electron beam machining – principles, equipments, beam control techniques, advantages, disadvantages and applications.

Nano manufacturing processes: General methods of preparation – bottom up, top down approach – Co precipitation – ultrasonication – mechanical milling – **Advanced Finishing process –** Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing, working principles, equipments, effect of process parameters. Thermal barrier coating – laser shock peening – nano scale surface hardening. **MEMS and Actuators** - Sensors and actuators, mems, wet and dry etching - surface micromachining, metrology for micro manufactured products.

Surface engineering: Fundamental of 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	Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, India, 2019.
2	P Pandey and H Shan, “Modern Machining Processes”, McGraw Hill Education, 2017.
3	Peter Martin, “Introduction to Surface Engineering and Functionally Engineered Materials”, Inter science Wiley, 2011.

Reference Books:

1	Golam Kibria, B. Bhattacharyya, J. Paulo Davim, “Non-traditional micro machining processes: Fundamentals and applications”, Springer International publishing, 2017.
2	H. El-Hofy, “Fundamentals of Machining Processes: conventional and nonconventional”, 2nd edition, CRC press, Taylor & Francis group, 2014.
3	Steven Abbott, Nigel Mac Dermid, “Nanocoatings: Principles and Practice: From Research to Production”, DEStech Publications, 2013.
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/

22ME915	FAILURE ANALYSIS AND NON-DESTRUCTIVE TESTING	3/0/0/3

Nature of Course	Theory Application
Pre-Requisites	Manufacturing Technology – I & II, Industrial Metallurgy, Strength of Materials

Course Objectives:

1	To introduce the scope of failure analysis and fundamental sources of failures.
2	To study the different types of failure analysis tool.
3	To examine the students to non-destructive testing methods and basic principles of visual inspection.
4	To examine the students to understand the principle of magnetic testing, radiography testing and inspection techniques.
5	To study the basic principles of ultrasonic and acoustic emission testing method.

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

C915.1	Recall the fundamental concepts of failures in engineering materials.	[R]
C915.2	Infer the types of engineering material failures and analyze its causes.	[An]
C915.3	Apply various failure analysis techniques / tools to appropriate scenario.	[Ap]
C915.4	Summarize the basic concepts of non-destructive testing methods.	[U]
C915.5	Identify and apply suitable non-destructive testing methods to predict surface and sub surface flaws.	[Ap]

Course Contents:

Introduction and need and scope of failure analysis. Engineering disasters and understanding failure analysis. Fundamental sources of failures. Deficient design. Improper manufacturing & assembly. Tree diagram and FMEA. Material failure modes and their identification. Tensile test, static loading, combined stress, principal stresses, theories of failure, fracture processes, meaning of ductile and brittle fracture, fracture mechanics and failure. **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.

Introduction to Non-Destructive Testing: Introduction, visual examination, Basic principle, applications. **Liquid Penetrant Testing**: Procedure for penetrant testing, penetrant testing materials, penetrant testing methods, applications, limitations and standards. **Magnetic Particle Testing:** Principle of magnetic particle testing, magnetizing techniques, procedure used for testing a component, limitations. **Eddy Current Testing:** Principles, instrumentation for eddy current testing techniques. applications, limitations. **Radiographic Testing**: Radiography, radiographic imaging, inspection techniques, applications of radiographic inspection, limitations, safety in industrial radiography, standards, neutron radiography.

Ultrasonic Testing: Basic principle, techniques for normal beam inspection, techniques for angle beam inspection, flaw characterization techniques, advantages, limitations. **Acoustic Emission Testing**: Principle of acoustic emission testing, technique, applications, standards. **Thermograph:** Basic principles, techniques, applications, codes and standards. **In Situ Metallographic Examination:** Approach to the selection of site for metallographic examination, significance of microstructure observation, applications, codes and standards (digital signal process).

Total Hours:	45

Text Books:

1	Fausto Pedro Garcia Marquez, “Non-Destructive Testing”, Intech, 2016.
2	Gilles Corneloup, Cécile Gueudré, Marie-Aude Ploix, “Non Destructive Testing and testability of materials and structures”, The university of chigaco press, 2022.

Reference Books:	
1	ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2	ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
3	J. Prasad and C. G. K. Nair, “Non-Destructive Test and Evaluation of Materials”, Tata McGraw-Hill Education, 2nd edition, 2011.
Web References:	
1	https://www.asminternational.org/learning/courses/online//journal_content/56/10192/1961171/CLASS/
2	https://www.intertek.com/non-destructive-testing/materials-testing/component-failureanalysis-engineering-manufacturing/
Online Resources:	
1	https://onlinecourses.nptel.ac.in/noc21_me14/preview
2	https://onlinecourses.nptel.ac.in/noc20_mm07/preview

22ME916	GREEN AND SUSTAINABLE MANUFACTURING	3/0/0/3
Nature of Course	Theory	
Pre requisites	Environmental Science, Manufacturing Technology	
Course Objectives:		
1	To introduce the concept of green and sustainable manufacturing.	
2	To impart knowledge about air, noise and water pollution and its effects on the environment.	
3	To introduce the concept of green co-rating and its need.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C916.1	Elucidate the concept of green and sustainable manufacturing and applying metrics in manufacturing.	[R]
C916.2	Analyze the difficulties in the conventional machining process.	[A]
C916.3	Summarize the manufacturing processes in order to minimize the air, noise and water pollution.	[U]
C916.4	Evaluate green co-rating and its benefits.	[AP]
C916.5	Select the modern approach for sustainable manufacturing.	[R]
Course Contents:		
INTRODUCTION TO SUSTAINABLE GREEN MANUFACTURING: Introduction of green factory, sustainability and its relevance, metrics for green manufacturing, modern approaches for sustainable manufacturing, toxic substances in industry and need of renewable sources. **DIFFICULTIES IN CONVENTIONAL MACHINING:** Importance of cutting fluids- health hazard and environmental issues using coolants-coolant selection criteria-motivations behind the use of green machining-concept for productivity improvement-typical measures of affecting productivity. **AIR POLLUTION SAMPLING AND MEASUREMENT:** Primary and secondary pollutants- automobile pollutants- industrial pollution- ambient air quality standards-metrological aspects of air pollution. **NOISE POLLUTION AND CONTROL:** Frequency and sound levels-units of noise based power radio- contours of loudness. effect of human-environment and properties-measuring instruments for frequency and noise levels. **WATER DEMAND AND WATER QUALITY**: Factors affecting consumption- variation- contaminants in water- taste and odour-radio activity in water- criteria for different impurities in water for portable and non-portable use. **GREEN CO-RATING:** Ecological footprint - need for green co-rating – green co-rating system, assessment process – types of rating – green co-benefits – case studies of green co rating. **MODERN APPROACHES FOR SUSTAINABLE MANUFACTURING:** Green manufacturing techniques: dry and near-dry machining-edible oil based cutting fluids- cryogenic machining - energy efficiency characterization of manufacturing processes - various instruments used for green machining.		
	Total Hours:	**45**
Text Books:		
1	T E H Graedel, “Industrial Ecology and Sustainable Engineering”, Pearson, 2015.	
2	Tang, Sustainable Environmental Engineering”, Wiley, 2018.	
Reference Books:		
1	Ni-Bin Chang and Ana Pires, “Sustainable Solid Waste Management A Systems Engineering Approach”, Wiley, 2018.	
2	Dr. K. Jagannadha Rao, Dr. Srinivas Vasam, “Sustainable Engineering”, S.K. Kataria & Sons, 2021.	
3	Bali, Vikram, “Handbook of Sustainable Development Through Green Engineering and Technology”, Hardbound, Taylor and Francis Ltd, 2022.	

Web References:	
1	https://www.teslamechanicaldesigns.com/blog/concept-of-green-design-andmanufacturing/
2	https://blog.hexagonmi.com/en/beyond-green-factories-the-power-of-eco-design/
Online Resources:	
1	https://study.com/learn/lesson/green-design-sourcing-manufacturing.html

22ME917	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

C917.1	Recall the concept of additive manufacturing and post processing	[R]
C917.2	Summarize the reverse engineering, data processing and AM design	[U]
C917.3	Apply the various types of additive manufacturing techniques	[Ap]
C917.4	Use the various AM process parameter effects on response	[Ap]
C917.5	Develop critical parts using various AM technology	[A]

Course Contents:

Introduction to Additive Manufacturing: Overview of AM - scope and need - survey of AM applications. classification of AM process, AM process chain, reverse engineering – basic concepts, digitization techniques types. **Data Processing for AM:** Conceptualization to build model, AM software's – **AM Design:** Need for Design for Additive Manufacturing (DfAM), CAD tools vs. DfAM tools - generative design technology for developing critical parts - topology optimization. **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 AM Process: Powder Bed Fusion: Selective laser sintering, selective laser melting, electron beam melting, **Directed Energy Deposition:** Laser metal deposition- laser engineered net shaping -direct metal deposition, electron beam based metal deposition, principle of operation, machine details and variants, materials used, process details, process parameters effect on responses and applications, advantages and disadvantages, case studies – research findings of binder jetting technique, friction stir additive manufacturing - wire arc additive manufacturing.

Self-study: Role of AM in I4.0, IIoT AI and ML for AM Systems (not for exam)

Total Hours:	**45**

Text Books:

1	3D Printing Technology, Applications, and Selection By Rafiq Noorani · 2017
2	Additive Manufacturing: Advanced Materials and Design Techniques by Pulak Mohan Pandey 2022.

Reference Books:

1	Duc Pham, S.S. Dimov, "Rapid Manufacturing Technologies and Applications of Rapid Prototyping and Rapid Tooling", 2012
2	Gibson, Ian, David W. Rosen, Brent Stucker, and Mahyar Khorasani, "Additive Manufacturing Technologies", Springer, 2021.

Web References:

1	https://www.youtube.com/watch?v=NkC8TNts4B4

2	https://www.youtube.com/watch?v=t7yv4gSnNkE&list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy
Online Resources:	
1	https://nptel.ac.in/courses/112107077/382
2	https://nptel.ac.in/courses/112107078/37
3	https://www.coursera.org/learn/additive-manufacturing-3d-printing

22ME918	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 design cost/time, maximizing the quality and improve ease of manufacture and assembly.
3	To enable the students to understand the principles and design rules pertaining to design for casting, welding, machining and assembly.
4	To outline the features of DFMA software.

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

C918.1	Summarize the design procedure of engineering products in order to minimize the cost/time.	[U]
C918.2	Analyse the importance of tolerance and process capability in promoting interchangeability and selective assembly.	[A]
C918.3	Analyze the design process of engineering products for ease of assembly.	[A]
C918.4	Apply the design concepts for engineering products for casting, welding and machining operations.	[Ap]
C918.5	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.

Design for casting, welding and machining: Design considerations for sand cast – die cast – permanent mold cast parts, arc welding – design considerations for cost reduction – minimizing distortion – weld strength – weldment & heat treatment. resistance welding – design considerations for spot – seam – projection – flash & upset weldment, design considerations for turned parts – drilled parts – milled, planed, shaped and slotted parts– ground parts.

Design for welding and DFMA software: Design for assembly – general assembly recommendations – minimizing the no. of parts – design considerations for: rivets – screw fasteners – gasket & seals – press fits – snap fits – automatic assembly, advances in DFMA-Design for robustness– 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	Kalandar Saheb, 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
2	https://engineeringproductdesign.com/knowledge-base/design-for-manufactureand-assembly/
Online Resources:	
1	www.nptel.ac.in/courses/107103012
2	www.mjme.ir-International journal of advanced design and manufacturing

22ME919	LEAN SIX SIGMA	3/0/0/3

Nature of Course	Theory Application
Pre-Requisites	Manufacturing Technology - I

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

C919.1	Recall the various applications of lean six sigma tools in industries.	R
C919.2	Study the challenges in implementing six sigma.	U
C919.3	Illustrate the various principles of lean six sigma in different sectors.	A
C919.4	Reduce the process variation and improve the efficiency of the process using the tools of lean six sigma.	Ap
C919.5	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 team – 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,2022.
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.html
Online Resources:	
1	http://nptel.ac.in/courses/110105039

22ME920	INDUSTRIAL LAYOUT, SAFETY AND PRODUCTION MANAGEMENT	3/0/0/3
Nature of Course	Theory Application	
Pre-Requisites	Manufacturing Technology	

Course Objectives:

1	To acquire knowledge about the importance of industrial layout, types of hazards and safety requirement in industries.
2	To study the importance of production planning and control in industry.
3	To enable the students estimate the cost for various products after process planning.

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

C920.1	Identify the key factors influencing plant location decision and site selection.	R
C920.2	Interpret all types of plant layouts for better industrial layout design.	U
C920.3	Analyse the workplace hazards and implement the procedures to control them.	A
C920.4	Apply the concepts of production and process planning to solve the various production scheduling problems.	Ap
C920.5	Estimate the manufacturing cost for foundry, machining and welding operations.	A

Course Contents:

PLANT ECOLOGY: 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, 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 AND SAFETY:** Industrial accidents, electrical hazards, detection and prevention of electrical hazards, chemical hazardous materials, mechanical hazards and the environment hazards of the environment hazardous waste reduction. Safety and health training, occupational safety and work place violence.

PRODUCTION PLANNING AND PROCESS PLANNING: Product planning - extending the original product information – value analysis - problems in lack of product planning. Process planning and routing – pre-requisite information needed for process planning – steps in process planning - quantity determination in batch production - machine capacity, balancing - analysis of process capabilities in a multi-product system. Introduction to production control. **CAPACITY PLANNING:** Measures of capacity, factors affecting capacity, capacity planning, systematic approach to capacity planning, long-term and short-term capacity decisions, tools for capacity planning.

PRODUCTION SCHEDULING: Principles of scheduling –Inputs to scheduling strategies - types of scheduling. Master production scheduling- Inputs and data sources for MPS –Material requirement planning - dispatching - manufacturing lead time. **COST ESTIMATION:** Types of estimates – methods of estimates – data requirements and sources- collection of cost-allowances in estimation, Elements of cost. Estimation of material cost, labor cost and over heads, allocation of overheads, estimation of machining cost for drilling, boring and grinding, estimation of foundry and welding costs.

Total Hours:	45

Text Books:

1	Seán Moran, “Process Plant Layout” Butterworth-Heinemann publishers, 2018.
2	Martand T. Telsang, “Introduction to process planning”, S.Chand and Co, 2018.

Reference Books:	
1	Jack Greene “Plant Design, Facility Layout, Floor Planning”, CreateSpace Independent Publishing Platform, 2018.
2	Gregory K. Mislick, Daniel A. Nussbaum, “Cost Estimation: Methods and Tools”, Wiley series, 2020.
3	S.N. Chary, “Production and operations management”, Tata McGraw-Hill Education India, 5th edition, 2020.
Web References:	
1	https://www.educationalstuffs.in/types-of-plant-layouts/
2	http://www.treehugger.com/sustainable-product-design
Online Resources:	
1	http://nptel.ac.in/courses/107103004/31
2	https://www.coursera.org/learn/business-planning

22ME921	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 enable the students to understand the importance of IPR.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C921.1	Recall the basic product development process.	[R]
C921.2	Apply the design thinking process for product development.	[Ap]
C921.3	Elaborate the use of computers in decision making.	[U]
C921.4	Discover the IPR related issues and patent registration.	[U]
C921.5	Analyze the feasibility of the proposed project.	[A]
Course Contents:		
INTRODUCTION: Characteristics of successful product development, challenges of product development, the product development process, product life cycle, design thinking, product planning, identifying customer needs. **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 architecture, system level design issues. Embodiment design, robust design, design for environment, design for manufacturing and assembly. **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” 7th Edition, New York, McGraw-Hill Education, 2020.	
2	Ken Hurst, “Engineering Design Principles”, Elsevier Science and Technology Books, 2020.	
Reference Books:		
1	G. E. Dieter, “Engineering Design”, McGraw – Hill International, 2021.	
2	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-delftxdda691x-1

22ME922	ENTREPRENEURSHIP MANAGEMENT	3/0/0/3

Nature of Course	Theory Skill based
Pre-Requisites	Nil

Course Objectives:

1	To enable the students understand the scope of entrepreneurship and key areas of development.
2	To expose the students to institutions offering financial assistance, 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

C922.1	Define the basic concepts of entrepreneurship and skills needed for entrepreneurial management.	[R]
C922.2	Identify the motivational factors and techniques for evaluating business opportunities.	[U]
C922.3	Examine the opportunities for launching start-ups and expansion.	[Ap]
C922.4	Implement the accounting and financing skills to make sound business decisions and overcome risks.	[Ap]
C922.5	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– economic, non-economic, government actions. **Motivation**: Theories of 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. 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, fundamentals of balance sheet, break even analysis, 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 subcontracting, entrepreneurship development support, central and state government industrial policies.

Total Hours:	45

Text Books:

1	Hisrich R D and Peters M P, “Entrepreneurship”, 11th Edition, Mc Graw-Hill, 2020.
2	Donald F Kuratko, “Entrepreneurship – 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 Resources:	
1	http://nptel.ac.in/courses/118105009/50
2	https://www.coursera.org/specializations/wharton-entrepreneurship

22ME923	SUPPLY CHAIN MANAGEMENT	3/0/0/3

Nature of Course	Theory Application
Pre-Requisites	-

Course Objectives:

1	To develop an understanding of basic concepts and role of logistics and supply chain management in business.
2	To understand how performance measurement and cost management play an important role in redefining value chain excellence of firms.
3	To develop analytical and critical understanding & skills required for planning, designing and operation of supply chain through inventory models.

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

C923.1	Elucidate the importance of supply chain management in the formulation of the business strategy and the conduct of supply chain operations.	U
C923.2	Study the supply chain strategies, purchasing aspects and modeling systems.	U
C923.3	Predict the demand in the supply chain and formulate strategies for effective supply chain management.	AP
C923.4	Examine the importance of cost management in the supply and customer satisfaction.	AP
C923.5	Analyze and improve supply chain processes through Inventory models.	A

Course Contents:

Fundamentals of Supply Chain Management: Fundamentals - supply chain networks, integrated supply chain planning, decision phases in supply chain, supply chain models and modeling systems. Supply chain planning: Strategic, operational and tactical, supply chain strategies, supply chain drivers and obstacles, strategic alliances and outsourcing, purchasing aspects of supply chain, sustainable supply chain, green supply chain, digital supply chain and circular supply chains.

Inventory theory models: Economic order quantity models, reorder point models and multiechelon inventory systems, relevant deterministic and stochastic inventory models and vendor managed inventory models. Role of transportation in a supply chain: Direct shipment, warehousing, cross-docking; push vs. pull systems; transportation decisions (mode selection, fleet size), market channel structure and vehicle routing problem.

Supply chain performance measurement and Cost Management: The balanced score card approach, performance metrics. Planning demand and supply, Demand forecasting in supply chain, aggregate planning in supply chain, predictable variability. Supply Chain Inventory Management. Strategic cost management in supply chain- the financial impacts, volume leveraging and cross docking, global logistics and material positioning, global supplier development, target pricing, cost management enablers, measuring service levels in supply chains, customer satisfaction.

Total Hours:	45

Text Books:

1	David Simchi-Levi, Philip Kaminsky, and Edith Simchi-Levi, "Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies", 4 thEdition, McGraw-Hill, 2022.
2	Michael Hugos, "Essentials of Supply Chain Management",4th Edition,Wiley,2018.

Reference Books:

1	Coyle, John J, “Supply Chain Management: A Logistics Perspective”, 10th Edition, Cengage, 2021.
2	Wisner, Joel D, “Principles of Supply Chain Management: A Balanced Approach”,

	6th Edition, Cengage Learning, 2014.
3	Sunil Chopra and Peter Meindl, "Supply Chain Management: Strategy, Planning and Operation", 6th Edition, Cengage Learning, 2014.
Web References:	
1	https://guides.emich.edu/c.php?g=187846&p=1269509
2	https://onlinelibrary.wiley.com/journal/1745493X
Online Resources:	
1	https://nptel.ac.in/courses/110106045
2	https://archive.nptel.ac.in/courses/110/107/110107074/

22ME924	SUSTAINABLE MANUFACTURING	3/0/0/3
Nature of Course	Theory Application	
Pre-Requisites	Manufacturing Technology - I	

Course Objectives:

1	To familiarize the concept of sustainability manufacturing and its associated techniques.
2	To recognize the importance of sustainable manufacturing.
3	To inculcate the knowledge on performing life cycle analysis and its assessment methods.
4	To understand about the methods and strategies of ecofriendly manufacturing.
5	To explore the practical applications and implementation models of sustainability concepts.

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

C924.1	Recall the concept of sustainable manufacturing.	R
C924.2	Study the tools and techniques of sustainable manufacturing.	U
C924.3	Perform life cycle assessment and assess environmental impacts of manufacturing processes.	A
C924.4	Infer the applications of sustainability concepts in various domains.	Ap
C924.5	Evaluate product sustainability using software packages.	E

Course Contents:

Introduction to Sustainable Manufacturing: Concept of sustainability, manufacturing operations, resources in manufacturing. Concept of triple bottom line, environmental, economic and social dimensions of sustainability. Relation between green, lean and sustainable manufacturing. Linkages between technology and sustainability - sustainable manufacturing – scope, need and benefits.

Tools and Techniques of Sustainable Manufacturing: Environmental conscious- quality function deployment-R3 and R6 cycles-Environmental impact assessment methds- CML, EI 95 and 99, ISO 14001, EMS and PAS 2050 standards, environmental impact parameters. Sustainability assessment-concept models and various approaches, product sustainability and risk assessment-corporate social responsibility. Design for recycling – eco friendly product design methods – Methods to infuse sustainability in early product design phases Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

Life Cycle Assessment and Applications: Life Cycle Assessment Phases-Remanufacture and disposal, tools for LCA, optimization for achieving sustainability in manufacturing, value analysis, analysis for carbon footprint-software packages for sustainability analysis.

Total Hours:	45

Text Books:

1	Atkinson G, Dietz S, Neumayer E, “Handbook of sustainable manufacturing” Edward Elgar Publishing limited, 2021.
2	Rodick, D, “Industrial Development for the 21st century: Sustainable development perspectives” UN New York, 2017.

Reference Books:

1	Dornfeld, D.A., “Green manufacturing: fundamentals and applications”, Springer Science & Business Media, 2020.
2	Klemes, J., “Sustainability in the process industry”, McGraw-Hill. 2011.
3	Ashby, M. F., “Materials and the environment: eco-informed material choice”, Elsevier, 2012.

Web References:

1	https://pll.harvard.edu/course/sustainable-manufacturing-and-technologies?delta=0

2	https://onlinecourses.nptel.ac.in/noc21_mg85

Online Resources:	
1	http://nptel.ac.in/courses/110105039
2	https://www.coursera.org/courses?query=sustainability

22ME925	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 thermal, gas turbine, steam turbine, hydro, diesel and nuclear power plants.
3	To create awareness about renewable energy, tariff calculation and economics of various power plants.

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

C925.1	Recall the various techniques used for power generation.	[R]
C925.2	Describe the functioning of components in steam power plant.	[U]
C925.3	Sketch the design layout and explain the working of diesel, gas turbine, hydroelectric and nuclear power plants.	[Ap]
C925.4	Identify the ways to extract power from renewable/ non-conventional energy sources.	[Ap]
C925.5	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 - induction technology.

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.

Non-conventional energy based power plant: Hydro power plant: Classification of hydroelectric power plants – selection of prime movers – governing of turbines - 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	Prof. Sudipta De, “Nag’s Power Plant Engineering”, McGraw Hill, 5th Edition, 2021.
2	P.K. Nag, “Power Plant Engineering”, McGraw – Hill Education, Fourth Edition, 2017.

Reference Books:

1	Dipak Kumar Mandal, Somnath Chakrabarti, Arup Kumar Das, Prasanta Kumar Das, “Power Plant Engineering: Theory and Practice”, Wiley, 2019.

2	R. Yadav, “Fundamentals of Power Plant Engineering (Conventional and Nonconventional) An Innovative Approach”, 2nd Edition, IK International Publishing
	House Pvt Ltd, 2022.
3	P.K Das, A.K Das, “An Introduction to Thermal Power Plant Engineering and Operation”, 1st Edition, 2018.
Web References:	
1	https://www.academia.edu/28181314/Power_Plant_Engineering
2	https://link.springer.com/book/10.1007/978-1-4613-0427-2
Online Resources:	
1	https://archive.nptel.ac.in/courses/112/107/112107291/

22ME926	BIOENERGY CONVERSION TECHNOLOGIES	3/0/0/3

Nature of Course	Theory Technology
Pre-Requisites	Engineering Thermodynamics Thermal Engineering

Course Objectives:

1	To understand the biomass, types, availability, and characteristics
2	To study the bio-methanation process.
3	To impart knowledge on combustion of biofuels
4	To describe the significance of equivalence ratio on thermochemical conversion of biomass
5	To provide insight on the possibilities of producing liquid fuels from biomass

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

C926.1	Study the surplus biomass availability of any given area.	[U]
C926.2	Analyze the biogas plant required for variety of biofuels.	[A]
C926.3	Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.	[U]
C926.4	Analyse the influence of governing parameters in thermochemical conversion of biomass.	[A]
C926.5	Evaluate the properties of Synthesize liquid biofuels used for power generation.	[Ap]

Course Contents:

Introduction and Biomethenation: Biomass types – advantages and drawbacks – typical characteristics – proximate & ultimate analysis – comparison with coal - Indian scenario - carbon neutrality – biomass assessment studies – typical conversion mechanisms - densification technologies, Biomethenation process – influencing parameters – typical feed stocks – biogas plants: types and design.

Combustion and Application: Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

Gasification and Liquified Biofuels: Chemistry of gasification - types – comparison – typical application – performance evaluation – economics. Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization – merits of carbonized fuels – techniques adopted for carbonisation-Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel Vs. Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications.

Total Hours:	45

Text Books:

1	Nidhi Adlakha, Rakesh Bhatnagar, Syed Shams Yazdani, “Biomass for Bioenergy and Biomaterials”, CRC Press, 2021.
2	Augustine O. Ayeni, Samuel Eshorame Sanni, Solomon U. Oranusi, “Bioenergy and Biochemical Processing Technologies”, Springer, 2022.

Reference Books:

1	M. Moo-Young, J. Lamptey, B. Glick, “Biomass Conversion Technology: Principles and Practice”, Pergamon 1st edition, 2013.
2	Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3	Pratima Bajpai, “Biomass to Energy Conversion Technologies: The Road to Commercialization”, Elsevier Science, 2019.

4	Sergio Capareda, “Introduction to Biomass Energy Conversions”, CRC Press, 2013.

Web References:	
1	https://www.intechopen.com/chapters/73832
2	https://www.energy.gov/eere/bioenergy/conversion-technologies
Online Resources:	
1	https://onlinecourses.nptel.ac.in/noc22_ch28/preview
2	https://onlinecourses.nptel.ac.in/noc19_bt16/preview

22ME927	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**		
C927.1	Study the behavior of various flow regimes.	[U]
C927.2	Assess the properties of fluid while the fluid flows under different conditions.	[Ap]
C927.3	Analyse the flow behavior and consequent loads due to flow.	[A]
C927.4	Analyse the shock in flows.	[A]
C927.5	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, choking.

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 and Space 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. Types of rocket engines and propellants.

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”, McGrawHill 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/

22ME928	HEATING, VENTILATION AND AIR-CONDITIONING SYSTEMS	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 heating, ventilation and air-conditioning system, indicating the role of mechanical engineers in their operation and maintenance.
2	To understand the construction and working principle of sensors and auxiliary devices, electric controls and pneumatic controls.
3	To create awareness about various control systems in sequence of operation of HVAC.

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

C928.1	Recall the various techniques used for air-conditioning systems.	[R]
C928.2	Describe the functioning of components in air-conditioning systems.	[U]
C928.3	Sketch the design layout and explain the working of AC circuits, variable speed drives, valves and dampers	[Ap]
C928.4	Identify the accuracy, range and reliability of various sensors used in the HVAC systems.	[Ap]
C928.5	Analyze the water vapor, relative humidity and temperatures in the HVAC system.	[A]

Course Contents:

Introduction to HVAC Control Systems: Need of controls, brief history of controls, control loops, control modes - two-position control, floating control, modulating control, pulse-width modulating, and time-proportioning control, gains and loop tuning, control actions and normal position, control range and sequencing, controls documentation, maintenance and operations.

Basics of Electricity: Simple circuits and ohm's law, ac circuits, transformers and power services, relays, motors and motor starters, variable speed drives. **Control Valves and Dampers:** Two-way control valves styles and principles of operation, three-way control valves, selecting and sizing valves, flow characteristic selection, close-off pressure, control dampers, styles and principles of operation, selecting and sizing dampers.

Sensors and Auxiliary Devices: Accuracy, range, reliability, repeatability, precision, transmitter, temperature sensors – bimetal, fluid expansion, electrical, self-powered, electrical resistance, humidity and the psychrometric chart, relative humidity, moisture sensors, relative humidity sensors, pressure sensors, flow sensors and meters, auxiliary devices. heating and cooling load calculation.

Total Hours:	45

Text Books:

1	Chris P. Underwood, "HVAC Control Systems: Modelling, Analysis and Design", Routledge Publisher, 2022.
2	N C Gupta, "Comprehensive HVAC System Design", Narosa Book Distributors Pvt Ltd, 2020.

Reference Books:

1	Shankar Kumar Chatterjee, "A Practical Approach to Air Conditioning and Refrigeration", Notion Press, 2022.
2	Carter Stanfield, David Skaves, "Fundamentals of HVACR", Pearson Education, 2021.
3	John W. Mitchell, James E. Braun, "Principles of Heating, Ventilation, and Air Conditioning in Buildings, Wiley, 2020.

Web References:

1	http://www.digimat.in/nptel/courses/video/112107208/L35.html
2	https://www.digimat.in/nptel/courses/video/112105128/L13.html
Online Resources:	
1	https://archive.nptel.ac.in/courses/112/105/112105129/
2	https://brennanheating.com/how-does-hvac-system-work/

22ME929	RENEWABLE ENERGY TECHNOLOGIES	3/0/0/3

Nature of Course	Theory.
Pre Requisites	Thermodynamics, Fluid Mechanics, Heat and Mass Transfer.

Course Objectives:

1	To understand and analyze the patterns of renewable energy resources and its environmental merits
2	To discuss technologies for utilization of renewable energy sources.
3	To enable the students to understand the various economics involved in the utilization of renewable energy sources.

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

C929.1	Recall the various sources of energy.	[R]
C929.2	Elucidate the various means of utilizing the solar energy resources.	[U]
C929.3	Infer the impact of Wind energy resources on the environment.	[Ap]
C929.4	Analyze the scope of ocean energy, geothermal energy, Biomass and their application.	[A]
C929.5	Analyze the new energy sources like OTEC energy, MHD energy.	[A]

Course Contents:

Role and potential of renewable source , Renewable energy sources – types , energy 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:** Availability, measurement and estimation, introduction to solar collectors flat, plate collectors, air heater and concentrating collectors and thermal storage, solar pond, solar refrigeration, solar water heating systems - active and passive, passive heating and cooling of buildings, solar distillation, solar drying.

Energy available from wind, Basis of wind energy conversion, general formula, 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, bio diesel production and economics. principle of **ocean thermal energy conversion**, tidal energy – data, technology options, offshore and onshore wave energy conversion machines.

Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems – Open and closed OTEC Cycles – small hydro turbines, **Geothermal energy sources**, power plant and environmental issues – potential in India. **Hydrogen**, generation, storage, transport and utilization, Fuel cells – technologies, types – economics and the power generation - **Magneto-hydro-dynamic** (MHD) energy conversion. Fuel from sea – concept.

Total Hours: 45

Text Books:

1	S.P.Sukhatme-Solar Energy:Principles of Thermal Collection and Storage, Tata McGraw-Hill (2016).
2	A G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.

Reference Books:

1	F.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley 2015.
2	E.G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling& applications, Narosa Publishing House, New Delhi, 2012.
3	C. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 2012.

Web References:	
1	https://www.nrdc.org/stories/renewable-energy-clean-facts#sec-whatis
2	https://www.energy.gov/eere/renewable-energy
Online Resources:	
1	https://www.coursera.org/courses?query=renewable%20energy
2	https://www.renewableinstitute.org/training-courses/

22ME930	ENERGY STORAGE DEVICES AND THERMAL MANAGEMENT OF BATTERIES	3/0/0/3
Nature of Course	THEORY	
Pre Requisites	Thermal Engineering	
Course Objectives:		
1	To study the various types of energy storage devices and technologies used for building them.	
2	To have an insight about different types of batteries.	
3	To learn the vital components of thermal management systems used in various Electric Vehicles.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C930.1	Paraphrase the working of various energy storage devices and their importance.	U
C930.2	Elucidate the basic characteristics of batteries for mobile and hybrid systems.	U
C930.3	Choose the different types of Batteries.	AP
C930.4	Evaluate a Battery pack with appropriate PCM.	A
C930.5	Analyze different thermal management systems used in E-vehicles.	A
Course Contents:		
INTRODUCTION TO ENERGY STORAGE-Need for energy storage – types of energy storage – various forms of energy storage – mechanical–thermal - chemical– electrochemical – electrical. **ENERGY STORAGE SYSTEMS** Batteries – types-charging and discharging – battery testing and performance, batteries for electric vehicles - battery specifications for cars, superconducting magnetic energy storage (SMES), tesla model S- 18650 cell specifications, P85 battery pack, texas instruments battery management system, super capacitors, diamond battery concepts. **THERMAL MANAGEMENT IN BATTERIES-** Thermal management systems- impact, types- air, liquid, direct refrigerant, heat pipe, thermo electric, phase change material cooling methods. solid-liquid PCM types- organic, inorganic, eutectics. PCM thermal properties and applications. Tesla model-S battery module- bonding techniques, thermal management. **BATTERY THERMAL MANAGEMENT CASE STUDIES-** EV battery cooling- challenges and solutions. heat exchanger design and optimization model for EV Batteries using PCMs- system set up, selection of PCMs. chevrolet volt model battery thermal management system- case study. Modelling liquid cooling of a Li-Ion battery pack with COMSOL multiphysics- simulation concepts.		
	Total Hours:	**45**
Text Books:		
1	Rober Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2nd Edition, Springer, 2015.	
2	Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems’’, Wiley, 2017.	
Reference Books:		
1	“Vehicle thermal Management Systems Conference Proceedings”, 1st Edition; 2013, Coventry Techno centre, UK.	
2	Jerry Sergent, Al Krum, “Thermal Management Handbook: For Electronic Assemblies Hardcover”, 2007, Mc Graw- Hill.	
3	Younes Shabany,” Heat Transfer: Thermal Management of Electronics Hardcover” 2010, CRC Press.	
Web References:		

1	https://energystorage.org/why-energy-storage/technologies/
2	https://www.techtarget.com/whatis/definition/battery-management-system-BMS
Online Resources:	
1	https://www.coursera.org/lecture/21st-century-energy-transition/energy-storageU5WyJ
2	https://www.coursera.org/learn/battery-management-systems

OPEN ELECTIVE

22ME001	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	Toenablethestudentstoidentifythecausesofaccidentsanditspreventions.	
4	To train 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	Analyze the process to avoid, prevent and control workplace hazards.	[A]
C001.5	Evaluatetheroleofgovernmentagenciesandprivateconsultingagenciesin 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 act1974 – labour laws; safety in industries – general safety concepts, machine guarding, hazards in metal removing process, Hazardous Wastes (management, handling and Transboundary Movement) Rules 2016, check list for LPG installations, safety precautions using CNG. Introduction to OHSAS 18000and 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 casestudy.

SAFETY PERFORMANCE MONITORING: Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilitiesCalculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate. **SAFETY EDUCATION ANDTRAINING:** 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	CharlesD.Reese “Occupational Health and Safety Management: A Practical Approach”, 3rd Edition CRC press 2017.
2	MarkA.Friend,JamesP. Kohn “Fundamentals of Occupational Safety and Health”6thEditionBernanpress, 2016.
3	Krishnan N.V., “Safety Management in Industry”, Jaico Publishing House, Bombay,2016.
Reference Books:	
1	JoelM. Haight, “Principles of Industrial Safety”, ASSE publishers, 2017.
2	R.K.Mishra, “SafetyManagement”,AITBSpublishers,2022
3	Relevant India Acts and Rules, Government of India, 2020.
4	C. Ray Asfahl, David W. Rieske “Industrial Safety and health management”, Practice,7thEdition, Pearson,2021
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/safetyengineering

22ME002	Fundamentals of MEMS/NEMS	3/0/0/3

Nature of Course	Theory
Pre requisites	Nil

Course Objectives:

1	To encourage the students to 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	Interpret 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	Analyze the characteristics of MEMS and NEMS devices.	[A]
C002.5	Recall the principles and applications of MEOMS	[R]

Course Contents:

INTRODUCTION TO MEMS/NEMS: Introduction – MEMS vs NEMS - Evolution of Microsensors 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 - Nano-mechanical Resonators, Nano-mechanical Sensors. NEMS architecture, Surface Plasmon effects **LITHOGRAPHY:** Introduction - Photolithography- Overview to Critical Dimension and Lithographic Sensitivity 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 MethodsSurface Micromachining, Silicon on Insulator Technology (SOI), Bottom-Up Approaches - modelling, brains, packaging, sample preparation and new MEMS materials Introduction- Modeling, 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, 2017.
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 Micro fabrication 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

22ME003	TOTAL QUALITY MANAGEMENT	3/0/0/3
Nature of Course	D (Theory Application)	
Pre Requisites	Nil	
Course Objectives:		
1.	To understand the engineering and management aspects of quality planning and control	
2.	Study the methodology of improving quality in manufacturing process / products	
3.	To understand 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.	[U]
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 and their techniques: Walter Shewhart, W.Edward Deming, Kaoro Ishikawa, ,Joseph.M.Juran,Philip Crosby. **PRODUCT DESIGN AND ANALYSIS:** Basic Design Concepts and TQM Principles, Failure Mode Effect Analysis, Fault Tree Analysis, Value Analysis. **PROCESS IMPROVEMENT AND MODERN PRODUCTION MANAGEMENT TOOLS:** Six Sigma Approach, Total Productive Maintenance, Just-In-Time, Lean Manufacturing, 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, Functional safety.		
	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.	PoornimaM. 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

22ME004	PRODUCT DEVELOPMENT	3/0/0/3
Nature of Course	Theory	
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.	[R]
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	Apply the design knowledge in design for manufacturing.	[Ap]
C004.5	Devise innovative product development plan with environmental and societal consideration.	[A]
Course Contents:		
INTRODUCTION: Importance of engineering design, Characteristics of successful product development, Challenges of product development, New product development process Identifying Customer Needs - Concept generation- Concept selection - Pugh Matrix method – concept screening and scoring-Concept testing. **DESIGN THINKING TECHNIQUES**: Product Specifications - Product Architecture - Industrial Design - User Interface Design – Function based design - Designing to codes and standards. TRIZ- axiomatic design – Robust Design. **DESIGN FOR MANUFACTURING**: Design for Manufacturing - Prototyping - Product Validation and implementation. 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 in design.		
	Total Hours:	**45**
Text Books:		
1	Ulrich, Karl, and Steven Eppinger. “Product Design and Development”, 7th edition. New York, Y: McGraw-Hill, 2020.	
2	George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2017	
Reference Books:		
1	Steven Selikoff “The complete book of Product Design, Development, Manufacturing, and Sales”, Product Development Academy; 2nd edition (2 June 2020).	
2	Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, 2014	

Web References:	
1	www.nptel.ac.in/courses/112107217/

2	https://ocw.mit.edu/courses/sloan-school-of-management/15-783j-productdesignand-development-spring-2017/
Online Resources:	
1	https://www.edx.org/course/product-design-delft-design-approach-delftxdda691x-1

22ME005	FUNDAMENTALS OF ADDITIVE MANUFACTURING	3/0/0/3
Nature of Course	Theory application	
Pre Requisites	-	

Course Objectives:

1	To provide a detailed insight 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	Illustrate the basic concepts of additive manufacturing technologies along with recent trends in advanced manufacturing.	[U]
C005.2	Summarize 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 the appropriate 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:
Prototyping fundamentals - Historical development - Fundamentals of Additive Manufacturing (AM)- Advantages and Limitations of AM - Commonly used Terms - AM Process Chain: Fundamental Automated Processes - Process Chain - CAD Model - 3D modelling -3D solid modeling software and their role in AM –Input file formats - Classification of AM systems- AM Benefits.

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. Reverse Engineering -3D Scanner.

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, 2019.

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

22ME006	TECHNOLOGY MANAGEMENT	3/0/0/3
Nature of Course	Theory	
Pre Requisites	Nil	

Course Objectives:

1	To understand about basic concepts of management and to get equipped with the nuances of management functions
2	To create an awareness about the impact of technology and innovation on business management.
3	To gain knowledge to build an effective communication model and to manage innovation

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

C006.1	Recognize the role and significance of technology management	[U]
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 deployment of technology management concepts	[A]
C006.5	Develop strategies for business units to attain global recognition	[Ap]

Course Contents:

Introduction to Technology Management: Concept and Meaning of Technology and Technology Management; 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, Forms of Technology-Process technology; Product technology, Case studies of Technological Futures

Managing Technology Based Innovation: Innovation and Technology- Role of technology in innovation; Technological innovation and management, Process of Technology – Based Innovation, IPR and Patents, Characteristics of Innovative Work Environment, Information Technology for Business Measures for Building High- Performing Innovative Technology- Based Organizations. International Business and Strategic Alliances, Management of R&D and Innovation, TRIZ.

Social Issues in Technology Management: Social Issues, Technological Change and Industrial Relations; Technology Assessment and Environmental Impact Analysis-Environmental impact analysis process. Performance Appraisal and Counseling, Leadership and Change Management, Sustainable Technology Management.

Total Hours:	**45**

Text Books:

1	Sanjiva Shankar, Technology and innovation management, Dubey publisher: PHI learning, 2020.
2	Margaret A. White, Garry D. Bruton, The Management of Technology and Innovation: A Strategic Approach, 2nd Edition, 2019.

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.

Web References:

1	https://professional.mit.edu/course-catalog/management-technology-roadmappingdevelopment
2	https://www.referenceforbusiness.com/management/Str-Ti/TechnologyManagement.html
Online Resources:	
1	https://nptel.ac.in/courses/110107141
2	https://in.coursera.org/specializations/technology-management

EMERGING ELECTIVE

22ME007	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 NetworkFuzzy 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/

22ME008	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

22ME009	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

22ME010	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-DiagnosisDesign-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

22ME011	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

C011.1	Familiarize with the fundamentals of the product lifecycle and thus acquire the capability to apply them.	[R]
C011.2	Recall the methods and technologies for adopting PLM strategies.	[R]
C011.3	Manage and analyze the challenges in different stages of product development.	[A]
C011.4	Apply the tools/techniques of product life cycle management to industrial problems.	[Ap]
C011.5	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

MANDATORY COURSES

22MC101	INDUCTION PROGRAMME (FOR ALL BRANCHES OF B.E / B.TECH/ M.TECH PROGRAMMES)	1/0/0/0
Nature of Course	Induction Programme	
Pre requisites	Nil	
Course Objectives:		
1	To have broad understanding of society and relationships	
2	To nurture the character and fulfil one's responsibility as an engineer, a citizen and a human being	
3	To incorporate meta skills and values	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C101.1	Explore academic interest and activities	[AP]
C101.2	Work for excellence	[AP]
C101.3	Promote bonding and give a broader view of life and character	[AP]
Course Contents:		

LECTURES BY EMINENT PEOPLE: Teaching with Lectures. ... It is essential to see lectures as a means of helping students learn to think about the key concepts of a particular subject, rather than primarily as a means of transferring knowledge from instructor to student. During the induction period students will attend to Guest lectures by subject experts.(CO mapping: C101.1, C101.2, C101.3)

VISIT TO LOCAL AREAS: Traveling is in fact a way of learning to learn. You are out of your comfort zone and so you must learn to be able to adapt to a new learning environment in a very short time. It also helps in your overall learning as well. In the induction period students will be taken to different places near college to learn new things. Eg.Meditation centre/orphanage/Hospital.(CO mapping: C101.1, C101.2, C101.3)

FAMILIARIZATION TO DEPARTMENT/BRANCH INNOVATION: Hod's of different branches will present about their department followed by department visit to view various facilities available at their department, new innovations from students and faculties etc. .(CO mapping: C101.1, C101.2, C101.3)

22MC102	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	Illustrate the importance of natural resources and conservation of biodiversity.	[U]
C102.3	Interpret 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. Soil pollution - Solid waste management-Recycling of plastics-Pyrolysis method- causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazardscase 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.

Total Hours: 30

Text Books:

1	AnubhaKaushik and C P Kaushik “Perspectives in Environmental Studies”4th Edition, Newage 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

22MC103	SOFT SKILLS	2/0/0/0

Nature of Course: Theory Concept

Pre Requisites : Technical Communication Skills

Course Objectives:

1	To develop the students competency level and their capabilities.
2	To teach the students to be effective in workplace and social environments.
3	To create self confidence among the students and to resolve stress and conflict within themselves.
4	To help the students to enhance their career skills by increasing their productivity and performances.
5	To concentrate more on conversation skills, presentation skills, verbal ability, critical and creative thinking.

Course Outcomes:

Upon completion of the course, students shall have ability to

C103.1	Remember the principles of soft skills required for their profession.	[R]
C103.2	Understand the importance of Interpersonal communication Skills among individuals, groups and cultures.	[U]
C103.3	Apply verbal and non-verbal communication skills in corporate environment.	[AP]
C103.4	Analyse and apply creativity skills, critical thinking skills and problem-solving skills.	[AN]
C103.5	Articulate oral and written messages in an appropriate and persuasive manner to suit specific purposes, audiences and contexts at work place.	[AP]
C103.6	Apply good teamwork skills and Leadership Skills	[AP]

Course Contents:

Module 1: Professional Communication Skills

Introduction to the Soft Skills, Performance Evaluation 1 – Significance of Soft Skills - Understanding the basic Communication Principles –Listening Skills- Listening Exercises Speaking Skills- How to start and Sustain a Conversation- Speaking in Groups- Understanding self and Personal Branding, attitude, types of attitudes, Positive Attitude, Self Confidence and Self-Motivation - Personal Application/Action Taken. Advanced Writing Skills-Principles of Business Writing- E mails- Writing Reports- Types of Reports- Strategies for Report WritingPersonal Application/Action Taken. Verbal Ability- Analogy- Classification- Odd One Out-Idioms and Phrases- Sentence Correction- Empathy and its importance in career -Personal Application/Action Taken.

(10 Hours) Module 2: Interpersonal Communication

Nonverbal Communication- Individual, Groups and Cultures- Body Language- Attire and Etiquettes- Interpersonal Skills- dealing with diverse People- Networking- Emotional Intelligence and its importance. Personal Application/Action Taken. Developing Creativity-Critical Thinking and Problem-Solving Skills- Making the Right Choice- Never Give Up- Begin to Grow- Personal Application/Action Taken. Interviews- Facing Job Interviews - Planning and Preparing- Effective Resume along with Covering Letter- Planning and Preparing- Personal Application/Action Taken. Self-Discipline - Self Presentation - Personal Application/Action Taken.

(10 Hours) Module 3: Teamwork and Leadership Skills

Industry Expectations- Universal Hiring Rule- Personal Application/Action Taken. Importance of Human Values-Importance of Team Work- Developing Key Traits in Motivation, Persuasion, Negotiation and Leadership Skills- Being an Effective Team Player- Personal Application/Action Taken. Planning- Prioritization - Delegation- Conflict Management-Decision and its necessity in crucial situations- Group Discussion- Personal Application/Action Taken. Essential Skills in working Strategies- Presentation and Interaction Skills- What to Present and How- Being Assertive-Multimedia Presentation-Making Effective Presentations. Interview Skills- Do's and Don'ts - Body Language – Answering the Common Questions of Interview- Performance Evaluation 2- Mock Interview

(10 Hours)	
	Total Hours: 30
Text Books:	
1	Penrose, “Business Communication for managers: An advanced approach”, Cengage learning.
2	H.E. Sales, “Professional Communication in Engineering”, Palgrave Macmillan 2009.
3	W. P. Scott, Bertil Billing, “Communication for Professional Engineers”, Thomas Telford, 1998.
Reference Books:	
1	Peter Davson-Galle, “Reason and Professional Ethics”, Ashgate Publishing, Ltd., 2009.
2	William B. Gudykunst, “Cross Cultural and Inter Cultural Communication”, Sage Publications India Pvt Ltd, New Delhi, 2003.
3	Joep Cornelissen, “Corporate Communications: Theory and Practice”, Sage Publications India Pvt Ltd, New Delhi, 2004.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc16_hs15/preview
2	https://www.getinternship.switchidea.com/NTAT/syllabus/InterpersonalCommunication
3	https://smude.edu.in/smude/programs/bca/soft-skills.html
4	https://swayam.gov.in/course/4047-developing-soft-skills-and-personality
5	https://www.clearias.com/interpersonal-skills-including-communication-skills-for-csat/
6	https://www.bizlibrary.com/soft-skills-training/

22MC104	MANAGEMENT ORGANIZATIONAL BEHAVIOUR	2/0/0/0
Nature of Course	Theory Concept	
Pre requisites	Nil	
Course Objectives:		
1.	The objective of the course is to provide basic knowledge about management to familiarize the students with the management principles and organizational behavior.	
2.	The course is designed to enable the students to adapt & apply theoretical concepts in business	
3.	To know about the role of manager in the area of management.	
4.	To create and implement team building strategies for organization building.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C104.1	Identify and understand different management principles techniques in business environment.	[U]
C104.2	Apply management fundamentals and planning to solve organization problems and make effective decisions.	[AP]
C104.3	Understand and analyze the changes within an individual will change the group as well as the organization	[A]
C104.4	Understand and analyze the leadership style and organization theories to create a productive environment to workforce.	[A]
C104.5	Analyze the organizational climate and change management strategies and tactics	[A]
C104.6	Apply the empowerment strategy and tactics for productivity	[AP]

Course Contents:

Module 1: Fundamentals of Management, Planning and Decision Making (10 Hours)

Introduction to Management- Concept and functions- Thought Managerial roles and stylesPrinciples of Management - Levels of Management- Theories of Management - Classical, Scientific, Administrative, Behavioral, Management Sciences Theories. Organizational planning - Vision, Mission and goals, Types of plans, steps in planning process, Approaches to planning, Planning in Dynamic Environment. Decision making process, types of decisions, decision making styles, Behavioural influences on decision making - Group decision making - Vroom's Participative decision-making model.

Module 2: Individual, interpersonal and group behavior (10 Hours)

Definition, need and importance of Organizational behavior –Learning-Nature -Importance of Learning- Introduction and theories Motivation: Content and process theories-Leadership: Styles and Theories - Perception-Personality – Attitudes- Definition, need and importance -Nature and scope-Importance of Groups and Teams- Role relationships and conflict-Group dynamics- Work values. Organization Theories: Maslow's needs hierarchy theory, two factor theory of motivation, McGregor's theory, ERG theory, McClelland's needs theory, Valance Theory.

Module 3: Organizational Development (10 Hours)

Organizational culture: Elements - Organizational climate– Factors affecting organizational climate-Organizational Commitment, Organizational schange- Importance- Stability Vs Change-Proactive Vs Reaction change- Change process– Resistance to change- Managing changes-Managing International Workforce – Productivity- Alternative change management approaches and cultural contingencies - power to manage effectively; Empowerment and Participation strategies and tactics.

Total Hours:	**30 Hrs**

Text Books:	
1.	Nelson, Quick, Khandelwal, “Organizational Behavior”, 2nd Edition, Cengage Learning, 2016.
2.	Williams, Tripathy, “Principles of Management”, Cengage Learning, 2016.
3.	Aswathappa, K, “Organizational Behavior”, 12th Edition, Himalaya Publication, 2016.
4.	Stephen Robbins, Timothy A. Judge, “Organizational Behavior”, 16th Edition, Prentice Hall India Pvt. Ltd, 2014.
Reference Books:	
1.	Chandrani Singh, Aditi Khatri, “Principles and Practices of Management and Organizational Behavior”, Sage Publications, 2016.
2.	Richard L. Daft, “Understanding the Theory and Design of Organizations”, 11th Edition, Cengage Learning, 2013.
3.	John M Ivancevich and Robert Konopaske, “Organizational Behavior and Management”, McGraw-Hill Education, 2013.
4.	UdaiPareek, Sushama Khanna, “Organization Behavior”, 3rd Edition, Oxford Publishing, 2012.
Web References:	
1.	https://iedunote.com/fundamental-concepts-of-organizational-behavior
2.	https://nscpolteksby.ac.id/ebook/
3.	https://ebooks.lpude.in/management/mba/term_1/DMGT402_MANAGEMENT PRACTICES_AND_ORGANIZATIONAL_BEHAVIOUR.pdf
4.	https://www.studocu.com/in/document/vellore-institute-of-technology/organizational-behaviour/lecture-notes/ob-notes/3208134/view
Online Resources:	
1.	https://nptel.ac.in/syllabus/110105034/
2.	https://nptel.ac.in/courses/110/105/110105033/
3.	https://freevideolectures.com/course/3502/organizational-behaviour-i
4.	https://nptel.ac.in/courses/110/106/110106145/

22MC105	GENERAL APTITUDE	2/0/0/0

Nature of Course: Problem analytical

Pre Requisites : Basic Mathematical calculations

Course Objectives:

1	To ensure that students learn to think critically about mathematical models for relationships between different quantities and use those models effectively to solve problems and reach conclusions about them.
2	To impart skills that enable students to effectively use and interpret data, formulas, and graphs in the workplace.
3	To instills confidence in facing technical aptitude questions interviewed by recruiters

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

C105.1	To teach the basics of Quantitative Techniques in a graded manner.	[R]
C105.2	Understand the verbal and non-verbal nature of problems in reality and know the shortcut methods of solving it.	[U]
C105.3	Solve problems using their general mental ability.	[AP]
C105.4	To give intense focus on improving and increasing the ability of solving real problems.	[AP]
C105.5	Think critically about mathematical models for relating different quantities to reach conclusion.	[AP]
C105.6	Enable effective use of data interpretation, formulas, graphs and assumptions.	[AP]

Course Contents:

Module 1: Number Theory and Statistics

Number Systems– HCF and LCM of Numbers – Decimal Fractions – Simplification – Square Root and Cube Root of a number – Surds and Indices – Problems on numbers – Percentage – Ratio and Proportion – Divisibility – Mixtures – Averages- Polynomials – Solving Equations and Inequalities – Discard's rule of signs – Problems on ages – Chain rule – Time and Work – Time and Distance – Problems on Trains – Problems on Boats and Streams- Measures of central tendency – Mean, Median and Mode – Variance and Standard deviation Logarithms – Profit and Loss – Simple Interest – Compound Interest. **(14 Hours)**

Module 2: Logic and Decision Making

Analogy – Classification – Series completion – Coding and Decoding – Blood Relations – Puzzle Test – Direction Sense test – Logical Venn Diagrams - Number Ranking and Time Sequence Test – Decision Making – Assertion and Reason– Inserting the missing one – Logical Sequence of words – Syllogisms. **(8 Hours)**

Module 3: Reasoning

Logic – Statement and Arguments – Statements and Assumptions – Statements and Course of Action – Statements and Conclusions – Deriving conclusions from passages – Functions – Different kinds of functions – Miscellaneous sets- Series – Analogy – Classifications – Analytical Reasoning – Problems on Cubes and Dice – Mirror Images – Water Images – Rule Detection.

(8 Hours)

Total Hours: 30

Text Books:

1	Aggarwal R. S, "Quantitative Aptitude" Revised Edition, S. Chand Publication.
2	Abhijit Guha, "Quantitative Aptitude" 5th Edition, McGraw Hill Education.

Reference Books:

1	Edgar Thorpe "Mental Ability & Quantitative Aptitude" 3rd Edition, McGraw Hill Education.

Web References:	
1	https://www.wiziq.com/tutorial/815468-quantitative-aptitude-reasoning-datainterpretation-video-lectures
2	https://learningpundits.com/contest?referrer=harsh.cse15@nituk.ac.in
3	https://nptel.ac.in/courses/114106041/8
4	https://nptel.ac.in/courses/111103020/2
5	http://aptitudetraining.in/home/index.php
6	https://www.udemy.com/vedicmaths/
7	https://www.youtube.com/channel/UCtmn-DsF4BhPug-ff9LiDAA?disable_polymer=true

22MC106	LIFE SKILLS AND ETHICS	2/0/0/0

Nature of Course: Theory Concept

Pre Requisites : Nil

Course Objectives:

1	To develop communication competence in prospective engineers.
2	To enable them to convey thoughts and ideas with clarity and focus.
3	To develop report writing skills.
4	To equip them to face interview & Group Discussion.
5	To inculcate critical thinking process.
6	To prepare them on problem solving skills.
7	To provide symbolic, verbal, and graphical interpretations of statements in a problem description.

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

C106.1	Define and Identify different life skills required in personal and professional life.	[U]
C106.2	Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.	[AP]
C106.3	Explain the basic mechanics of effective communication and demonstrate these through presentations.	[A]
C106.4	Use appropriate thinking and problem solving techniques to solve new problems.	[AP]
C106.5	Understand the basics of teamwork and leadership	[U]

Course Contents:

Communication Skill:
Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication. **(10 Hours)**

Critical Thinking & Problem Solving:
Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats Mind Mapping & Analytical Thinking. Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts. **(10 Hours)**

Ethics, Moral & Professional Values:
Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE. **Leadership Skills:** Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation **(10 Hours)**

Total Hours: 30

Text Books:

1	Barun K. Mitra, “Personality Development & Soft Skills”, First Edition, Oxford Publishers, 2011.
2	Kalyana, “Soft Skill for Managers”, 1st Edition, Wiley Publishing Ltd, 2015.
3	Larry James, “The First Book of Life Skills”, 1st Edition, Embassy Books, 2016
4	Shalini Verma, “Development of Life Skills and Professional Practice”, 1st Edition, Sultan Chand (G/L) & Company, 2014

5	John C. Maxwell, “The 5 Levels of Leadership”, Centre Street, A division of Hachette Book Group Inc, 2014.
Web References:	
1	https://www.coursera.org/courses?query=ethics

22MC107	STRESS MANAGEMENT	2/0/0/0

Nature of Course: Theory Concept

Pre Requisites : Nil

Course Objectives:

1	Understand the basic principles of stress management
2	Recognize your stress triggers and how to manage them
3	Develop proactive responses to stressful situations
4	Use coping tips for managing stress both on and off the job
5	Learn to manage stress through diet, sleep and other lifestyle factors
6	Develop a long term action plan to minimize and better manage stress
7	Understand the basic principles of stress management

Course Outcomes:

Upon completion of the course, students shall have ability to

C107.1	Understand the basic principles of stress management	[U]
C107.2	Apply the concept of recognizing your stress triggers and find was to manage them.	[AP]
C107.3	Develop proactive responses to stressful situations	[A]
C107.4	Develop a long term action plan to minimize and better manage stress	[AP]

Course Contents:

Scientific Foundations of Stress:

What is stress? – Sources of Stress – Types of Stress – Personality Factors and stress – Stress and the college student. Stress Psychophysiology: Stress and nervous system – Hypothalamic – Pituitary – Adrenal (HPA) Axis – Effect of Stress on Immune system – Health risk associated with chronic stress – Stress and Major Psychiatric disorders. **(10 Hours)**

Developing Resilience to Stress:

Understanding you stress level – Role of personality pattern, Self-esteem, Locus of control – Role of Thoughts Beliefs and Emotions – I & II – Life situation Intrapersonal: (Assertiveness, Time Management). **(10 Hours)**

Strategies for Relieving Stress:

Developing cognitive coping skills – Autogenic training, imagery and progressive relaxation – Other relaxation techniques – Exercise and Health – DIY strategies stress management. **(10 Hours)**

Total Hours: 30

Reference Books:

1	Jonathan C. Smith, “Stress Management: A Comprehensive Handbook of Techniques and Strategies”, 1st Edition, Springer Publishing Company, 2011.
2	Bob Stahl, Elisha Goldstein, Jon Kabat-Zinn, “A Mindfulness–based Stress Reduction Workbook”, 2nd Edition, New Harbinger Publications, 2019.
3	Ryan M. Niemiec, “The Strengths-based Workbook for Stress Relief”, 1st Edition, New Harbinger Publications, 2019.

Web References:

1	https://thiswayup.org.au/courses/coping-with-stress-course/
2	https://www.classcentral.com/course/swayam-stress-management-14309

22MC108	CONSTITUTION OF INDIA	2/0/0/0

Nature of Course: Theory

Pre Requisites : Nil

Course Objectives:

1	To familiarize with basic information about Indian constitution
2	To understand the fundamental rights and duties as citizens of India

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

C108.1	Explain the objectives of the Constitution of India and its formation	[U]
C108.2	Recall state and central policies (Union and State Executive), fundamental Rights and their duties.	[R]
C108.3	Make use of legal directions in developing solutions to societal issues	[AP]
C108.4	Solve for competitive exams that requires knowledge of Indian Constitution	[AP]

Course Contents:

Module I
Historical perspective, The making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights, Directive Principles of State Policy, Fundamental Duties, Citizenship Article 5-11.

(10 Hours)

Module II
Federal structure, Powers of the Union and the states, Centre-State Relations, Union Executive – President, Prime Minister, Union Cabinet, Parliament, Supreme Court of India, State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Elections, Electoral Process, and Election Commission of India, Election Laws. Powers and Functions of Municipalities and Panchayat

(10 Hours)

Module II
Amendments - Methods, Emergency Provisions, National Emergency, President Rule, Financial Emergency, Provisions for SC & ST, OBC, women, children and backward classes, Right to Property, Freedom of Trade and Commerce. Agricultural Law

(10 Hours)

Total Hours: 30

Text Books:

1	D. D. Basu, “Introduction to the Constitution of India”, LexisNexis, New Delhi, 22nd edition, 2016.
2	“Bare act-constitution of India”, The universal Publications, LexisNexis 2020, New Delhi, India.

Reference Books:

1	Subhash. C. Kashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National Book Trust, India, 5th edition, 2019.
2	M. Laxmikanth, “Constitution of India”, Cengage Learning India. 1st edition 2018.

Web References:

1	https://unacademy.com/course/the-indian-constitution/NSKQ8XXQ
2	https://unacademy.com/goal/upsc-civil-services-examination-ias-preparation/KSCGY

22MC109	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2/0/0/0

Nature of Course: Theory

Pre Requisites : Nil

Course Objectives:

1	To make understand the contribution of Indian mind in various fields.
2	To cultivate critical appreciation of the thought content and provide insights relevant for promoting cognitive ability, health, good governance, aesthetic appreciation and right values.

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

C109.1	Relate classical Indian traditions with contemporary traditions and culture.	[U]
C109.2	Describe the thoughts of Indians in different disciplines.	[R]
C109.3	Apply the knowledge to the present context.	[AP]
C109.4	Discover a better appreciation and understanding of Indian traditions.	[AP]

Course Contents:

Indian Ethics: Individual and Social – Society state and Polity (Survey) - Education systems – Agriculture (Survey) – Early & Classical Architecture – Medieval & Colonial Architecture.

(10 hours)

Astronomy in India – Martial Arts Traditions (Survey) - Indian Literatures - Indian Philosophical Systems - Indian Traditional Knowledge on Environmental Conservation - Ayurveda for Life, Health and Well-being.

(10 hours)

The Historical Evolution of Medical Tradition in Ancient India - Music in India - Classical & Folk dance - Theatre and Drama in India.

(10 hours)

Total Hours: 30

Text Books:

1	Kapil Kapoor and Michel Danino, Textbook of “Knowledge Traditions and Practices of India”, Central Board of Secondary Education, 2017.
2	Yogesh Atal, “Indian Society: Continuity and Change”, Pearson Education India, 2016.

Reference Books:

1	Douglas Osto, “An Indian Tantric Tradition and Its Modern Global Revival”, Routledge publications, 2020.
2	Rao C.N. Shankar, “Sociology: Principles of Sociology with an Introduction to Social Thoughts”, S Chand Publisher, 2019.

Web References:

1	http://nopr.niscair.res.in/handle/123456789/43
2	https://nptel.ac.in/courses/109/104/109104102/

22MC110	BIOLOGY	2/0/0/0

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To understand the basic biological concepts related to engineering systems.
2. To have adequate knowledge about the various human anatomy and physiological systems.
3. To impart the knowledge about biological systems in the environment.

Course Outcomes:

Upon completion of the course, students shall have ability to

C110.1	Relate the biological system with engineering concepts	[R]
C110.2	Understands the anatomy and physiology of human system.	[U]
C110.3	Understand the concept of plant, animal and microbial systems and growth in real life situations	[U]
C110.4	Apply the knowledge of applications of biological systems in relevant industries.	[AP]

Course Contents:

Introduction, Science and Engineering – Phylogeny, Motivation, Methods, Synthesis, Biological Classification, Biology as whole, Applications of Biology, Principles of biology – Genetic Basics, substance for life – Basic organic chemical structure, chemical bonding, acid, base reactions, physicochemical interactions. **(10 hours)**

Cell – prokaryotes and eukaryotes, biological membrane, membrane transport, eukaryotic cell structure and function. Plant – plant division, Animal – reproductive strategies, Human – Skin, skeletal system, muscular system, nervous system, cardiovascular system, respiratory system, digestion, nutrition, excretory system.
(10 hours)

Industrial Microbiology and its Applications, Relationship between Engineering and Biology - Living things as solution, models, recipients, inadvertently affected. Biological solutions to Industrial Problems. Cell organization, signalling and deciphering human genetic variation

(10 hours)

Total hours: 30

Text Books:

1.	A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publications, 2015.
2.	ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P., Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K., “Biology for Engineers”, Tata McGraw-Hill, New Delhi, 2017.

Reference Books:

1.	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2014.
2.	David A. Vaccari, Peter F. Strom, James E. Alleman,” Environmental Biology for Engineers and Scientist”, A John Willey Inc. publications, 2018.

Web References:

1.	https://www.cellsalive.com/
2.	https://www.visiblebody.com/teaching-anatomy/courseware

Online Resources:

1.	https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/17%3A_Industrial_Microbiology/17.1%3A_Industrial_Microbiology
2.	http://sites.khas.edu.tr/bioinformatics/whats/bioinformatics-genetics/

Sri Krishna College of Engineering and Technology

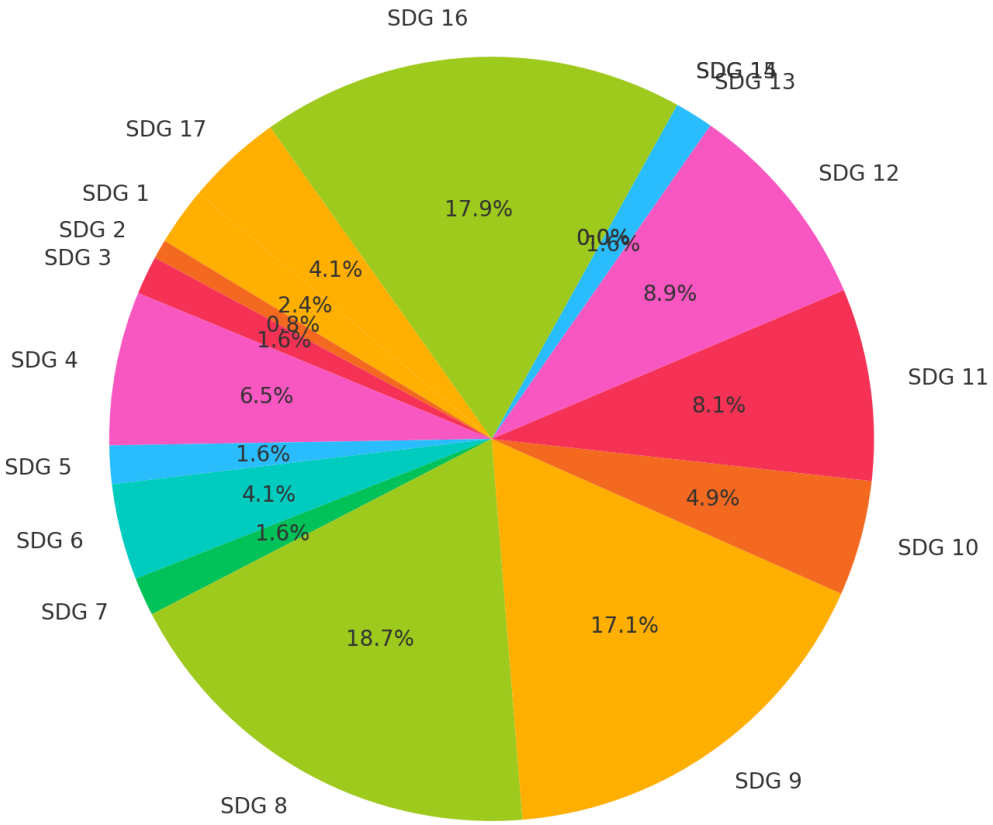
An Autonomous Institution, Affiliated to Anna University

Kuniamuthur, Coimbatore – 641 008

CURRICULUM AND SYLLABI

MASTER OF BUSINESS ADMINISTRATION

REGULATION 2022


SDG Mapping Across Courses
SDG 16
17.9%
SDG 14
1.6%
SDG 13
0.0%
SDG 12
8.9%
SDG 11
8.1%
SDG 10
4.9%
SDG 9
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SDG 8
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SDG 7
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SDG 6
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SDG 5
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SDG 4
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SDG 3
1.6%
SDG 2
0.8%
SDG 1
2.4%
SDG 17
4.1%

SCHOOL OF MANAGEMENT

CURRICULUM STRUCTURE (2022-24)

Course Type	Semester I		Semester II		Semester III		Semester IV		Total	
	No. of Courses	Credit	No. of Courses	Credit	No. of Courses	Credit	No. of Courses	Credit	No. of Courses	Credit
PC	**07**	**21**	**07**	**24**	**03**	**09**	**0**	**0**	**17**	**54**
PE	**-**	**-**	**-**	**-**	**04**	**12**	**04**	**12**	**08**	**24**
EEC	**-**	**-**	**-**	**-**	**02**	**06**	**01**	**06**	**03**	**12**
MC	**02**	**05**	**01**	**01**	**-**	**-**	**-**	**-**	**03**	**06**
Total	**09**	**26**	**08**	**25**	**09**	**27**	**05**	**18**	**31**	**96**
Marks	**900**		**800**		**900**		**500**		**3100**	

NOTE:

PC: Programme Core Course **PE:** Programme Elective Course

EEC: Employment Enhancement Course **MC**: Mandate Course

Courses	Courses	Credits
PC: Programme Core Course	**17**	**54**
PE: Programme Elective Course	**08**	**24**
EEC: Employment Enhancement Course: Internship Training / Project Work	**03**	**12**
MC: Mandate Course**:** Outbound Training / Rural Immersion Programme / Entrepreneurship Immersion Programme	**03**	**06**
TOTAL	**31**	**96**

SEMESTER I

Sl No.	Type	Course Code	Courses	L	T	P	C	Internal	External	Total Marks	SDG
1	PC	22PNC101	Organisational Behaviour	3	-	-	3	40	60	100	8,16
2	PC	22PNC102	Managerial Economics	3	-	-	3	40	60	100	8,16
3	PC	22PNC103	Accounting for Managers	3	2	-	4	40	60	100	12,16
4	PC	22PNC104	Statistics for Management	3	2	-	4	40	60	100	9,16
5	PC	22PNC105	IT for Managers	3	-	-	3	40	60	100	9,16
6	PC	22PNC106	Legal Aspects of Business SDG 16	3	-	-	3	40	60	100	10,16
7	PC	22PNC107	Soft Skills	-	-	2	1	60	40	100	5,16
8	MC	22PNB101	Business Fundamentals	-	-	8	4	100	0	100	8,16
9	MC	22PNI101/ 22PNI102	Outbound Training / Rural Immersion Program SDG 6	-	-	-	1	100	0	100	1,6,11
				18	**4**	**10**	**26**			**900**	

SEMESTER II

Sl No.	Type	Course Code	Courses	L	T	P	C	Internal	External	Total Marks	SDG
10	PC	22PNC201	Human Resource Management	3	-	-	3	40	60	100	8, 5, 16
11	PC	22PNC202	Marketing Management	3	-	-	3	40	60	100	12, 9, 16
12	PC	22PNC203	Financial Management	3	2	-	4	40	60	100	8, 16,10
13	PC	22PNC204	Quantitative Techniques	3	2	-	4	40	60	100	9, 16, 3
14	PC	22PNC205	Production and Operations Management	3	-	-	3	40	60	100	12, 9, 13
15	PC	22PNC206	Business Analytics	3	-	-	3	40	60	100	9, 16, 17
16	PC	22PNC207	Business Research Methods	3	-	2	4	50	50	100	4, 16, 10
17	MC	22PNI201	Entrepreneurship Immersion Programme	-	-	-	1	100	0	100	8, 1, 9, 11
				21	**4**	**2**	**25**			**800**	

SEMESTER III

Sl No	Type	Course Code	Courses	L	T	P	C	Internal	External	Total Marks	SDG
18	PC	22PNC301	Strategic Management	3	-	-	3	40	60	100	8, 9, 16
19	PC	22PNC302	Indian Ethos and Business Ethics SDG 12	3	-	-	3	40	60	100	12, 16, 4
20	PC	22PNC303	International Business Management	3	-	-	3	40	60	100	10,17, 8
21	PE		ELECTIVE-1	3	-	-	3	40	60	100	4, 8, 9, 12, 16
22	PE		ELECTIVE-2	3	-	-	3	40	60	100	4, 8, 17
23	PE		ELECTIVE-3	3	-	-	3	40	60	100	4, 9, 11
24	PE		ELECTIVE-4	3	-	-	3	40	60	100	8, 9, 16
25	EEC	22PNI301	Internship Training	-	-	-	2	60	40	100	12, 16, 4
26	EEC	22PNP301	Project Work (Phase I)	-	-	20	4	60	40	100	10,17, 8
				21	**0**	**20**	**27**			**900**	

SEMESTER IV

Sl. No	Type	Course Code	Courses	L	T	P	C	Internal	External	Total Marks	SDG
27	PE		ELECTIVE-5	3	-	-	3	40	60	100	4, 8, 9, 12, 16
28	PE		ELECTIVE-6	3	-	-	3	40	60	100	4, 8, 17
29	PE		ELECTIVE-7	3	-	-	3	40	60	100	4, 9, 11
30	PE		ELECTIVE-8	3	-	-	3	40	60	100	8, 9, 16
31	EEC	22PNP401	Project Work (Phase II)	-	-	30	6	60	40	100	12, 16, 4
				12	**0**	**30**	**18**			**500**	

LIST OF ELECTIVES

Sl. No	Course Code	Courses	L	T	P	C	Internal	External	Total Marks	SDG
FINANCE ELECTIVES										
1	22PNE001	Investment Analysis and Portfolio Management	3	-	-	3	40	60	100	8, 10
2	22PNE002	Banks and Financial Institutions	3	-	-	3	40	60	100	8, 16
3	22PNE003	Financial Markets and Services	3	-	-	3	40	60	100	8, 10
4	22PNE004	Mergers, Acquisitions and Corporate Restructuring	3	-	-	3	40	60	100	8, 16
5	22PNE005	Corporate Finance	3	-	-	3	40	60	100	8, 12
6	22PNE006	Strategic Cost Management	3	-	-	3	40	60	100	12, 9
7	22PNE007	Financial Analytics	3	-	-	3	40	60	100	9, 16
8	22PNE008	Financial Derivatives	3	-	-	3	40	60	100	8, 10
MARKETING ELECTIVES										
9	22PNE009	Digital Marketing and Content Writing	3	-	-	3	40	60	100	12, 3
10	22PNE010	Consumer Behaviour	3	-	-	3	40	60	100	12, 16
11	22PNE011	Integrated Marketing Communication	3	-	-	3	40	60	100	9, 12
12	22PNE012	Strategic Brand Management	3	-	-	3	40	60	100	8, 12
13	22PNE013	Services Marketing	3	-	-	3	40	60	100	9, 12
14	22PNE014	Marketing Analytics	3	-	-	3	40	60	100	8, 10
15	22PNE015	Rural Marketing SDG 8	3	-	-	3	40	60	100	9, 17
16	22PNE016	Business to Business Marketing	3	-	-	3	40	60	100	8, 16
HUMAN RESOURCE ELECTIVES										
17	22PNE017	Performance Management System	3	-	-	3	40	60	100	8, 16
18	22PNE018	Compensation and Benefits Management	3	-	-	3	40	60	100	4, 8
19	22PNE019	Leadership and Change Management	3	-	-	3	40	60	100	8, 10
20	22PNE020	Learning and Development	3	-	-	3	40	60	100	8, 16

21	22PNE021	Labour legislation and Employee relations SDG 8	3	-	-	3	40	60	100	8,16
22	22PNE022	Strategic Human Resource Management	3	-	-	3	40	60	100	8,9
23	22PNE023	HR Metrics and Analytics	3	-	-	3	40	60	100	8,9
24	22PNE024	Talent Acquisition and Deployment	3	-	-	3	40	60	100	8,4
GENERAL MANAGEMENT ELECTIVES										
25	22PNE025	Supply Chain and Logistics Management SDG 9	3	-	-	3	40	60	100	9,12
26	22PNE026	Business Analytics using R	3	-	-	3	40	60	100	8,9
27	22PNE027	Business Plan Preparation for Small Business	3	-	-	3	40	60	100	8,1
28	22PNE028	Operations Strategy	3	-	-	3	40	60	100	9,12
29	22PNE029	Social Entrepreneurship SDG 10	3	-	-	3	40	60	100	1,10
30	22PNE030	Agri Business Management SDG 11	3	-	-	3	40	60	100	2,11
31	22PNE031	Total Quality Management	3	-	-	3	40	60	100	9,12
32	22PNE032	Data Visualization for Managers	3	-	-	3	40	60	100	9,12

COURSE CODE

2	2	P	N	C/E/I/P/B	X1	X2	X3

C –Programme Core
E – Programme Elective
I – Internship Training
P – Project Work
B – Bridge Course
X1 – Semester number
X2, X3 -Course Identification starting from 01-32

22PNC106	LEGAL ASPECTS OF BUSINESS	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic knowledge about laws

COURSE OBJECTIVES

1. To create the knowledge of Legal perspectives to improve the business.
2. To learn about the Business Operations within the framework of Governance of Law.
3. To learn the industrial laws relevant to Business operations.
4. To understand the Consumer Protection and Cyber Laws

COURSE OUTCOMES

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

C106.1	Enhance the legal literacy of students by developing a body of legal knowledge	U
C106.2	Apply the principles of a company's Incorporation and its applicability	AP
C106.3	Analyse the performance of the negotiable instruments.	AN
C106.4	Evaluate the business-related legislative framework and provisions.	E

COURSE CONTENTS

MODULE 1	**BASICS OF BUSINESS LAW**	**15**

Indian Contract Act 1872: Contract – Meaning – Essential elements – Nature of contract - Offer and Acceptance- Classifications of Contracts, Formation of a contract, performance of contracts, breach of contract and its remedies, Quasi contracts -Special Contracts: Contract of Indemnity and Guarantee – Bailment and Pledge, The Sale of Goods Act 1930: Nature of Sales contract, Documents of title, risk of loss, performance of sales contracts

MODULE 2	**PARTNERSHIP AND COMPANY ACT**	**15**

The Companies (Amendment) Act, 2015: Company –Features and Types, One Person Company, Incorporation of Company – Memorandum of Association (MOA), Articles of Association (AOA), Share capital & Debentures, Acceptance of deposits, Appointment of director including woman Director-Meetings: Types - Winding up - Limited Liability Partnership Act 2008 - The Negotiable Instrument Act, 1881: Negotiable Instruments – Meaning, Characteristics, Types.

MODULE 3	**CONSUMER PROTECTION ACT AND CYBER LAWS**	**15**

The Consumer Protection Act, 1986, Unfair & Restrictive Trade Practices, Dispute Redressal Forums – District, State & National Forum, Composition, Jurisdiction, Powers, Appellate Authority. Information Technology Act, 2000, Digital Signature, Electronic Governance, Electronic Records, Cyber Crimes. Civil Remedies for Infringement. –Intellectual Property rights, Copy rights, Trade marks, Patent Act. Right to Information Act, 2005.

TOTAL HOURS:45

REFERENCES:

1. Ravinder Kumar (2021). Legal Aspects of Business, 5th edition, Noida, Cengage India Pvt Ltd.
2. Pathak, Akhileshwar (2018). Legal Aspects of Business, 7th edition, New Delhi, McGraw Hill Education
3. Ravindra Kumar & Renukamurthy, (2019), Legal& Business Environment, 1st edition, Noida, Cengage learning India Pvt Ltd.
4. Saravanavel, P and Sumathi, S (2018). Legal Aspects of Business, 1st edition, Mumbai, Himalaya Publishing House
5. Bulchandani K.R.(2022) Business Law for management Vol-I&II,7th edition, Himalaya Publishing.

WEB REFERENCES:

1. https://hbr.org/topic/subject/business-law
2. https://hbr.org/topic/subject/business-law-and-ethics
3. https://www.thehindubusinessline.com/business-laws/
4. https://onlinecourses.swayam2.ac.in/cec21_mg02/preview
5. https://www.coursera.org/learn/corporate-commercial-law-part2

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) – Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**FA(16%) (80 Marks)**
C106.1	Understand	Group Assignment	20
C106.2	Apply	Seminar	20
C106.3	Analyze	Case Study	20
C106.4	Evaluate	Technical Quiz	20
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) (100 marks)**
	CIA 1 (60 marks)	**CIA 2 (60 marks)**	
Remember	10	10	10
Understand	20	10	10
Apply	20	20	30
Analyze	30	30	30
Evaluate	20	30	20

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)**	

22PNC302	INDIAN ETHOS AND BUSINESS ETHICS	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic Concept of Business

COURSE OBJECTIVES

1. To know the sustained business stability of Indian Ethos.
2. To understand the importance of Values and karma.
3. To know the need for business ethics to ensure sustained business stability
4. To make the students understand the various dimensions in ethics, analytical and ethical problem solving in business

COURSE OUTCOMES

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

C302.1	Understand the Indian ethos and holistic management	U
C302.2	Analyze the importance of Values and acquire insight on Karma in life.	AN
C302.3	Evaluate the need for business ethics to ensure sustained business stability.	E
C302.4	Apply various ethical principles in business and examine ethical dilemma in different functional areas that helps to solve business problem.	AP

COURSE CONTENTS

MODULE 1	INTRODUCTION TO INDIAN ETHOS & VALUES IN BUSINESS	15

History & Relevance- Role of Indian Ethos in Managerial Practices, Management Lessons from Vedas, Mahabharata, Bible, Quran - Kautilya's Arthashastra. Ethics v/s Ethos - Work Ethos and Values for Indian Managers, Impact of Values on Stakeholders, Value System in Work Culture, Principles Practiced by Indian Companies, Relevance of Value Based Management in Global Change

MODULE 2	CONTEMPORARY APPROACHES TO INDIAN ETHOS	15

Personal and Managerial Effectiveness in Indian Thoughts - Management of the Self-Management of Body, Thoughts and Emotions; Interpersonal and Group Effectiveness. Importance of Karma to Managers - Nishkama Karma- Laws of Karma - Law of Creation- Law of Humility, Law of Growth, Law of Responsibility, Law of Connection, Law of Focus, Law of giving and hospitality, Law of here and now, law of change, Law of patience and reward, Law of significance and Inspiration.

MODULE 3	BUSINESS ETHICS	15

Business Ethics: Meaning, Characteristics and Importance; Understanding the need for ethics - Managing Ethical Dilemma in different business areas of finance, marketing, human resource and internationalbusiness - Corporate Social Responsibility, transparency and accountability, social media, Discrimination in employment. Unjust dismissal, workers' rights and duties. Whistle blowing, working conditions. Quality of working life. Gender issues. Women at workplace.

TOTAL HOURS: 45

REFERENCES:

1. Tushar Agarwal and Nidhi Chandorkar (2017). Indian Ethos in Management,1st edition, Himalaya Publishing House.
2. Nandagopal.R and Ajith Sankar.N (2011). Indian Ethos and Values in Management, 4th edition, Tata McGraw Hill.
3. Nagarajan K (2013). Indian Ethos and Values for Leadership excellence,1st edition, New Age International.
4. N.M. Khandelwal (2015). Indian Ethos and Values for Managers,5th edition, Himalaya Publishing

House.
5. Rinku Sanjeev, Parul Khanna (2013). Ethics and Values in Business Management, 5th edition,

WEB REFERENCES:

1. https://hbr.org/2010/05/the-india-way-of-leading-busin
2. https://hbr.org/2010/03/leadership-lessons-from-india
3. https://www.edx.org/learn/business-ethics
4. https://www.scribd.com/document/272451856/Indian-Ethos-and-Business-Ethics
5. https://www.coursera.org/learn/business-ethics

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) – Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**FA (16%) (80 Marks)**
C302.1	Understand	Assignment	20
C302.2	Apply	Group Assignment / Seminar	20
C302.3	Analyze	Case study	20
C302.4	Evaluate	Technical Quiz	20

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) (100 marks)**
	CIA 1 (60 marks)	**CIA 2 (60 marks)**	
Remember	10	10	10
Understand	10	10	10
Apply	30	30	30
Analyze	30	30	30
Evaluate	20	20	20

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)**	

22PNE015	RURAL MARKETING	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Knowledge of Marketing Management

COURSE OBJECTIVES

1. To provide insights into the Indian rural scenario, rural market structure and the factors that affect rural market.
2. To impart theoretical concepts of rural consumer buying process.
3. To cultivate expertise in real time advertising strategy in rural marketing.
4. To develop professional capabilities in innovative rural marketing.

COURSE OUTCOMES

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

C015.1	Understand and gain insights on the Indian Rural market and its structure.	U
C015.2	Employ the knowledge gained on the rural consumer behavior in practical business.	AP
C015.3	Evaluate the rural market advertisement strategy in real time situations.	E
C015.4	Illustrate the role of innovation in rural marketing.	AN

COURSE CONTENTS

MODULE 1	INTRODUCTION TO RURAL MARKETING	15

Rural Markets - The AICDA Model-Developing Rural markets through Information technology_ Defining Rural India- Evolution of Rural marketing- Defining Rural Marketing- the Rural Marketing Matrix- Rural Market structure- Demographic Environment, Education and the level of demand, House hold pattern, Rural Housing pattern, Occupation pattern- Physical Environment - Economic Environment, Changing Rural consumers Expenditure pattern, Saving pattern - Social & Cultural Environment, Village community, caste system-Political Environment- Technological Environment.

MODULE 2	CONSUMER BUYING PROCESS	15

Consumer Buying Process- Buying Behavior Patterns- Stages in the Buying process- Role of Rural Women - Opinion Leadership process- Diffusion of Innovation- Brand loyalty- Customer Relationship Management- Consumer adoption process- Product Life Cycle- Product Mix- Rural Packaging, Packaging Material, Pack size and convenience - Packaging Aesthetics- Branding in Rural India-Brand spectrum in Rural, Brand Loyalty vs Stickiness- Fake Brands- Lookalikes, Spell-alikes, Duplicates- Strategy to counter fake- Structure of Competition in Rural India..

MODULE 3	ADVERTISEMENTS AND INNOVATIONS IN RURAL MARKET	15

Factors in Setting the Promotion mix- Push versus Pull Strategy-Creating Advertisements for Rural Audiences- General Scheme of Rural advertising Production- Rural Media, Mass media, Radio, Television, Cinema, Print, mass Media: the Changing Dynamics- Non conventional Media- Out door media- wall painting, Folk media, video van, Haats, Melas, Mandis- Role of Innovation in Rural Markets-
ICT initiatives in Rural Markets, ITCs e-Choupal, n-Logue Communications, Project i- shakthi.

TOTAL HOURS: 45

REFERENCES:

1. Pradeep Kashyap (2016) Rural Marketing, 3rd edition, Pearson Education.
2. Pradeep Kashyap, Siddhartha Raut (2005), The Rural Marketing Book, 1st edition, Dreamtech Press.
3. Dinesh Kumar and Punam Gupta (2017), Rural Marketing- Challenges and Opportunities, 1st edition, SAGE Publications Pvt. Ltd.

4. Debarun Chakraborty (2018), Rural marketing in India: Texts and cases, 1st edition, Atlantic Publishers and Distributors Pvt. Ltd.
5. Sarabjit Singh Puri (2020), Rural Market Unleashed: Position Yourself in the Rural Market Effectively, 1st edition, Notion Press.

WEB REFERENCES:

1. https://hbr.org/2014/06/unlocking-the-wealth-in-rural-markets
2. https://hbr.org/2016/12/how-unilever-reaches-rural-consumers-in-emerging-markets
3. https://www.thehindubusinessline.com/topic/rural-marketing/
4. https://www.coursera.org/lecture/subsistence-marketplaces/lesson-4-1-2-rural-conversation-and-observation-a853H
5. https://www.deskera.com/blog/rural-marketing/

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) – Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**FA (16%) (80 Marks)**
C015.1	Understand	Assignment	20
C015.2	Apply	Assignment / Seminar	20
C015.3	Analyze	Case study	20
C015.4	Evaluate	Technical Quiz/ Case study	20
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) (100 marks)**
	CIA 1 (60 marks)	**CIA 2 (60 marks)**	
Remember	10	10	10
Understand	10	10	10
Apply	30	30	30
Analyze	30	30	30
Evaluate	20	20	20

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)	

22PNE021	LABOUR LEGISLATIONS AND EMPLOYEE RELATIONS	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic of Industrial Relations

COURSE OBJECTIVES

1. To create awareness of certain important and critical issues in Industrial Relations.
2. To impart basic knowledge of the Indian Industrial Relations System and its distinctive features.
3. To familiarize with the administration of labour laws in India at the Central and State levels.
4. To propagate the concept of Trade Unions at workplace.

COURSE OUTCOMES

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

C021.1	Understand the components of industrial relations and the trends that affect them.	U
C021.2	Apply the knowledge in industrial conflicts to develop a different line of action to settle the disputes.	AP
C021.3	Analyze the laws related to occupational health and safety working environment.	AN
C021.4	Evaluate the rules governing pay, benefits, and labour unions.	E

COURSE CONTENTS

MODULE 1 INDUSTRY RELATIONS & DISPUTES

Overview of Industrial Relations (IR), Statutory and Non Statutory welfare measures, Perspectives/Approaches to IR, Major stakeholders of IR, Changing Dimensions of IR in India, Impact of globalization on IR, ILO Causes of Industrial Disputes, Standing Orders & Grievance Procedure, The Industrial Employment (standing orders) Act, 1946, Collective Bargaining - Collective bargaining and negotiation of service conditions, Non unionized organizations and industrial relation with non unionized workers., The Industrial Disputes Act, 1947.

MODULE 2 LEGISLATION

The Factories Act, 1948, Object and Scope of the Act Measures to be taken by Factories for Health, Safety and Welfare of Workers, Compliances Under The Act Minimum Wages Act -1948, Payment of Wages Act - 1936, Equal remuneration Act -197, Payment of Bonus Act, 1965, Payment of Gratuity Act, 1972 Workmen's Compensation Act, 1923, Employees' Provident Fund, 1952, Employees State Insurance Act, 1976, The Maternity Benefit Act, 1961, The Contract Labour Act, Shops and Establishments act, Child labour(Prohibition and Regulation) Act 1986, Unorganized Workers Social Security Act 2008

MODULE 3 TRADE UNION

Concepts, Functions, Objectives, Structure of Trade unions in India, Kinds of Trade Unions, Problems of Trade Union, Trade union movement in India, Objective, role and functions of the Trade Unions in Modern Industrial Society of India, Procedure for registration of Trade Unions, Grounds for the withdrawal and cancellation of registration, Trade Union Act, 1926, Importance of IRLL in HR career. Implications of Labour laws in IT and Manufacturing sector.

TOTAL HOURS: 45

REFERENCES:

1. S.C.Srivastava, (2020),Industrial Relations and Labour Laws, 8th edition, Vikas Publishing House Pvt Ltd.
2. Padhi P K, (2019), Labour and Industrial Laws, 4th edition, PHI Learning Pvt. Ltd.

3. CB Mamoria and Sathish Mamoria, P. Subba Rao (2022). Dynamics of Industrial Relation, 16th edition, Himalaya Publishing House.
4. PRN Sinha, Indu Bala Sinha,Seema Priyadarshini Shekar(2013) Industrial relations, trade unions and labour legislations, 3rd edition, Pearson Education.
5. Dr.Panchanan Saha (2014) Pioneers of Indian Trade Union Movement , Parul Prakashani Pvt Ltd

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2. https://labour.gov.in/
3. https://www.lawctopus.com/nujs-kolkatas-online-certificate-course-in-labour-and-industrial-laws
4. https://www.vakilno1.com/
5. https://onlinecourses.nujs.edu/landing/online-legal-courses-human-resource-professionals/

Assessment Methods & Levels (Based on Blooms' Taxonomy) - Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**Marks**
C021.1	Understand	Assignment / Group Assignment	**04**
C021.2	Apply	Assignment / Seminar	**04**
C021.3	Analyze	Case study	**04**
C021.4	Evaluate	Technical Quiz	**04**

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**CIA 1 (12 marks)**	**CIA 2 (12 marks)**	**End Semester Examination (60 marks)**
Remember	1	1	05
Understand	1	1	05
Apply	2	2	10
Analyze	3	3	15
Evaluate	3	3	15
Create	2	2	10

Summative Assessment based on Continuous and End Semester Examination						
CIA I			**CIA II**			**ESE**
FA1	**FA2**	**SA1**	**FA1**	**FA2**	**SA2**	
04	**04**	**12**	**04**	**04**	**12**	**60**

FA: Formative Assessment (Internal Component) **SA: Summative Assessment (CIA)**

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)**	

GENERAL MANAGEMENT ELECTIVES

22PNE025	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic knowledge of Operations Management

COURSE OBJECTIVES

1. To understand the function and significance of the supply chain
2. To demonstrate the supply chain network design and distribution management concepts
3. To make the students to understand the Importance of logistics and outsourcing in organizations
4. To facilitate to take decisions related to logistics and its outsourcing

COURSE OUTCOMES

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

C025.1	Understand and take efficient and responsive supply chain decisions	U
C025.2	Analyze the supply chain network design, distribution management and to acquire comprehensive knowledge to take business decisions	AN
C025.3	Finalize and apply the decisions on location of the facility and network design	AP
C025.4	Evaluate the Information on the transportation and distribution management with appropriate logistics service providers	E

COURSE CONTENTS

MODULE 1	INTRODUCTION TO SUPPLY CHAIN	15

Introduction to Supply chain strategy; Understanding the Supply Chain -Supply Chain Management Basics- Drivers of Supply Chain Performance – Metrics of Supply chain - Decision Phases, and Process View - Link between Supply Chain Management and Other Management Functions-Achieving Strategic Fit - Obstacles for Achieving Strategic Fit - Efficient and Responsive Supply Chains - Managing Uncertainties in a supply chain – IT in Supply Chain Management.

MODULE 2	SUPPLY CHAIN NETWORK DESIGN AND DISTRIBUTION MANAGEMENT	15

Facility location and network design; Role of Network Design - Factors Influencing Network Design Decisions- Framework for Network Design Decisions-Supply Chain Co-ordination and Bullwhip Effect - Lack of Coordination - Obstacles to Coordination-Managerial Levers to Achieve Co-ordination- MilkVendor Model-Distribution Management-Transportation fundamentals and planning- Green logistics- E-Commerce and Reverse Logistics-Supply chain sustainability

MODULE 3	LOGISTICS AND OUTSOURCING	15

The Logistics of Business-Scope-Functions-Logistics Management and its elements - Service Phases and attributes-Demand Forecasting-Sourcing Decisions- Basics of multimodal Transport: Carriage by Air, Sea, Road, Rail - Warehousing-Types-Functions of Warehouses; Inventory Management-Risk management-Warehousing Strategy -Elements-of Warehousing Costs - Warehouse Design Principles- 3PL and 4PL service providers- Packaging Cross Docking-Critical Issues- International commercial documents.

TOTAL HOURS:45

REFERENCES:

1 Sunil Chopra, Peter Meindal, D V Kalra (2018). Supply Chain Management, Strategy, Planning and Operation 7th edition, Pearson Prentice Hall Education Ltd.

2 Sasikumari V and Purushothaman S (2022). Logistics and Supply Chain Management, 1st edition, Sultan Chand and Sons.

3 Pierre David (2013). International Logistics,1st edition, Biztantra.

4 David Simchi Levi, Edith Simchi – Levi, Ravi Shankar and Philip Kaminsky (2022), Designing and Managing the supply Chain: Concepts, Strategies amd Case Studies, 4th edition, McGraw Hill Education

(India) Pvt. Ltd.
5 Shridara Bhat (2012). Supply Chain Management, 2ndedition, Himalaya Publishing House.
6 Coyle, Langley, Novack, Bardi, (2020). Supply Chain Management: A Logistics Perspective,10th edition, South – Westerm College Publishing.

WEB REFERENCES:

1. https://hbr.org/topic/subject/supply-chain-management
2. https://hbr.org/2020/09/global-supply-chains-in-a-post-pandemic-world
3. https://www.thehindubusinessline.com/opinion/logistics-and-supply-chain-trends-for-021/article36366467.ece
4. https://onlinecourses.nptel.ac.in/noc21_mg79/preview
5. https://www.coursera.org/specializations/supply-chain-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) – Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**FA (16%) (80 Marks)**
C025.1	Understand	Assignment	20
C025.2	Apply	Assignment / Seminar	20
C025.3	Analyze	Case	20
C025.4	Evaluate	Technical Quiz	20
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) (100 marks)**
	CIA 1 (60 marks)	**CIA 2 (60 marks)**	
Remember	10	10	10
Understand	20	10	10
Apply	20	20	30
Analyze	30	30	30
Evaluate	20	30	20

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)	

22PNE029	SOCIAL ENTREPRENEURSHIP	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic Knowledge in Entrepreneurship

COURSE OBJECTIVES

1. To define the field of social entrepreneurship and key traits of social entrepreneurs.
2. To describe and apply key theories and concepts of social entrepreneurship.
3. To apply the theories on business Models in environments for social entrepreneurs.
4. To synthesize the concepts for Marketing and Financial Evaluation of social entrepreneurship.

COURSE OUTCOMES

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

C029.1	Understand how social entrepreneurship contributes to the creation of a sustainable society.	U
C029.2	Apply the knowledge and abilities to become a social entrepreneur	AP
C029.3	Analyze the viable business plan for creating a social venture to bring the changes in the social environment.	AN
C029.4	Undertake the feasibility analysis and evaluate the financial avenues for Social Ventures.	E

COURSE CONTENTS

MODULE 1	INTRODUCTION TO SOCIAL ENTREPRENEURSHIP	15

Introduction to Social Entrepreneurship – Basic Traits /Characteristics of Social Entrepreneurs – Roles and Responsibilities of Social Entrepreneurs – Social Entrepreneurial Motivation – Factors affected the individual to become social entrepreneurs - Challenges faced by Social Entrepreneurs in India - Impact of social enterprises on the economy- Opportunity identification in Social Entrepreneurship – Learning real life stories from Social Entrepreneurs.

MODULE 2	INNOVATIONS AND EXTERNAL ENVIRONMENT	15

External Environment of Social Entrepreneur venture: Macro Environment, PEST Model, Tools for Analyzing social Venture, Porters 5 force model-Idea's about Social Innovations– Importance of social innovation - Forms of Innovation – Types of Social Innovation – Process of Social Innovation – Understanding Social Problems-Creating Business Models–Social Enterprise related Policies - Social Venture Business sustainability models– Innovative Business Models Creating Social Changes

MODULE 3	SOCIAL VENTURE FINANCING	15

Feasibility Analysis of Social Venture-Marketing Challenges of Social Venture-Managing Financial sides of Social Venture: Source of funding, Grant, Loan Providers, Boot strapping, Micro finance, Crowd Funding, -Organizational and Management of social venture-Social venture Effectiveness-Scaling of social venture-Measuring the impact of social venture

TOTAL HOURS:45

REFERENCES:

1. Robert A. Philips Margret Bonefiel Ritesh Sharma, (2011),Social entrepreneurship: The next big business opportunity, 1st edition, New Delhi, Global Vision Publishing House.
2. Constant Beugre,(2017) Social Entrepreneurship: Managing the creation of Social value,1st edition, New York , Routledge, Taylor & Francis Group.
3. S.S.Khanka(2009), Entrepreneurship in India, perspective and practice,1st edition, New Delhi, Akansha publishing house,

4. Vasanth Desai (2019), Entrepreneurial development,1st edition, Mumbai Himalaya Publishing House,
5. David Bornstei6 and Susan Davis (2010) Social entrepreneurship What every one needs to know, 1st edition, USA, Oxford University Press.

WEBREFERENCES:

1. https://hbr.org/2015/10/how-social-entrepreneurs-make-change-happen
2. https://hbr.org/topic/subject/social-enterprise
3. https://www.thehindubusinessline.com/news/world/social-entrepreneurs-turn-creative-in-this-pandemic-time/article33130118.ece
4. https://www.coursera.org/specializations/social-entrepreneurship-cbs
5. https://www.edx.org/learn/social-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) – Theory

Formative assessment based on capstone Model (Max. Marks: 16)

Course Outcome	Bloom's level	Assessment Component	FA (16%) (80 Marks)
C029.1	Understand	Assignment / Group Assignment	20
C029.2	Apply	Assignment / Seminar	20
C029.3	Analyze	Case Analysis	20
C029.4	Evaluate	Technical Quiz	20

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) (100 marks)
	CIA 1 (60 marks)	CIA 2 (60 marks)	
Remember	10	10	10
Understand	20	10	10
Apply	20	20	30
Analyze	30	30	30
Evaluate	20	30	20

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)	

22PNE030	AGRI BUSINESS MANAGEMENT	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic knowledge in Economics

COURSE OBJECTIVES

1. To gain exposure on the nuances of agribusiness.
2. To explore the agribusiness environment and policies
3. To familiarize the features of agricultural marketing
4. To comprehend the scope and recent trends in agro based industries

COURSE OUTCOMES

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

C030.1	Understand the fundamentals of management with reference to agribusiness.	U
C030.2	Identify suitable agribusiness environment policies to effectively apply in actual business situations.	AP
C030.3	Effectively analyze the marketing of agricultural products.	AN
C030.4	Evaluate agro-based industries in close collaboration with the relevant public agencies.	E

COURSE CONTENTS

MODULE 1	INTRODUCTION TO AGRIBUSINESS	15

Agribusiness – Definition, objectives, Importance and nature – Role of NITI Aayog-Role of NABARD-Changing dimensions of agricultural business. Structure of Agriculture – Linkages among sub-sectors of the Agribusiness sectors- Green Revolution-economic reforms and Indian agriculture; impact of liberalization, privatization and globalization on Agribusiness Sector-Modern farming practices – Risks that affect Agriculture business – Management of risks – Types of Costs in Agribusiness: Variable, Overhead, Financial, Capital and Personal Costs - Progress in India

MODULE 2	AGRICULTURAL MARKETING	15

Agricultural marketing-Difference in Marketing of agricultural and manufacturing goods – Importance of Agricultural Marketing - Public distribution system and other policies- Public agencies involved in agricultural marketing: FCI, NAFED and STC – Agricultural Processed Products and Export Development Authority (APEDA) – Warehousing: Central and State warehousing corporation – Co-operative marketing - The Directorate of Marketing and Inspection (DMI) – National Dairy Development Board (NDDB).

MODULE 3	AGRO INDUSTRIES	15

Agro based industries – meaning – Agro-produce processing units/ manufacturing units, Agro service centers – Factors influencing growth of Agro based industries – Location factors for Agro based industries – Role of Agro based industries in Indian economy – Contribution to GDP – Institutional arrangements for the promotion of Agro based industries in India: Ministry of Agriculture, Khadi and Village Industries Commission, Director General of Trade and development, Small Industry Development Organization

TOTAL HOURS: 45

REFERENCES:

1. Dr. SmitaDiwase (2017). Agri business Management, 3rd edition, Everest Publishing House.
2. Freddie L. Barnard (2020). Agri business Management,6/e, New Delhi, Routledge Publishing.
3. Johl, S. S and T.R. Kapoor (2015). Fundamentals of Farm Business Management, 3rd edition, Delhi, Kalyani Publishers.

4. Sanket S. Kadam (2016). A Textbook of Agri-Business Management, 2nd edition, Pune, Universal Prakashan Publications.
5. Jay T.Akridge (2012). Agri business Management, 4th edition, New Delhi, Taylor & Francis

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2. https://www.tn.gov.in/scheme/department_wise/2
3. http://agritech.tnau.ac.in/agricultural_engineering/agriengg_govt_schemes.html
4. https://www.nabard.org/
5. https://onlinecourses.swayam2.ac.in/nou19_ag08/preview

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) – Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**FA (16%) (80 Marks)**
C030.1	Understand	Assignment	20
C030.2	Apply	Assignment / Seminar	20
C030.3	Analyze	Case study	20
C030.4	Evaluate	Technical Quiz	20

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) (100 marks)**
	CIA 1 (60 marks)	**CIA 2 (60 marks)**	
Remember	10	10	10
Understand	10	10	10
Apply	30	30	30
Analyze	30	30	30
Evaluate	20	20	20

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)**	

22PNE031	TOTAL QUALITY MANAGEMENT	3/0/0/3
Nature of Course	**THEORY**	

PREREQUISITES: Basic knowledge in Operations Management

COURSE OBJECTIVES

1. To understand the concepts of Total Quality Management
2. To demonstrate the tools and techniques of TQM for effective decision-making
3. To familiarize with the current practices in the field of QM
4. To provides an insight about quality tools

COURSE OUTCOMES

Upon successful completion of the course, the students will be able to:

C031.1	Understand the TQM concepts	U
C031.2	Apply quality assurance techniques in industries to assure quality	AP
C031.3	Analyse the extensive information regarding QMS and the its industrial usage	A
C031.4	Evaluate the benefits of Quality Management System and quality tools	E

COURSE CONTENTS

MODULE 1	**TOTAL QUALITY MANAGEMENT**	**15**

Definitions of quality- Dimensions of quality- TQM-Definition- Evolution of TQM- Approaches to Quality Management by Deming, Juran, and Crosby-Customer Focus – Customer perception of quality – Core concepts, and benefits of TQM- Dimensions of product and service quality -Traditional organization versus TQM Organization-TQM Implementation, Challenges in implementation-Cost of quality

MODULE 2	**TOOLS AND TECHNIQUES OF TQM**	**15**

Seven Quality Tools of Analysis - Control Charts - Pareto Diagram - Ishikawa Diagram - Histogram-Flow Charts- Scatter Diagram and Stratification – New QC tools -Affinity diagram, Relationship Diagram, Tree Diagram, Matrix Diagram-Six Sigma concepts of process quality- -Continuous Process Improvement – PDSA Cycle – Kaizen - 5Sprinciples -POKAYOKE – Kaizen -Benchmarking – Types, Reasons - Process. Quality Function Deployment (QFD) – Benefits -QFD Process – House of Quality – Failure Mode and Effect Analysis (FMEA)

MODULE 3	**QUALITY MANAGEMENT SYSTEMS AND ADVANCED QUALITY TOOLS**	**15**

Quality management systems – guidelines for performance improvements-TQM culture, Leadership-Benefits of ISO Registration - Quality Circles, ISO9000, ISO14000 - ISO9001:2015-ISO/TS16949:2015 – Quality Systems – Auditing – Audit standards - Objectives and types-Reliability concepts – definitions, reliability in series and parallel – Reliability vs. Quality Control–The bath tub curve –Taguchi's Loss function – Business Process Management–concepts-Corrective action and Preventive action (CAPA)

TOTAL HOURS:45

REFERENCES:

1. Poornima M. Charantimath (2013). Total Quality Management, 2nd edition, Pearson Education India.
2. Sunil Sharma (2018), Total Quality Management: Concepts, Strategy and Implementation for Operatinal Excellence, 1st edition, SAGE Publication Ltd.
3. Sridhara Bhat K (2017), Total Quality Management, 1st edition, Himalaya Publishing House.
4. Suganthi Anand and Samuel A (2011), Total Quality Management, 7th edition, Prentice Hall of India
5. David L Goetsch Stanley Davis (2014), Quality Management for Organisational Excellence: Introduction to Total Quality, 7th edition, Pearson Education Limited.

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2. https://hbsp.harvard.edu/download?url=%2Fcatalog%2Fsample%2F192003-PDF-ENG%2Fcontent&metadata=e30%3D
3. https://www.thehindubusinessline.com/companies/tvs-group-chairman-venu-srinivasan-conferred-with-deming-prize/article29899971.ece
4. https://onlinecourses.nptel.ac.in/noc22_mg69/preview
5. https://nptel.ac.in/courses/110104080

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) – Theory			
Formative assessment based on capstone Model (Max. Marks: 16)			
Course Outcome	**Bloom's level**	**Assessment Component**	**FA (16%) (80 Marks)**
C031.1	Understand	Assignment / Group Assignment	**10**
C031.2	Apply	Assignment / Seminar	**25**
C031.3	Analyze	Case	**25**
C031.4	Evaluate	Technical Quiz	**20**

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) (100 marks)**
	CIA 1 (60 marks)	**CIA 2 (60 marks)**	
Remember	10	10	10
Understand	20	10	10
Apply	20	20	30
Analyze	30	30	30
Evaluate	20	30	20

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)**	