MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE

MADANAPALLE

(UGC-AUTONOMOUS)

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DEPARTMENT OF MECHANICAL ENGINEERING

Course Structure
&
Detailed Syllabi

For the students admitted to

B. Tech. Regular Four Year Degree Programme from the academic year 2018-19

and

B. Tech. Lateral Entry Scheme from the academic year 2019-20

B.TECH. MECHANICAL ENGINEERING

MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE, MADANAPALLE

B. Tech Four Year Curriculum Structure

Branch: MECHANICAL ENGINEERING

Total Credits: 160 (4 Year Course)

I. Induction Program and Holistic Development Activities

Sl. No.	Title	Duration
1	Induction Program (Mandatory)	Three weeks duration at the start of First Year (Refer Annexure - I)
2	Holistic Development Activities (Every Student from Semester 2 – 8 should register for at least one activity)	Three hours per week (Activity list is enclosed in Annexure - I)
3	Virtual Laboratory (Students are encouraged to choose and register for any of the Virtual laboratories he /she is interested)	As specified by the Virtual Laboratory

II. Semester-wise Structure of Curriculum

(L = Lecture, T = Tutorial, P = Practical, C = Credit)

I Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Basic Science Course	18MAT101	Engineering Calculus	3	1	0	4	4
2	Basic Science Course	18PHY101	Engineering Physics	3	1	0	4	4
3	Engineering Science Course	18EEE101	Basic Electrical Engineering	3	0	0	3	3
4	Engineering Science Course	18CSE101	Programming for Problem Solving (Python)	2	0	2	4	3
5	Basic Science Course	18PHY201	Physics Laboratory	0	0	3	3	1.5
6	Engineering Science Course	18EEE201	Electrical Engineering Laboratory	0	0	3	3	1.5
			Total	**11**	**2**	**8**	**21**	**17**

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I Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Humanities and Social Sciences including Management	18ENG101	Professional English	2	0	2	4	3
2	Basic Science Course	18MAT107	Linear Algebra, Complex Variables and Ordinary Differential Equations	3	1	0	4	4
3	Basic Science Course	18CHE101	Engineering Chemistry	3	0	0	3	3
4	Engineering Science Course	18CSE102	C Programming and Data Structures	3	0	0	3	3
5	Engineering Science Course	18ME101	Engineering Graphics	2	0	3	5	3.5
6	Basic Science Course	18CHE201	Chemistry Laboratory	0	0	3	3	1.5
7	Engineering Science Course	18CSE201	C Programming and Data Structures Laboratory	0	0	3	3	1.5
8	Engineering Science Course	18ME201	Workshop Practice	0	0	3	3	1.5
			Total	**13**	**1**	**14**	**28**	**21**

II Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Humanities, Social Sciences including Management	18HUM102	Principles of Management	3	0	0	3	3
2	Basic Science Course	18MAT108	Partial Differential Equations and Probability & Statistics	3	1	0	4	4
3	Engineering Science Course	18ME102	Engineering Mechanics	2	1	0	3	3
4	Professional Core Course	18ME103	Basic Thermodynamics	2	1	0	3	3
5	Professional Core Course	18ME104	Materials Science and Engineering	3	0	0	3	3
6	Humanities, Social Sciences including Management	18ENG201	English Communication – Listening & Speaking Laboratory	0	0	3	3	1.5
7	Professional Core Course	18ME202	Materials Science and Engineering Laboratory	0	0	3	3	1.5
8	Professional Core Course	18ME203	3-D Modelling Laboratory	0	0	3	3	1.5
9	Mandatory non-credit Course		Mandatory Course – I (Refer Annexure –V)	2	0	0	2	0
			Total	**15**	**3**	**9**	**27**	**20.5**

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II Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Humanities, Social Sciences including Management	18HUM101	Economics and Financial Accounting for Engineers	3	0	0	3	3
2	Basic Science Course	18BIO101	Life Sciences for Engineers	3	0	0	3	3
3	Professional Core Course	18ME105	Mechanics of Solids	2	1	0	3	3
4	Professional Core Course	18ME106	Manufacturing Process	3	0	0	3	3
5	Professional Core Course	18ME107	Theory of Machines	2	1	0	3	3
6	Professional Core Course	18ME108	Fluid Mechanics & Hydraulic Machinery	2	1	0	3	3
7	Professional Core Course	18ME204	Mechanics of Solids Laboratory	0	0	3	3	1.5
8	Professional Core Course	18ME205	Dynamics & Electrical Machines Laboratory	0	0	3	3	1.5
9	Professional Core Course	18ME206	Manufacturing Process Laboratory	0	0	3	3	1.5
10	Mandatory non-credit Course		Mandatory Course – II (Refer Annexure –V)	2	0	0	2	0
			Total	**17**	**3**	**9**	**29**	**22.5**
Summer Internship								

B. Tech Mechanical Engineering

III Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Engineering Science Course	18ME109	Engineering Analysis	2	0	2	4	3
2	Professional Core Course	18ME110	Design of Machine Elements	2	1	0	3	3
3	Professional Core Course	18ME111	Manufacturing Technology	3	0	0	3	3
4	Professional Core Course	18ME112	Heat Transfer	2	1	0	3	3
5	Professional Elective Course		Discipline Elective – I (Refer Annexure –III)	3	0	0	3	3
6	Open Elective Course		Open Elective – I (Refer Annexure –II)	3	0	0	3	3
7	Humanities, Social Sciences including Management	18ENG202	Corporate Communication Laboratory	0	0	2	2	1
8	Professional Core Course	18ME207	Fluid Mechanics and Hydraulic Machines Laboratory	0	0	3	3	1.5
9	Professional Core Course	18ME208	Manufacturing Technology Laboratory	0	0	3	3	1.5
10	Mandatory non-credit Course		Mandatory Course – III (Refer Annexure –V)	2	0	0	2	0
			Total	**17**	**2**	**10**	**29**	**22**

III Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Humanities, Social Sciences including Management	18ENG102	English Communication - Reading and Writing	2	0	0	2	2
2	Professional Core Course	18ME113	CAD/ CAM	3	0	0	3	3
3	Professional Core Course	18ME114	Thermal Engineering	2	1	0	3	3
4	Professional Elective Course		Discipline Elective-II (Refer Annexure –III)	3	0	0	3	3
5	Professional Elective Course		Discipline Elective-III (Refer Annexure –III)	3	0	0	3	3
6	Open Elective Course		Open Elective – II (Refer Annexure –II)	3	0	0	3	3
7	Professional Core Course	18ME209	Advanced Manufacturing Laboratory	0	0	3	3	1.5
8	Professional Core Course	18ME210	Robotics Laboratory	0	0	3	3	1.5
9	Professional Core Course		Virtual Laboratory (Refer Annexure - IV)	0	0	2	2	0
10	Mandatory non-credit Course		Mandatory Course – IV (Refer Annexure –V)	2	0	0	2	0
			Total	**18**	**1**	**8**	**27**	**20**
Summer Internship								

IV Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Professional Core Course	18ME115	Engineering Metrology and Measurements	3	0	0	3	3
2	Professional Core Course	18ME116	Machine Learning for Mechanical Engineering	2	0	2	4	3
3	Professional Elective Course		Discipline Elective-IV (Refer Annexure –III)	3	0	0	3	3
4	Professional Elective Course		Discipline Elective-V (Refer Annexure –III)	3	0	0	3	3
5	Open Elective Course		Open Elective -III (Refer Annexure –II)	3	0	0	3	3
6	Professional Core Course	18ME211	Thermal Engineering Laboratory	0	0	2	2	1
7	Professional Core Course	18ME212	CAE Laboratory	0	0	2	2	1
8	PROJ-ME	18ME701	Project Work – I	0	0	4	4	2
			Total	**14**	**0**	**10**	**24**	**19**

IV Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
1	Professional Elective Course		Discipline Elective-VI (Refer Annexure –III)	3	0	0	3	3
2	Open Elective Course		Open Elective IV (Refer Annexure –II)	3	0	0	3	3
3	PROJ-ME	18ME702	Project Work - II	0	0	24	24	12
			Total	**6**	**0**	**24**	**30**	**18**

ANNEXURE - I

THREE WEEK MANDATORY INDUCTION PROGRAMME

- Yoga and Meditation
- Sports and Games
- NSS
- NCC
- MITS Social Responsibility Club
- Management module
- Design Thinking
- Spoken and Written Communication

- *Proficiency modules*

  - Basic Computer Proficiency
  - Interpersonal skills
  - Computer Graphics
  - Web programming
  - Mobile Apps
  - Vocabulary enhancement

HOLISTIC DEVELOPMENT ACTIVITIES

Description of Activities

1. Physical and Health
2. Culture
3. Literature and Media
4. Social Service
5. Self-Development
6. Nature and Environment
7. Innovation

ANNEXURE – II

OPEN ELECTIVE – I

(To be offered under MOOC's Category from SWAYAM – NPTEL)
Students can opt to be assessed either in Conventional mode or through proctored exams conducted by Swayam NPTEL

Sl. No.	Course Code	Course Title	Course Offered by Department of
1	18ENG3M01/ 18ENG3M01C	Soft Skills	English & Training
2	18ENG3M02/ 18ENG3M02C	Developing Soft Skills and Personality	English & Training
3	18ENG3M03/ 18ENG3M03C	Soft Skill Development	English & Training
4	18HUM3M01/ 18HUM3M01C	Project Management for Managers	Humanities
5	18HUM3M02/ 18HUM3M02C	Ethics in Engineering Practice	Humanities
6	18CE3M01/ 18CE3M01C	Integrated Waste Management for Smart City	Civil
7	18CE3M02/ 18CE3M02C	Soil and Water Conservation Engineering	Civil
8	18CE3M03/ 18CE3M03C	Engineering Geology	Civil
9	18EEE3M02/ 18EEE3M02C	Design of Photovoltaic Systems	EEE
10	18ECE3M01/ 18ECE3M01C	Semiconductor Opto-Electronics	ECE
11	18ECE3M02/ 18ECE3M02C	Digital VLSI Testing	ECE
12	18CSE3M01/ 18CSE3M01C	Social Networks	CSE
13	18CSE3M02/ 18CSE3M02C	Privacy and Security in Online Social Media	CSE

Any new Interdisciplinary Course offered by SWAYAM NPTEL can be appended in future.

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OPEN ELECTIVE – II (To be offered under Conventional Mode)			
Sl. No.	**Course Code**	**Course Title**	**Course Offered by Department of**
1	18MAT301	Advanced Numerical Methods	Mathematics
2	18MAT302	Engineering Optimization	Mathematics
3	18PHY301	Optical Physics and its Applications	Physics
4	18PHY302	LASER Physics and Advanced LASER Technology	Physics
5	18CHE301	Introduction to Petroleum Industry	Chemistry
6	18CHE302	Green Chemistry and Catalysis for Sustainable Environment	Chemistry
7	18HUM301	Intellectual Property Rights	Humanities
8	18HUM302	Human Resource Development	Humanities
9	18HUM304	National Cadet Corps	Humanities
10	18CE301	Ground Improvement Techniques	Civil
11	18CE302	Environmental Impact Assessment	Civil
12	18CE303	Watershed Management	Civil
13	18EEE301	Industrial Electrical Systems	EEE
14	18EEE302	Introduction to MEMS	EEE
15	18ECE301	Bio-Medical Electronics	ECE
16	18ECE302	VLSI Design	ECE
17	18CSE301	Operating Systems	CSE
18	18CSE302	E-Learning Technologies	CSE
19	18CSE303	AI Tools, Techniques and Applications	CSE

B. Tech Mechanical Engineering

OPEN ELECTIVE – III (To be offered under MOOC's Category from SWAYAM – NPTEL) Students can opt to be assessed either in Conventional mode or through proctored exams conducted by Swayam NPTEL			
Sl. No.	**Course Code**	**Course Title**	**Course Offered by Department of**
1	18ENG3M04/ 18ENG3M04C	Speaking Effectively	English
2	18HUM3M03/ 18HUM3M03C	Management Information System	Humanities
3	18CE3M04/ 18CE3M04C	Remote Sensing and GIS	Civil
4	18CE3M05/ 18CE3M05C	Waste Water Treatment and Recycling	Civil
5	18CE3M06/ 18CE3M06C	Building Materials and Composites	Civil
6	18EEE3M03/ 18EEE3M03C	Introduction to Smart Grid	EEE
7	18ECE3M03/ 18ECE3M03C	Introduction to Embedded Systems	ECE
8	18ECE3M04/ 18ECE3M04C	Embedded System Design with ARM	ECE
9	18ECE3M05/ 18ECE3M05C	Advanced Computer Architecture	ECE
10	18CSE3M03/ 18CSE3M03C	Human Computer Interactions	CSE
11	18CSE3M04/ 18CSE3M04C	Programming in JAVA	CSE
12	18CSE3M05/ 18CSE3M05C	Multi-Core Computer Architecture – Storage and Interconnects	CSE
13	18CSE3M06/ 18CSE3M06C	Introduction to Internet of Things	CSE
	18IE3M01/ 18IE3M01C	Introduction to Research	General
Any new Interdisciplinary Course offered by SWAYAM NPTEL can be appended in future			

B. Tech Mechanical Engineering

OPEN ELECTIVE – IV (To be offered under Conventional Mode)			
Sl. No.	**Course Code**	**Course Title**	**Course Offered by Department of**
1	18ENG301	Creative Writing	English
2	18HUM303	Entrepreneurship Development	Humanities
3	18MAT303	Graph Theory	Mathematics
4	18MAT304	Mathematical Modeling and Numerical Simulation	Mathematics
5	18PHY303	Thin Film Technology and its Applications	Physics
6	18CHE303	Introduction to Nano Science and Technology	Chemistry
7	18CHE304	Computational Methods in Materials Science and Engineering	Chemistry
8	18CE304	Green Building and Energy Conservation	Civil
9	18CE305	Environmental Engineering	Civil
10	18EEE303	Robotics	
11	18EEE304	Electrical Safety	EEE
12	18ECE303	Nano Electronics	ECE
13	18ECE304	Wireless Sensor Networks	ECE
14	18CSE304	Mobile Application Development	CSE
15	18CSE305	Software Project Management	CSE
16	18CSE306	Software Testing	CSE

ANNEXURE – III

List of Discipline Electives

Discipline Elective – I		
Sl. No.	**Course Code**	**Course Title**
1.	18ME401	Production Planning and Control
2.	18ME402	Computational Fluid Dynamics
3.	18ME403	Tool and Die Design
4.	18ME404	Fluid Power Systems
5.	18ME405	Finite Element Methods
6.	18ME426	Design Thinking and Product Innovation
Any advanced courses can be appended in future.		

Discipline Elective – II (To be offered under MOOC's category from SWAYAM NPTEL) Students can opt to be assessed either in Conventional mode or through proctored exams conducted by Swayam NPTEL		
Sl. No.	**Course Code**	**Course Title**
1.	18ME4M01/ 18ME4M01C	Experimental Stress Analysis
2.	18ME4M02/ 18ME4M02C	System Design for Sustainability
3.	18ME4M03/ 18ME4M03C	Material Characterization
4.	18ME4M04/ 18ME4M04C	Design and Analysis of Experiments
5.	18ME4M05/ 18ME4M05C	Industrial Safety Engineering
6.	18ME4M06/ 18ME4M06C	Non-Conventional Energy Resources
7.	18ME4M07/ 18ME4M07C	Operations Management
Any other new Disciplinary Course which doesn't exist in the Curriculum can be appended in future.		

Discipline Elective – III		
Sl. No.	**Course Code**	**Course Title**
1.	18ME406	Design and Analysis of Welded Structures
2.	18ME407	Refrigeration and Air Conditioning
3.	18ME408	Internet of Manufacturing Things
4.	18ME409	Solar Energy for Process Heat and Power Generation
5.	18ME410	Industrial Tribology and Corrosion
Any advanced courses can be appended in future.		

Discipline Elective – IV		
Sl. No.	**Course Code**	**Course Title**
1.	18ME411	Fundamentals of Automobile Engineering
2.	18ME412	Design of Pressure Vessels and Piping Systems
3.	18ME413	Design of Heat Exchangers
4.	18ME414	Non Destructive Testing
5.	18ME415	Total Quality Management
Any advanced courses can be appended in future.		

Discipline Elective – V		
Sl. No.	**Course Code**	**Course Title**
1.	18ME416	Mechanical Vibrations
2.	18ME417	Introduction to Gas Turbine Engines
3.	18ME418	Design and Manufacture of Composites
4.	18ME419	Design of Power Plant Systems
5.	18ME420	Operations Research
Any advanced courses can be appended in future.		

Discipline Elective – VI		
Sl. No.	**Course Code**	**Course Title**
1.	18ME421	Automation and Robotics
2.	18ME422	Electric Vehicle Technology
3.	18ME423	Additive Manufacturing
4.	18ME424	Energy Auditing
5.	18ME425	Entrepreneurship and Project Management
Any advanced courses can be appended in future.		

ANNEXURE - IV

MECHANICAL ENGINEERING - VIRTUAL LABS

Sl. No.	Course Code	Course Title
1.	18ME213	Vibration and Acoustics Laboratory
2.	18ME214	Laser Based Flow Diagnostics Laboratory
3.	18ME215	Micromachining Laboratory
4.	18ME216	Nano-Composite, Fabrication and Biomaterials Laboratory and Signal Processing Laboratory
5.	18ME217	Material Response to Micro-structural, Mechanical, Thermal and Biological Stimuli Laboratory
6.	18ME218	Virtual Labs for Mechanical Vibrations Laboratory
7.	18ME219	Machine Dynamics & Vibration Laboratory
8.	18ME220	Virtual Combustion and Atomization Laboratory

ANNEXURE - V

MECHANICAL ENGINEERING –MANDATORY COURSES

Sl. No.	Course Code	Course Title
1	18CHE901	Environmental Sciences
2	18HUM902	Indian Constitution
3	18HUM903	Essence of Indian Traditional Knowledge
4	18CE904	Disaster Management

ANNEXURE VI

Honors in Mechanical Engineering

SI. No	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
III Year I Semester								
1	Professional Elective Course (Choose any two from three courses)	18HDME101	Advanced Welding Technology	3	0	0	3	3
2		18HDME102	Advanced Optimization Techniques	3	0	0	3	3
3		18HDME103	Combustion and Emissions	3	0	0	3	3
	Sub Total			**6**	**0**	**0**	**6**	**6**
	III Year II Semester							
4	Professional Elective Course (Choose any two from three courses)	18HDME104	Ergonomics	3	0	0	3	3
5		18HDME105	Gas Dynamics	3	0	0	3	3
6		18HDME106	Fracture Mechanics	3	0	0	3	3
	Sub Total			**6**	**0**	**0**	**6**	**6**
	IV Year I Semester							
7	Professional Elective Course (Choose any one from three courses)	18HDME107	Powder Metallurgy	3	0	0	3	3
8		18HDME108	Advanced Fluid Mechanics	3	0	0	3	3
9		18HDME109	Modeling of SI and CI Engines	3	0	0	3	3
10	**Project**	18HDME701	Mini Project	0	0	10	10	5
	Sub Total			**3**	**0**	**10**	**13**	**8**
	Total			**15**	**0**	**10**	**25**	**20**

ANNEXURE VII

Minors in Mechanical Engineering
(Applicable to CE, EEE, ECE, CSE, CST & CSIT)

Stream Name: Electric Vehicles

SI. No	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
III Year I Semester								
1	**Professional Core Course**	18MDME101	Fundamentals of Automotive Engineering	3	0	0	3	3
2	**Professional Core Course**	18MDME102	Fundamentals of Electrical Vehicles	3	0	0	3	3
III Year II Semester								
3	**Professional Core Course**	18MDME103	Production Technology of Automobile Components	3	0	0	3	3
4	**Professional Core Course**	18MDME104	Battery Management Systems	3	0	0	3	3
5	**Professional Core Course**	18MDME201	Electric Vehicles Laboratory	0	0	4	4	2
IV Year I Semester								
6	**Professional Core Course**	18MDME105	Vehicle Body Engineering	3	0	0	3	3
7	**Project**	18MDME701	Mini Project	0	0	6	6	3
			Total	**15**	**0**	**10**	**25**	**20**

Minors in Mechanical Engineering

(Applicable to CE, EEE, ECE, CSE, CST & CSIT)

Stream Name: Digital Manufacturing

SI. No	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
III Year I Semester								
1	**Professional Core Course**	18MDME106	Computer Aided Manufacturing Process	3	0	0	3	3
2	**Professional Core Course**	18MDME107	Product Design and Development	3	0	0	3	3
III Year II Semester								
3	**Professional Core Course**	18MDME108	Digital Manufacturing Planning and Control	3	0	0	3	3
4	**Professional Core Course**	18MDME109	Big Data Analytics for Manufacturing	3	0	0	3	3
5	**Professional Core Course**	18MDME202	Computer Aided Design and Manufacturing Laboratory	0	0	4	4	2
IV Year I Semester								
6	**Professional Core Course**	18MDME110	Smart Sensors and Industry 4.0	3	0	0	3	3
7	**Project**	18MDME701	Mini Project	0	0	6	6	3
			Total	**15**	**0**	**10**	**25**	**20**

Minors in Mechanical Engineering
(Applicable to CE, EEE, ECE, CSE, CST & CSIT)

Stream Name: Mechatronics

SI. No	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
III Year I Semester								
1	**Professional Core Course**	18MDME111	Engineering Statics and Applied Mechanics	2	1	0	3	3
2	**Professional Core Course**	18MDME112	Fluid Power Systems	3	0	0	3	3
III Year II Semester								
3	**Professional Core Course**	18MDME113	Industrial Automation	3	0	0	3	3
4	**Professional Core Course**	18MDME114	Robotics and Control	3	0	0	3	3
5	**Professional Core Course**	18MDME203	Mechatronics Laboratory	0	0	4	4	2
IV Year I Semester								
6	**Professional Core Course**	18MDME115	Mechatronics	3	0	0	3	3
7	**Project**	18MDME701	Mini Project	0	0	6	6	3
			Total	**14**	**1**	**10**	**25**	**20**

Minors in Mechanical Engineering
(Applicable to CE, EEE, ECE, CSE, CST & CSIT)

Stream Name: Nanotechnology

SI. No	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
III Year I Semester								
1	**Professional Core Course**	18MDME116	Elements of Nanoscience and Nanotechnology	3	0	0	3	3
2	**Professional Core Course**	18MDME117	Fundamentals of Solid-State Engineering	3	0	0	3	3
III Year II Semester								
3	**Professional Core Course**	18MDME118	Quantum Mechanics for Nanotechnology	3	0	0	3	3
4	**Professional Core Course**	18MDME119	Micro and Nanofabrication	3	0	0	3	3
5	**Professional Core Course**	18MDME204	Micro and Nanofabrication Laboratory	0	0	4	4	2
IV Year I Semester								
6	**Professional Core Course**	18MDME120	Industrial Nanotechnology	3	0	0	3	3
7	**Project**	18MDME701	Mini Project	0	0	6	6	3
			Total	**15**	**0**	**10**	**25**	**20**

Minors in Mechanical Engineering
(Applicable to EEE, ECE, CSE, CST & CSIT)

Stream Name: Energy Engineering

SI. No	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total Contact Hours	
III Year I Semester								
1	**Professional Core Course**	18MDME121	Fluid Mechanics and Hydraulic Machinery	2	1	0	3	3
2	**Professional Core Course**	18MDME122	Applied Thermodynamics	2	1	0	3	3
III Year II Semester								
3	**Professional Core Course**	18MDME123	Heat Transfer	2	1	0	3	3
4	**Professional Core Course**	18MDME124	Computational Fluid Dynamics	2	1	0	3	3
5	**Professional Core Course**	18MDME205	Thermal Engineering Laboratory	0	0	4	4	2
IV Year I Semester								
6	**Professional Core Course**	18MDME125	Design of Gas Turbine Engines	2	1	0	3	3
7	**Project**	18MDME701	Mini Project	0	0	6	6	3
	Total			**10**	**5**	**10**	**25**	**20**

B. Tech I Year I Semester

B. Tech I Year I Semester

18MAT101 ENGINEERING CALCULUS

L	T	P	C
3	1	0	4

Course Prerequisite: Mathematics at Intermediate or Equivalent Level

Course Description

The course introduces the concepts of single variable and multivariable calculus with the view of its applications in various engineering fields. It prepares the students to develop various methods of finding derivatives and integrals; understanding of concepts related to continuous functions and enrich their experience in critical analysis.

Course Objectives

1. To introduce the basic concepts of definite integrals and its applications, Beta and Gamma functions,
2. To acquire knowledge on mean value theorems in calculus.
3. To illustrate various techniques of testing the convergence of infinite series and introduces the functions of sine and cosine series.
4. To familiarize the knowledge of limit, continuity and derivatives, extreme values in multivariable.
5. To emphasize the role of Double and Triple integrals in dealing with area and volume of the regions.

UNIT I: INTEGRAL CALCULUS

Definite integrals; Applications of definite integrals to evaluate area and length of curves, surface areas and volumes of revolutions; Beta and Gamma functions and their properties **(12)**

UNIT II: DIFFERENTIAL CALCULUS

Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders (without proofs);indeterminate forms, Maxima and minima. **(12)**

UNIT III: SEQUENCE AND SERIES

Sequence and Series, their Convergence and tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithmic functions; Fourier series: Half rangesine and cosine series, Parseval's theorem. **(12)**

UNIT IV: **MULTIVARIABLE DIFFERENTIAL CALCULUS**

Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers. **(12)**

UNIT V: **MULTIVARIABLE INTEGRAL CALCULUS**

Multiple Integration: Double integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes (double integration); triple integrals, curl and divergence, Green's, Stokes and Gauss divergence theorems (without proofs). **(12)**

Course Outcomes

At the end of the course, the students should be able to

1. Evaluate the definite integrals, Beta and Gamma functions and calculate length of curve and underlying area.
2. Relate the results of mean value theorems in calculus to Engineering problems.
3. Use the power series and Fourier series for ascertaining the stability and convergence of various techniques.
4. Apply the functions of several variables to evaluate the rates of change with respect to time and space variables in engineering.
5. Compute the area and volume by interlinking them to appropriate double and triple integrals.

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42th Edition, 2012.
2. G. B. Thomas, Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas' Calculus Pearson education 11th Edition, 2004.

Reference Books

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech Mechanical Engineering

B. Tech I Year I Semester

18PHY101 ENGINEERING PHYSICS

L	T	P	C
3	1	0	4

Course Prerequisite: Plus two level physics course

Course Description: Engineering Physics for Civil and Mechanical Engineers is a physics course which provides fundamental knowledge to understand the concepts of mechanics, waves and oscillations, interference, diffraction, and lasers.

Course Objectives:

1. Expose students to the fundamental principles and laws of mechanics in Physics to understand the types of motion.
2. Demonstrate the ability to identify and apply the appropriate analytic, numerical, and mathematical reasoning, to situations of the physical world.
3. Analyze the concepts of mechanics, oscillations, waves and optics to prepare the students for advanced level courses.
4. Expose students to theoretical and mathematical aspects of interference and diffraction of light for testing of materials.
5. Adaptability to new developments in science and technology.

UNITI: MECHANICS OF PARTICLES

Velocity and Acceleration, Motion in one dimension, several dimensions, formal solution of kinematical equations. Polar Co-ordinates, velocity and acceleration in polar coordinates. Newton's Laws, applications of Newton's laws (Constraint equations, Block on string, Conical Pendulum, Block and Wedge). **(12)**

UNITII: MOMENTUM & WORK ENERGY

Momentum, law of conservation of linear momentum, flow of mass, Rocket Equation, Rocket in free space and in a gravitational field. Integrating equation of motion in one-dimension-work energy theorem, orbital velocity and escape velocity, Potential energy, Potential energy of a uniform force field, potential energy of an inverse square force, stability, conservation laws and particle collisions. **(12)**

UNITIII: WAVES AND OSCILLATIONS

Simple Harmonic Motion, damped harmonic oscillations, forced harmonic oscillations, resonance, and quality factor. Superposition of vibrations along same direction (equal frequency) and in perpendicular directions, Lissajous figures. Transverse waves, solution of wave equation, velocity of a transverse wave along a stretched string, modes of vibration of stretched string, standing waves, standing wave ratio. **(12)**

UNITIV: INTERFERENCE & DIFFRACTION

Interference of light by division of wave front- Young's double slit experiment, expression for fringe width, intensity distribution graph, interference of light by division of amplitude-interference in thin film by reflection, Newton's rings experiment, Michelson interferometer, applications of Interference (colours of thin films). Diffraction, Farunhofer diffraction due to single slit, double slit and, Diffraction grating (N-slit),applications of Diffraction (List only)

(12)

UNITV: LASERS

Introduction to Lasers, characteristics of Laser, interaction of radiation with matter-spontaneous and stimulated emission, Einstein's coefficients; amplification of light by population inversion, excitation mechanism, types of lasers: solid-state lasers – ruby laser, gas lasers - He-Ne Laser, semiconductor p-n junction diode laser; applications of lasers.

(12)

Course Outcomes:

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

1. Describe and explain the fundamental physical principles and laws of Mechanics in Physics.
2. Explain the concepts conservation of momentum, energy, and predict the future state of a system based on its present state.
3. Apply the physical principles of waves together with logical and mathematical reasoning, to situations of the physical world of vibrations.
4. Define and evaluate the fundamentals of materials testing using Interference and Diffraction techniques.
5. Identify the working elements of different lasers and estimate laser operation parameters.

Text Books:

1. An Introduction to Mechanics, by D. Kleppner and R. Kolenkow, Tata McGraw-Hill Edition, 2007.
2. H. J. Pain, "The physics of vibrations and waves", Wiley, 2006.
3. A. Ghatak, "Optics", McGraw Hill Education, 2012.
4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

Reference Books:

1. Physics Vol I & II, Halliday/Resnick/Krane 5th Edition, John Wiley, 2003.
2. Berkeley Physics Course Volume I, Tata-McGraw Hill.
3. Engineering Mechanics, 2nd ed. — MK Harbola
4. Introduction to Mechanics — MK Verma
5. Theory of Vibrations with Applications — WT Thomson

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. I Year I Semester

18EEE101 BASIC ELECTRICAL ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisite: Intermediate Physics

Course Description:
This course equips the students with a basic understanding of Electrical circuits and machines for specific applications. In specific, the course covers basic of DC circuit & its analysis, introduction to single-phase and three-phase AC Systems, magnetic circuits, transformers, DC & AC electrical machines, basic converters and Components of LT Switchgear.

Course Objectives:
1. To learn the basics of the D.C. circuit analysis.
2. To have an idea about single-phase and three-phase A.C. electrical circuits.
3. To gain knowledge about basic magnetic circuits and transformers.
4. To learn the construction and operation of D.C. and A.C. machines.
5. To understand the operation of basic rectifiers and various components of LT Switchgear.

UNIT I: DC CIRCUIT ANALYSIS
Electrical circuit elements (R, L and C), voltage and current sources, Series and parallel resistive circuits, Kirchhoff's current and voltage laws, Nodal and Mesh analysis of simple circuits with dc excitation. Source Transformation, Star-Delta Transformation, Superposition Theorem. **(9)**

UNIT II: AC CIRCUIT ANALYSIS
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations. Three phase balanced circuits, voltage and current relations in star and delta connections. **(9)**

UNIT III: MAGNETIC MATERIALS AND TRANSFORMERS
Magnetic materials, B-H characteristics, ideal and practical transformer, principle of operation, emf equation, equivalent circuit, losses in transformers, regulation and efficiency.
(9)

UNIT IV: DC AND AC MACHINES
Construction, working, emf equation of DC generator, methods of excitation, speed control of dc motor. Generation of rotating magnetic fields, construction and working of a three-phase induction motor.Introduction of Single-phase induction motor. Introduction to Alternators.
(9)

UNIT V: RECTIFIERS AND ELECTRICAL INSTALLATIONS
PN junction diode, half wave, full wave and bridge rectifiers. Components of LT Switchgear: switch fuse unit (SFU), MCB, ELCB, MCCB, types of wires and cables, earthing. **(9)**

Course Outcomes:
Upon successful completion of the course, students will be able to
1. To understand and analyze basic DC electric circuits.
2. To measure and analyze various electrical quantities of single phase and three AC electric circuits.
3. To develop magnetic circuits to experiment and analyze the transformers.
4. To study the working principles of electrical machines.
5. To create power converters for domestic applications with LT switchgear.

Text Books:
1. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
4. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

References:
1. Abhijit Chakrabarti, "Circuit Theory : Analysis and Synthesis", Dhanpat Rai & Co., 2014
2. J.B. Gupta, "Theory & Performance of Electrical Machines", S. K. Kataria& Sons, 2013.
3. John Bird, "Electrical Circuit Theory and Technology", Fourth edition, Elsevier Ltd., 2010.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech I Year I Semester

18CSE101 PROGRAMMING FOR PROBLEM SOLVING (PYTHON)

L	T	P	C
2	0	2	3

Course Prerequisite: None

Course Description:
Python is a language with a simple syntax, and a powerful set of libraries. It is an interpreted language, with a rich programming environment. While it is easy for beginners to learn, it is widely used in many scientific areas for data exploration. This course is an introduction to the Python programming language for students without prior programming experience. This course provides knowledge on how to implement programs in python language and to solve computational problems using the various programming constructs including data structures, functions, string handling mechanisms and file handling concepts.

Course Objectives:
1. Learn Python programming constructs.
2. Implement Python programs with conditional structures and loops.
3. Use functions for structuring Python programs.
4. Handle compound data using Python lists, tuples, and dictionaries.
5. Manipulate data using files handling in Python.

UNIT-I

Introduction: Algorithms, building blocks of algorithms (flow chart), History of Python, features of Python Programming, Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation. **Data Types** - Integers, Strings, Boolean.

a) Develop a flowchart for the various arithmetic operations on numbers.
b) Develop a flowchart to check whether the number is positive or negative.
c) Develop a flowchart for finding whether a given number is even or odd.
d) Develop a flowchart for finding biggest number among three numbers.
e) Develop a flowchart for displaying reversal of a number.
f) Develop a flowchart to print factorial of a number using function.
g) Develop a flowchart to generate prime numbers series up to N using function.
h) Develop a flowchart to check given number is palindrome or not using function.
i) Alexa travelled 150 kms by train. How much distance in miles she actually covered?

(9)

UNIT-II

Operators and Expressions: Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations .**Control Flow** - if, if-elif-else, for, while,break,continue,pass.

a) Swapping of two number with and without using temporary variable.
b) If the age of Ram, Sam, and Khan are input through the keyboard, write a python program to determine the eldest and youngest of the three.

c) Develop a program that performs arithmetic operations (Addition, Subtraction, Multiplication, and Division) on integers. Input the two integer values and operator for performing arithmetic operation through keyboard. The operator codes are as follows:
   - For code '+', perform addition.
   - For code '-', perform subtraction.
   - For code '*', perform multiplication.
   - For code '/', perform division.

d) Implement the python program to generate the multiplication table.

e) Implement Python program to find sum of natural numbers

f) If the first name of a student is input through the keyboard, write a program to display the vowels and consonants present in his/her name.

g) The marks obtained by a student in 5 different subjects are input through the keyboard. Find the average and print the student grade as per the MITS examination policy as shown below.

% OBTAINED	GRADE
90 - 100	O (Outstanding)
80 - 89	A+ (Excellent)
70 - 79	A (Very Good)
60 - 69	B+ (Good)
50 - 59	B (Above)
45 - 49	C (Average)
40 - 44	P (Pass)
< 40	F (Fail)

h) Implement Python Script to generate prime numbers series up to N.

i) Given a number x, determine whether it is Armstrong number or not. Hint: For example, 371 is an Armstrong number since 3**3 + 7**3 + 1**3 = 371. Write a program to find all Armstrong number in the range of 0 and 999.

(9)

UNIT-III

Data Structures Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions. **Functions** - Defining Functions, Calling Functions, Passing Arguments, variable in python-Global and Local Variables.

a) Write a Python script to
   - create a list
   - access elements from a list
   - slice lists
   - change or add elements to a list
   - delete or remove elements from a list

b) Write a Python script to read the values from a list and to display largest and smallest numbers from list.

c) Write a Python script to compute the similarity between two lists.

d) Write a Python script to read set of values from a Tuple to perform various operations.

e) Write a Python script to perform basic dictionary operations like insert, delete and display.

f) Write a Python program to count the occurrence of each word in a given sentence.
g) Define a dictionary named population that contains the following data.

Keys	Values
Shanghai	17.8
Istanbul	13.3
Karachi	13.0
Mumbai	12.5

h) Write a Python script to create Telephone Directory using dictionary and list to perform basic functions such as Add entry, Search, Delete entry, Update entry, View and Exit.
i) Implement Python script to display power of given numbers using function.
j) Implement a Python program that takes a list of words and returns the length of the longest one using function. **(9)**

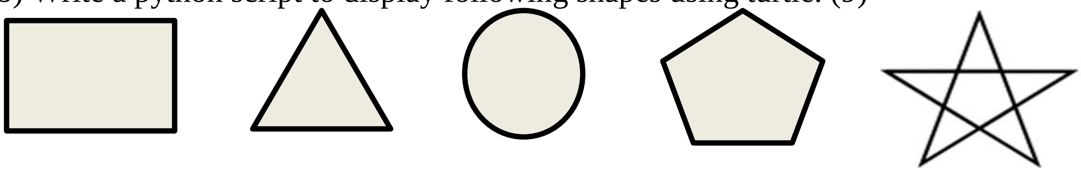
UNIT-IV
String Handling -Modules: Creating modules, import statement, from.import statement, name spacing-**Files and Directories**

a) Implement Python program to perform various operations on string using string libraries.
b) Implement Python program to remove punctuations from a given string.
c) Write a Python program to change the case of the given string (convert the string from lower case to upper case). If the entered string is "computer", your program should output "COMPUTER" without using library functions.
d) Implement Python program to capitalize each word in a string. For example, the entered sentence "god helps only people who work hard" to be converted as "God Helps Only People Who Work Hard"
e) Write a Python script to display file contents.
f) Write a Python script to copy file contents from one file to another.
g) Write a Python script to combine two text files contents and print the number of lines, sentences, words, characters and file size.
h) Write a Python commands to perform the following directory operations.
   - List Directories and Files
   - Making a New Directory
   - Renaming a Directory or a File
   - Removing Directory or File **(9)**

UNIT-V
Python packages, Introduction to PIP, Installing Packages via PIP(Numpy, Pandas etc.., Using PythonPackages.
Brief Tour of the Standard Library - Dates and Times, Data Compression, Turtle Graphics.

a) Create a package named Cars and build three modules in it namely, BMW, Audi and Nissan. Illustrate the modules using class. Finally we create the __init__.py file. This file will be placed inside Cars directory and can be left blank or we can put the initialization code into it.

b) Write a python script to display following shapes using turtle. (9)



(9)

Course Outcomes:

At the end of the course, students will be able to

1. Understand problem solving techniques and their applications.
2. Apply the basic elements and constructs of python to solve simple logical problems.
3. Demonstrate different data structures using functions.
4. Demonstrate different file operations and modules.
5. Apply object-oriented principles to build simple applications.

Text Book:

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. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

References:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013.
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers,LLC,2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech I Year I Semester

18PHY201 PHYSICS LABORATORY

L	T	P	C
0	0	3	1.5

Course Description:
Physics Practical course is meant for making the students to gain practical knowledge to co relate with the theoretical studies. It covers experiments on Principles of Mechanics and Optics, Measurement of Magnetic field and studying Resonance using LCR Circuit.

Course Objectives:
1. Elucidate the concepts of Physics through involvement in the experiment by applying theoretical knowledge.
2. Illustrate the basics of mechanics, waves and optics to analyze the behavior and characteristics of various materials for its optimum utilization.
3. Develop an ability to apply the knowledge of physics experiments in the later studies.

LIST OF EXPERIMENTS: (Any 10 Out of 18)
1. Spring constant - Coupled Pendulums.
2. Study of resonance effect in series and parallel LCR circuit.
3. Determination of radius of curvature of a curved surface - Newton's Rings.
4. Wavelength of a laser - Diffraction Grating
5. Wavelength of the spectral lines - Diffraction Grating.
6. Magnetic field along the axis of a current carrying coil - Stewart Gees' Apparatus
7. Ferroelectric hysteresis (B-H Curve).*(ECE)*
8. Thickness of a given wire - Wedge Method.
9. Determination of Planck's constant. *(EEE, CSE, CSIT, CST)*
10. Dispersive power of prism – Spectrometer.
11. Frequency of the tuning fork - Melde's apparatus.
12. Energy gap of a material of p-n junction. *(EEE, CSE, CSIT, CST)*
13. Width of single slit - Diffraction due to Single Slit.
14. Measurement of e/m of electron (Helical Coil method) *(ECE)*
15. Biot -Savart Law with Helmholtz Coil. *(ECE)*
16. The Wheatstone Bridge. *(ECE)*
17. Determination of particle size using Laser.
18. Torsional Pendulum. *(ME & Civil)*

Course Outcomes:
Upon successful completion of this course, the students should be able to:
1. Apply the scientific process in the conduct and reporting of experimental investigations.
2. Understand measurement technology, usage of new instruments and real time applications in engineering studies.
3. Verify the theoretical ideas and concepts covered in lecture by doing hands on in the experiments.
4. Know about the characteristics of various materials in a practical manner and gain knowledge about various optical technique methods.
5. Acquire and interpret experimental data to examine the physical laws.

Reference Books:
1. Physics Laboratory Manual
2. Optics, A. Ghatak, 4th Edition, Tata McGraw-Hill, New Delhi 2011.
3. Fundamentals of Optics, F. A. Jenkins and H. E. White, 4th edition, McGraw-Hill Inc., 1981.
4. Engineering Mechanics, 2nd ed. — MK Harbola
5. Introduction to Electrodynamics- David J Griffiths

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech. I Year I Semester

18EEE201 ELECTRICAL ENGINEERING LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: None

Course Description:
The laboratory facilitates the students to deal with electrical instruments which further strengthen the concepts & operation of various AC & DC circuits, and machines, and their characteristics. The lab also reinforce the concepts discussed in class with a hands-on approach which enable the students to gain significant experience with electrical instruments such as ammeter, voltmeter, digital multimeters, oscilloscopes, tachometer, switches, fuses and power supplies.

Course Objectives:
1. To provide hands on experience in setting up simple electrical circuits (DC and AC).
2. To get exposure to handle different electrical equipment's.
3. To measure various electrical parameters with different measuring instruments.
4. To get hands on experience in operating DC and AC machines.
5. To understand the operation of basic converters and various components of LT Switchgear.

LIST OF LABORATORY EXPERIMENTS/DEMONSTRATIONS:
DEMONSTRATIONS:
1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Study of passive components - resistors, capacitors and inductors.
2. Demonstration of voltage and current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). In star and delta connections.
3. Demonstration of cutout sections of transformer and DC & AC machines.
4. Demonstration of induction machine. Motor operation and generator operation of an induction machine driven at super-synchronous speed.
5. Familiarization of (i) different types of cables/wires and switches and their uses, (ii) different types of fuses & fuse carriers; MCB, ELCB, MCCB their ratings and uses (components of LT switchgear).

EXPERIMENTS:
1. Wiring of a simple circuit for controlling (1) a lamp/fan point, (2) Staircase or Corridor Winding.
2. Wiring of a power circuit for controlling an electrical appliance (16A Socket).
3. Verification of Kirchhoff's current and voltage laws (KCL & KVL).
4. Verification of superposition theorem
5. Sinusoidal steady state response of R-L, and R-C circuits (impedance calculation and verification).
6. Measurement of voltage, current and power in a single phase circuit using voltmeter, ammeter and wattmeter. Also, calculate the power factor of the circuit.
7. Measurement of active power for star and delta connected balanced loads (single wattmeter method).

8. Open-circuit and short-circuit test on a single phase transformer.
9. Speed control of separately excited DC motor.
10. Wiring of a power distribution arrangement using single phase MCB distribution board with ELCB, main switch and energy meter (or residential house wiring).
11. Regulated power supply for generating a constant DC Voltage.
12. Fabrication of a given electronic circuit on a PCB and test the same.

Course Outcomes:

Upon successful completion of the course, the students are expected to

1. Get an exposure to common electrical components and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the usage of common electrical measuring instruments.
4. Understand the basic characteristics of transformers and electrical machines.
5. Get an exposure to the working of various power electronic converters.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech I Year II Semester

B. Tech I Year II Semester

18ENG101 PROFESSIONAL ENGLISH
(Common to all branches)

L	T	P	C
2	0	2	3

Course Prerequisite: None

Course Description:
Communication takes place in many forms, however the major impact and effectiveness is in its professionalism. This course defines, enlightens and enables learners to engage in Professional Communication by addressing all the areas of communication – Listening, Speaking, Reading and Writing. This course also deals with various types of communication – Verbal, Non-verbal, Storytelling, Crucial Conversations, Written Communication, Vocalics, Eye Contact, Posture, etc.

Course Objectives:
This course enables the student to –
1. Engage effectively in a professional environment
2. Understand the intricacies and implications of professional communication
3. Use linguistic skills in any given context
4. Conduct self in a learning environment
5. Be better prepared for employment

UNIT I: GRAMMAR & VOCABULARY
Grammar - Tense, Reported Speech, Modals, Conditionals; Vocabulary development - prefixes, suffixes, compound words, synonyms & antonyms.
Practical: Dumb Charade, Giving Direction, Talking about an experiment (Tenses), Running Commentary **(9)**

UNIT II: READING SKILLS & WRITTEN COMMUNICATION
Reading - short comprehension passages, practice in skimming, scanning and predicting; Writing- completing sentences, developing hints; Paragraph writing- topic sentence, main ideas, coherence.
Practical: Short Passages – Reading Comprehension, Paragraph Writing, Skit Writing. **(9)**

UNIT III: VERBAL & NON-VERBAL ASPECTS
Verbal - Introducing oneself, exchanging personal information, Using 'Wh'- Questions, asking and answering, yes or no questions-asking about routine actions and expressing opinions; **Non-Verbal** – Use of body language, combating nervousness.
Practical: Daily Activities, Role Play, JAM . **(9)**

UNIT IV: CONVERSATIONS
Listening-short texts & conversing, formal and informal conversations, short group conversations, speaking about oneself, speaking about one's friend.

Practical: Speaking: formal and informal conversations, short group conversations, speaking about oneself, speaking about one's friend, Character Portrayal.
Listening: Listening/watching interviews, conversations, documentaries, etc.; Listening to lectures, discussions from TV/Radio/Podcast. **(9)**

UNIT V: BUSINESS ENVIRONMENT & ETIQUETTES
Sharing information of a personal kind - greeting & taking leave; Writing e-mails, memos, reports, etc.
Practical: Mock Interview, Oral Presentation **(9)**

Course Outcomes:
At the end of the course, learners will be able to
1. Read articles and understand professional communication
2. Participate effectively in informal conversations
3. Introduce themselves and their friends and express opinions in English
4. Comprehend conversations and short talks delivered in English
5. Write short essays of a general kind and personal letters and emails in English.

Suggested Reading/Textbooks:
1. Guy Brook Hart & Norman Whitby; Cambridge English-Business Benchmark: Pre-Intermediate to Intermediate; Published by: Cambridge University Press.
2. Adrian Doff, Craig Thaine, Herbert Puchta, et al; Empower: Intermediate (B1+); Published by: Cambridge University Press.

Reference:
1. AJ Thomson & AV Martinet; A Practical English Grammar; Oxford University Press, 2015.
2. Raymond Murphy; English Grammar in Use with CD; Cambridge University Press, 2013.
3. K.S. Yadurajan; Modern English Grammar; Oxford University Press, 2014.
4. William Strunk Jr; The Elements of Style; ITHACA, N.Y.; W.P. HUMPHREY, 2006.
5. Joseph Devlin; How to Speak and Write Correctly; ITHACA, N.Y.; W.P. HUMPHREY, 2006
6. Anjana Agarwal; Powerful Vocabulary Builder; New Age Publishers, 2011.
7. Writing Tutor; Advanced English Learners' Dictionary; Oxford University Press, 2012.
8. www.cambridgeenglish.org/in/
9. https://learnenglish.britishcouncil.org/en/english-grammar
10. https://www.rong-chang.com/

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech I Year II Semester

18MAT107 LINEAR ALGEBRA, COMPLEX VARIABLES AND ORDINARY DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

Course Prerequisite: 18MAT101

Course Description:
This course introduces the topics involving: Linear Algebra, Complex variable functions, Ordinary Differential Equations and their applications. The course starts with algebra of matrix, systems of linear equations and with preliminary course on complex variable. It introduces the CR equation, analytic function, Taylor and Laurent series expansions and determination of residues. Emphasis also placed on the development of concepts and applications for first and second order ordinary differential equations (ODE), systems of differential equations and Laplace transforms.

Course Objectives:
1. To solve the system of linear equations, and develop orthogonal transformation with emphasis on the role of eigen-values and eigen-vectors.
2. To analyze the function of complex variable and its analytic property with a review of elementary complex function.
3. To understand the Taylor and Laurent expansion with their use in finding out the residue and improper integral.
4. To identify important characteristics of ODE and develop appropriate method of obtaining solutions of ODE.
5. Explore the use of ODE as models in various applications to solve initial value problems by using Laplace transform method.

UNIT I: MATRICES
Symmetric, Skew-symmetric and Orthogonal matrices, Determinants, System of linear equations, Inverse and rank of a matrix, Rank-nullity theorem, Eigen values and eigenvectors, Diagonalization of matrices, Cayley-Hamilton Theorem, and Orthogonal transformation. **(12)**

UNIT II: COMPLEX VARIABLE - DIFFERENTIATION
Differentiation, Cauchy-Riemann equations, Analytic function, Harmonic functions, finding harmonic conjugate, Elementary analytic functions (exponential, trigonometric, logarithm) and their properties. **(12)**

UNIT III: COMPLEX VARIABLE - INTEGRATION
Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's and Maximum-Modulus theorem (without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's expansion (without proof), Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

(12)

UNIT IV: FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS
Exact, Linear and Bernoulli's, Equations not of first degree: equations solvable for p, equations solvable for x, equations solvable for y and Clairaut's type. **(12)**

UNIT V: ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDERS
Second order linear differential equations with variable coefficients, Method of variation of parameters, Laplace Transform, Inverse Laplace transform, Bromwich contour method, and its applications to solve ordinary differential equations. **(12)**

Text books:

1. Higher Engineering Mathematics by Dr. B.S. Grewal, 42nd Edition, Khanna Publishers.
2. Complex variables and applications by R. V Churchill and J. W. Brown, 8th edition, 2008, McGraw-Hill.
3. Differential Equations with applications and historical notes by G.F. Simmonssecond edition, McGraw Hill, 2003.

References:

1. Elementary linear Algebra by Stephen Andrilli and David Hecker, 4th Edition, Elsevier, 2010
2. Ordinary and partial differential equations. By M.D. Raisinghania, 2013. S. Chand Publishing.
3. Linear Algebra and its Applications by D.C. Lay, 3rd edition, Pearson Education, Inc.

Course outcomes

Students are able to

1. Solve the systems of linear equations occurring in engineering system.
2. Determine harmonic function, velocity potential and stream lines in fluid flow systems.
3. Evaluate a contour integral and definite integral involving exponential, sine and cosine functions.
4. Find general solutions to first and second order homogeneous differential equations by algebraic and computational methods.
5. Determine the solution of ODE of second and higher order.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. I Year II Semester

18CHE101 ENGINEERING CHEMISTRY

L	T	P	C
3	0	0	3

Course Pre-requisite: Basic Chemistry at Intermediate or equivalent level.

Course Description: Deals with the basic principles of various branches of chemistry like physical, organic, inorganic, analytical and nanomaterial chemistry.

Course Objectives:
Students will
1. Understand, analyse and determine the impurities present in the water.
2. Appreciate the synthetic organic reactions used in daily life
3. Learn the principles of spectroscopies to analyse them.
4. Value the basic concepts of thermodynamics and electrochemistry.
5. Be exposed to the importance of nano and engineering materials used in their daily life and industry.

UNIT I:IMPURITIES PRESENT IN WATER AND WATER TREATMENT
Impurities present in Water: Impurities in water(BIS and WHO standards), Hardness of water-determination of hardness - EDTA Method (numerical problems), Alkalinity of water (numerical problems) and its importance and Chlorides. Disadvantages (industry level) of using hard water. Softening of water (Ion exchange method), Treatment of brackish water by Reverse Osmosis method. Water treatment for civic applications: coagulation, sedimentation, filtration, sterilization - chlorination and ozonation. Concept of break point chlorination. **(9)**

UNIT II: PERIODIC PROPERTIES AND ORGANIC REACTIONS
Periodic properties: Electronic configurations, atomic and ionic sizes, ionization energies, oxidation states, molecular geometries. Organic Reactions: Introduction to substitution (S_N^1 and S_N^2), elimination (E_1 and E_2) - Addition, Condensation and Free Radical Polymerization Reaction (only the mechanism). **(9)**

UNIT III: SPECTROSCOPY
Basic Principle and Applications of UV-Visible, FT-IR, Raman, Microwave and Nuclear Magnetic Resonance (NMR) Spectroscopy. **(9)**

UNIT IV: THERMODYNAMICS AND ELECTROCHEMISTRY
Thermodynamics: Systems, State Functions, Thermodynamic Functions: Work, Energy, Entropy and Free energy. Estimations of Entropy in Isothermal, Isobaric and Isochoric processes and Free Energies. Electrochemistry: Free energy and EMF. Cell potentials, the Nernst equation and applications. Batteries (Lead-Acid and Lithium ion) and Fuel-Cells (H_2-O_2 and Solid Oxide). **(9)**

UNIT V: ENGINEERING MATERIALS, NANOSCIENCE & NANOTECHNOLOGY
Engineering Materials: Cement Materials and Manufacturing Process. Lubricants – definition, Properties of lubricants – Viscosity, Viscosity Index, Saponification Number, Flash Point and Pour Point. Nanomaterials: Introduction, Classes/Types, Chemical synthesis of Nanomaterials: Sol-Gel, Hydrothermal (Metal Oxide Nanoparticles) and Chemical Vapor Deposition method (Carbon Nanotubes), Characterization by powder XRD (Scherrer's equation). Applications of Nanomaterials – Energy (Hydrogen Storage and Solar Energy) and Environmental Sciences-Photocatalytic Dye Degradation (TiO_2 and ZnO) **(9)**

Course Outcomes:
At the end of the course, the students will be able to
1. Analyse and determine the impurities in water such as hardness, alkalinity for sustainable development.
2. Prepare organic compounds/polymers for environmental, safety and society need.
3. Comprehend the principles and applications of spectroscopies
4. Apply the concept of free energy in thermodynamics, electrochemistry for solving the problems evolve in the engineering processes.
5. Acquire spotlight to the nanomaterials and basic engineering materials used in academics, industry and daily life.

Text Books:
1. P.W. Atkins & Julio de Paula, 'The Elements of Physical Chemistry', Ninth edition (Oxford University Press, Oxford 2010).
2. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Fourth Edition, (Tata McGraw Hill, 2008).
3. Ralph H. Petrucci, F. Geoffrey Herring, Jeffry D. Madura, Carey Bissonnette, General Chemistry - Principles and Modern Applications, Tenth Edition, (Pearson, 2011).
4. Dr S. S. Dara and Dr S. S. Umare, A Text book of Engineering Chemistry,1stEdition.(S. Chand & Company Ltd, 2000).
5. T. Pradeep, Nano: The Essentials, 1st Edition, (Tata McGraw-Hill Publishing Company Limited, 2017).

Reference Books:
1. 'Physical Chemistry', D. W. Ball, First Edition, India Edition (Thomson, 2007).
2. Perry's Chemical Engineers' Handbook, Don W. Green and Marylee Z. Southard, 9th Edition (McGraw Hill, 2018).
3. Engineering Chemistry, Dr. Suba Ramesh and others, 1st Edition (Wiley India, 2011).
4. Jain and Jain, Engineering Chemistry,16th Edition (Dhanpat Rai Publishing Company (P) Ltd, 2016).
5. AmretashisSengupta, Chandan Kumar Sarkar (eds.), Introduction to Nano Basics to Nanoscience and Nanotechnology (Springer-Verlag, Berlin, Heidelberg, 2015)

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. I Year II Semester

18CSE102 C PROGRAMMING AND DATA STRUCTURES

L	T	P	C
3	0	0	3

Course Prerequisite: 18CSE101

Course Description:
This course includes C program basics, control structures, arrays, files, pointers and data structures.

Course Objectives:
1. To make the student understand problem solving techniques and their applications
2. Students will be able to understand the syntax and semantics of C programming language
3. Develop algorithms for manipulating stacks, queues, searching and sorting.

UNIT I: C PROGRAMMING
Structure of C Program, C Tokens: Variables, Data types, Constants, Identifiers, key words and Operators, Expressions. **Control Structures**: Conditional Statements (Simple if, if-else, Nested -if-else, Switch). Iterative Statements (for, While, Do-While), Jump Statements (break, Continue). **(9)**

UNIT II: FUNCTIONS & ARRAY
Functions Introduction, User defined function, accessing a function, Function prototypes, Recursion, storage classes **Arrays**: Defining an array, processing an array, one dimensional arrays, two dimensional arrays. **Searching:** Linear and Binary search **Sorting:** Bubble Sort and Insertion Sort. **(9)**

UNIT III: POINTERS AND STRUCTURE
Pointers: Fundamentals of pointer, Pointer Declarations, Parameter passing: Pass by value, Pass by reference – Example Program: Swapping of two numbers and changing the value of a variable using pass by reference. Dynamic memory allocation. **Structures:** Defining a structure, processing a structure. **(9)**

UNIT IV: STACK AND QUEUE
Classification of Data Structure, **Stack and Queues:** stack, stack operations, stack implementations using arrays.Queue, queue operations, queue implementations using array, types of queues, applications of stack and queue. **(9)**

UNIT V: STRINGS & FILES
Declaring and Defining a string, Initialization of strings, Strings Library functions **Files:** File Definition, Opening and closing a data file, Reading and Writing a data file, Files I/O Functions. **(9)**

Course Outcomes:

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

1. Illustrate the use of control structures, decision making and looping statement.
2. Build programs using arrays and functions.
3. Implement the concepts of pointer, structure and list.
4. Implement storage and retrieval of ordered data using stacks and queues.
5. Illustrate the concepts of Strings and File processing.

Text Books:

1. The C Programming Language, Kernighan and Ritchie, 2 nd Edition, Prentice Hall, India 1988.
2. Alfred V. Aho, John E. Hopcroft and Jeffry D. Ullman, Data Structures and Algorithms, Pearson Education, New Delhi, 2006.

References:

1. Programming in ANSI C, E. Balagurusamy, Sixth Edition, Tata Mc-Graw Hill Publishing Co.Ltd.-New Delhi
2. Problem Solving & Program Design in C, Hanly, Jeri R and Elliot. B Koffman, Pearson Education,5th edition, 20007.
3. K. N. King ,"C Programming ": A Modern Approach, 2nd Edition 2nd Edition
4. Byron Gottfried , Jitender Chhabra , Programming with C (Schaum's Outlines Series)

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. I Year II Semester

18ME101 ENGINEERING GRAPHICS

L	T	P	C
2	0	3	3.5

Course Prerequisite: None

Course Description:
Introduction to AutoCAD commands, simple drawings, orthographic projections, projection of points, lines, planes; auxiliary projections; projections and sections of solids; development and intersection of surfaces; isometric projections.

Course Objectives:
1. Engineering Graphics is the primary medium for development and communicating design concepts.
2. Through this course the students are trained in Engineering Graphics concepts with the use of AutoCAD.
3. The latest ISI code of practice is followed while preparing the drawings using AutoCAD.
4. Computerized drawing is an upcoming technology and provides accurate and easily modifiable graphics entities.
5. Storage and Retrieval of Drawings is also very easy and it takes very less time to prepare the drawings. Also enhances the creativity.

UNIT I: INTRODUCTION TO AUTO CAD
Introduction to AutoCAD commands, simple drawings, Orthographic Projections-Theory, techniques, first angle projections and third angle projections. **(15)**

UNIT II: PROJECTIONS OF POINTS & LINES
Projections of points: Positions, notation system and projections. Projections of lines: positions, terms used, different cases, traces of lines and finding true lengths, auxiliary projections. **(15)**

UNIT III: PROJECTIONS OF PLANES & SOLIDS
Projections of planes: positions, terms used, different cases and projections procedure. Projections of Solids: Projections of Regular Solids inclined to one planes. **(15)**

UNIT IV: SECTIONS AND DEVELOPMENTS OF SOLIDS
Section Planes and Sectional View of Right Regular Solids-Prism, cylinder. True shapes of the sections. Development of Surfaces of Right Regular Solids-Prism, Cylinder and their Sectional Parts. **(15)**

UNIT V: INTERSECTIONS & ISOMETRIC PROJECTIONS

Intersections of surfaces of solids: Intersection between: Line-plane, Plane-plane, line-solid, solid-solid. **Isometric Projections**: Theory of isometric drawing, construction of isometric projection from orthographic. **(15)**

Course Outcomes:

The students after completing the course will be able to:

1. Identify various commands in AutoCAD and their usage for engineering graphics
2. Draw the projections of points and straight lines with AutoCAD
3. Draw the projections of the planes and sections of solids.
4. Sketch the intersections of surfaces and developments of solids
5. Draw the conversion of the orthographic views to isometric views and vice versa.

Text Book:

1. D.M. Kulkarni, A.P. Rastogi and A.M. Sarkar., Engineering Graphics with AutoCAD, PHI Learning Private Limited, New Delhi 2009.

References:

1. Dhananjay A Jolhe, Engineering Drawing: with an introduction to AutoCAD, Tata McGraw Hill, 2008
2. Warren J. Luzadder& Jon M. Duff Fundamentals of Engineering Drawing, 11th edition, Prentice Hall of India, New Delhi.ss

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech I Year II Semester

18CHE201 CHEMISTRY LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisites: Basic Chemistry at Intermediate or equivalent level.

Course Description:
It deals with basic principles of volumetric and instrumental analytical methods.

Course Objective:
This Engineering Chemistry Laboratory is common to all branches of I Year B Tech. At the end of the course the student is expected to Students will

1. Learn to estimate the chemical impurities present in water such as hardness, alkalinity, chlorine, etc.
2. Understand and experience the formation of inorganic complex and analytical technique for trace metal determination.
3. Be trained to use the instruments to practically understand the concepts of electrochemistry.
4. Bridge theoretical concepts and their practical engineering applications, thus highlighting the role of chemistry in engineering.

Learn and understand the practical implementation of fundamental concepts.

LAB EXPERIMENTS (12 EXPERIMENTS)

1. Estimation of total, permanent and temporary hardness of water by EDTA method.
2. Estimation of alkalinity of water sample.
3. Adsorption of acetic acid by charcoal.
4. Determination of molecular weight of a polymer by using Ostwald's viscometer.
5. Determination of rate constant of an ester hydrolysis (Pseudo First Order reaction).
6. Determination of strength of a Strong acid (conc. H_2SO_4) by conductometric titration (Neutralisation Titration).
7. Conductometric titration of $BaCl_2$ Vs Na_2SO_4 (Precipitation Titration).
8. Dissociation constant of weak electrolyte by Conductometry.
9. Determination of percentage of Iron in Cement sample by colorimetry.
10. Estimation of ferrous ion by Potentiometric titration (Redox Titration).
11. Saponification value of oil.
12. Formation of Iron- 1,10-phenanthroline complex and determination of iron bycolorimetry.

Course Outcome:
After the completion of the Engineering Chemistry Laboratory experiments, students will be able to

1. Develop and perform analytical chemistry techniques to address the water related problems (for e.g., hardness, alkalinity present in water) technically.
2. Handle electro-analytical instruments like digital conductivity meter and potentiometer to perform neutralization, precipitation and redox titrations respectively.

3. **Acquire** practical skills to handle spectro-photochemical methods to verify Beer-Lambert's Law.
4. Operate various instruments for the analysis of materials and produce accurate results in a given time frame.
5. Think innovatively and improve the creative skills that are essential for solving engineering problems.

Text Book:

1. Engineering Chemistry Lab Manual (2017-18), Dept. of Chemistry, Madanapalle Institute of Technology and Science, Madanapalle – 517325, Chittoor Dist., Andhra Pradesh, India.
2. "Vogel's Textbook of Qualitative Chemical Analysis", Arthur Israel Vogel, Prentice Hall, 2000.
3. Laboratory Manual on Engineering Chemistry, by DrSudha Rani, Dhanpat Rai Publishing house, 2009.
4. A Text book on Experiments and calculations in Engineering Chemistry, by SS Dara, S Chand publications, 2015.
5. Laboratory Manual of Organic Chemistry, by Raj K Bansal, Wiley Eastern Limited, New age international limited, 2009.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech Mechanical Engineering

B. Tech I Year II Semester

18CSE201 C PROGRAMMING AND DATA STRUCTURES LABORATORY

Course Prerequisite: 18CSE101

L	T	P	C
0	0	3	1.5

Course Description:
This course includes C program basics, control structures, arrays, files, pointers and data structures.

Course Objectives:
1. To make the student understand problem solving techniques and their applications
2. Students will be able to understand the syntax and semantics of C programming language
3. Develop algorithms for manipulating linked lists, stacks, queues, searching and sorting.

LIST OF EXPERIMENTS
1. a) Write a C program to swap the two numbers.
b) Write a C Program to find the eligibility of admission for a Professional course based on the
following criteria:
Marks in Maths >=65
Marks in Physics >=55
Marks in Chemistry>=50
OR
Total in all three subject >=180

2. a) Write a C program to list all the factorial numbers less than or equal to an input number n.
A number N is called a factorial number if it is the factorial of a
Positive integer. For example, the first few factorial numbers are
1, 2, 6, 24, 120, ...
Note - We do not list the factorial of 0.
b) Write a program that reads numbers which are in the range 0 to 100, till it encounters -1. Print the sum of all the integers that you have read before you encountered -1

3. a) Given three points (x1, y1), (x2, y2) and (x3, y3), write a program to check if all the three points fall on one straight line.
b) The digital root (also called repeated digital sum) of a number is a single digit value obtained by an iterative process of summing digits. Digital sum of 65536 is 7, because 6+5+5+3+6=25 and 2+5 = 7. Write a program that takes an integer as input and prints its digital root.

4. a) Write a C program to find the series of prime numbers in the given range.
b) Write a C Program to Check Whether a Number is Palindrome or Not.

5. a) Write a c program to check whether a given number is a perfect number or not. (Perfect number is a positive number which sum of all positive divisors excluding that number is equal to that number. For example 6 is perfect number since divisor of 6 are 1, 2 and 3. Sum of its divisor is 1 + 2+ 3 = 6)

b) Write a C function to find the kth occurrence of an integer n in a sequence of non-negative integers, and then call your function from main.
Your function should be according to the following declaration:
int find(int n, int k);
sample example: input 3 2
1 1 3 2 3 -1
Output: 4

6. Write a C program to find Factorial, GCD, Fibonacci, (Using recursion)

7. Your program should take as input: dimension of a square matrix N, two matrices of size N x N with integer values, and one operator symbol (+, - ,*). It must perform the Corresponding operation given below
a) Matrix Addition b) Matrix Subtraction c) Matrix Multiplication

8. One needs to first input a set of N number of ALPHABETIC Strings each representing a name of a student in an array studname [N] . Assume each string can be Max. 40 Characters long. subsequently, one needs to input Marks obtained by those students in another array marks [N] Assume that studname [I] i.e. ith student in the list of student names has obtained Marks [I] in the Marks List. You need to find out and print the Max Marks obtained by a student and also print the name of the student who has obtained this mark.

9. Implement the following searching techniques
a) Linear Search b) Binary Search

10 .a) Bubble sort is a sorting algorithm that works by repeatedly stepping through lists that need to be sorted, comparing each pair of adjacent items and swapping them if they are in the wrong order. This passing procedure is repeated until no swaps are required, indicating that the list is sorted. Bubble sort gets its name because smaller elements bubble toward the top of the list. Consider an array of size 10. It will be filled it by reading 10 integers. The final output will be sorted output in Ascending Order.
b) Insertion sort is a sorting algorithm in which the elements are transferred one at a time to the right position. Here the first element in the array is considered as sorted, even if it is an unsorted array. Then each element in the array is checked with the previous elements, resulting in a growing sorted output list. With each iteration, the sorting algorithm removes one element at a time and finds the appropriate location within the sorted array and inserts it there. The iteration continues until the whole list is sorted. First an array of size 10 will be taken. We will fill it by reading 10 integers. The final output will be sorted output in Ascending Order.

11 a) Write a C program to swap two integers using pointers. You have to write a swap function that will accept the address of two integer and swap their values
b) Write a program in C to add two numbers using pointers. You have to write the fsum() function which accepts the address of two variables and returns the sum of their values to the main function.

12 Write a C program to compute internal marks of students for five different subjects using Structures.

13 Implement the following Data Structures
a) Stack ADT b) queue ADT c) Circular queue ADT

14 a)Write a C program to implement all string operations (string length, string copy, string compare, string concatenation and string reverse) without using standard string library functions.
b) Write a C program for reading a string and assigning its base address to the character pointer to count characters are vowels or consonants.

15 a) Write a C program to copy the file contents from one file to another file (pass file names as Command line arguments).
b) Write a C program to count no of lines, words and characters in a file.

Course Outcomes:

After completing this course the students should be able to

1. Apply the concepts of control structures using C.
2. Implement the concepts of arrays and functions through C programming.
3. Develop the source code to implement the concepts of Strings, Pointers and File processing.
4. Implement sorting and searching algorithms using arrays.
5. Implement stack and queue data structures using arrays.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination**.**

B. Tech. I Year II Semester

18ME201 WORKSHOP PRACTICE

L	T	P	C
0	0	3	1.5

Course Prerequisite: None

Course Description:
This course will provide students with a hands-on experience on various basic engineering practices. This course will also provide an opportunity to the students to experience the various steps involved in the industrial product fabrication.

Course Objectives:
1. Introduction to the use of Tools, Machinery and Power tools,
2. Hands on practice in Carpentry, Fitting, Forging, Tinsmith, Plumbing, Foundry, Welding, Fabrication of plastic components, Metrology, Fabrication of Polymer Composite materials, simple machine turning and wood turning, and basic electrical connections.
3. Introduction to 3 D Printing
4. Fabrication of final product at end of the semester.

LIST OF TRADES
1. Carpentry (Cross half lap Joint and Miter Joint)
2. Fitting (Square and 'V' fit)
3. Turning (Ball pane hammer and handles)
4. Forging (S hook L hook)
5. Tin smithy (Square tray)
6. Plumbing (Wash basin and simple connection)
7. Foundry (Solid and Split pattern)
8. Welding (Arc and Gas welding)
9. Fabrication of plastic components (Pen Stand)
10. Metrology (Internal and External dimension)
11. Composite Material Sample Preparation (Demo Only)
12. Introduction of Power Tools and CNC (Demo Only)
13. Introduction to 3D Printing (Demo Only)

Course Outcomes
On successful completion of this course, the student will be able to
1. Fabricate carpentry components with suitable joint and pipe connections including plumbing works.
2. Perform welding operation to join various structures.
3. Perform basic machining operations.
4. Create the models using sheet metal and plastic works.
5. Illustrate the operations of foundry, fitting and smithy
6. Fabricate a product using composite and plastic material
7. Design and fabricate a product using the tools and skills learned in the workshop.

Suggested Text/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998. (v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.
4. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech II Year I Semester

B.Tech. II Year I Semester

18HUM102 PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

The course provides students with a practical and concrete explanation of management concepts and techniques they will need to manage today's and tomorrow's organizations. The course will follow the "planning, organizing, leading, controlling" format of managerial functions while putting together many small pictures presented by individual modules into one bigger meaningful picture in which managerial knowledge would apply. At the end of the course students are expected to understand role of components of bigger picture and interactions between and among components.

Course Objectives:

The course is intended to

1. Describe the concepts of Management theories, approaches and their application with organizations around us;
2. Know the concepts of planning and management;
3. Explain the basic concepts of organization, types and structure of organization;
4. Make the students know leading, good communication, theories of motivation; and
5. Explain about controlling, managing operations and functional areas of marketing and financial management.

UNIT I: INTRODUCTION:

Introduction to Management and Organizations- Management definition, skills, roles, goals and functions of a manager, organization, value of studying management - Managing in a Global Environment- Global Perspective, Understanding global environment, - Social Responsibility and Managerial Ethics. **(10)**

UNIT II: PLANNING

Decision-making process, Types of decisions and decision making conditions, styles, biases and errors, Planning: Meaning of planning, establishing goals and developing plans, contemporary issues in planning - Strategic Management-Importance of strategic management, strategic management process, types of organizational strategies, current issues in strategic management. **(9)**

UNIT III: ORGANIZING

Organizational structures - HRM process, Contemporary issues in HRM – Departmentation – decentralization – delegation of Authority - Managing Change and Innovations **(8)**

UNIT IV: COMMUNICATION, MOTIVATION AND LEADING

Functions of communication, Inter-personal communication, Barriers of Communication – Understanding Information Technology- Motivation**:** Theories of motivation and current issues in motivation. Leading: Leaders and Leadership, Leadership theories - Leadership issues in twenty first century **(9)**

UNIT V: CONTROLLING

Process of control – Types of Control - feed-forward, concurrent and feedback controls, contemporary issues in control – Strategic role of Operations Management - Value Chain Management **(9)**

Course Outcomes:

At the end of the course, students will be able to

1. Understand the various concepts, approaches and theories of management in the real situation.
2. Analyze the concept of planning and apply on the decisions in strategic management.
3. Compare organization structure designs and chart diligently with theoretical learning concepts.
4. Apply communication and theories of motivation in an organization.
5. Understand various tools for controlling organizational performance and apply to achieve the corporate objectives.

Text Book:

1. Stephen P. Robbins, Mary Coulter "Management", Pearson Education, 2010, 10th edition.

References:

1. Gary Dessler, "Management", Prentice Hall, Inc., 1998, 1st edition.
2. Daft Richard L. 'Management' Thomson South Western, 5th edition.
3. Koontz H. and Weihrich H., "Essentials of Management", McGraw Hill Int. ed., 2004, 6th edition.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year I Semester

18MAT108 PARTIAL DIFFERENTIAL EQUATIONS AND PROBABILITY& STATISTICS

L	T	P	C
3	**1**	**0**	**4**

Course prerequisite: Engineering Calculus

Course description:
This course provides an introduction to partial differential equations and its applications, probability concepts, univariate distributions, Chebychev's inequality, moments for basic statistics, correlation and linear regression, hypothesis testing and confidence intervals.

Course objectives:

1. To introduce the partial differential equations and applications of partial differential equations.
2. To understand the concepts of probability, discrete random variables and their importance in engineering.
3. To solve real time problems in engineering by using continuous probability distributions.
4. To analyze the problems related to multivariate random variables.
5. To apply classical inference involving confidence intervals and hypothesis testing in engineering problems.

UNIT I: **PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS**
Definition and formulation of partial differential equations. Classification, method of separation of variables; One dimensional wave equation, D'Alembert's solution; Solution of one dimensional heat flow;Solution of two dimensional steady heat flow. **(12)**

UNIT II: **PROBABILITY AND DISCRETE RANDOM VARIABLES**
Axiomatic approach to probability, theorems on probability, conditional probability and Bayes' rule. Discrete random variable, discrete density function, cumulative distribution, expectation, moment generating function, geometric, discrete uniform, binomial and Poisson distributions **(12)**

UNIT III: CONTINUOUS RANDOM VARIABLES
Continuous Random Variables: Continuous density, cumulative distribution function, Expectation, moment generating function of a random variable, Uniform, gamma, exponential, normal distributions, Chebyshev's inequality, normal approximation to binomial distribution and transformation of random variable. **(12)**

UNIT IV: JOINT DISTRIBUTIONS
Joint densities: discrete and continuous joint densities, marginal densities, independence, expectation and covariance, correlation. Transformation of random variables. Correlation and linear regression **(12)**

UNIT V: **TESTS OF HYPOTHESIS**

Sampling distribution, tests of significance: Null and alternative hypothesis, errors in sampling, critical region and level of Significance. Large sample tests -single and difference of proportions, single and difference of means. Small sample tests :*t*- test for single mean, paired and difference of means, chi-square test for goodness of fit and test for ratio of variances.

(12)

Textbook

1. B.S. Grewal,Higher Engineering Mathematics, 43rd Edition(2014),Khanna Publishers.
2. J.S. Milton and J.C. Arnold, Introduction to Probability and Statistics, 4th edition (2003), Tata McGraw-Hill Publications.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2010.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4. S. Ross, A First Course in Probability, 6th edition, Pearson Education India, 2002.

Course Outcomes:

After the completion of the course, students should able to

1. Understand the partial differential equations and its applications in mechanical engineering.
2. Get the importance of probability and discrete probability distributions in engineering.
3. Solve real time problems in engineering by using continuous probability distributions.
4. Analyze the joint probability distributions and regression analysis.
5. Apply classical inference involving confidence intervals and hypothesis testing in engineering problems.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year I Semester

18ME102 ENGINEERING MECHANICS

L	T	P	C
2	1	0	3

Course Prerequisite: Engineering Calculus

Course Objectives:

1. To study the basics of statics of particles and rigid bodies.
2. To understand various support connections and loadings.
3. To analyze trusses for various loading conditions.
4. To study the problems involving ladder, wedge and belt friction.
5. To learn the geometric properties of the different shapes.

UNIT-I: STATICS OF PARTICLES

Introduction to Mechanics - System of Units - Laws of mechanics - Lame's theorem - Parallelogram and triangular Law of forces - Resolution of coplanar forces - Free body diagram - Equilibrium of particles

Statics of Rigid Body: Moment of a force - Varignon's theorem - Moments and Couples - Equivalent system of forces - Requirements of stable equilibrium - Equilibrium of Rigid bodies subjected to two, three and four force system. **(11)**

UNIT-II: ANALYSIS OF PIN JOINTED TRUSSES

Classification of trusses –Reactions at supports and connections –Types of loading - Reaction for simply supported and over hanging beams - Analysis of Trusses (Simply supported and cantilever beams)

Friction: Classification of friction – Laws of friction – Angle of repose – Force required to move a body along horizontal and inclines planes – Analysis of ladder, wedge and belt friction. **(9)**

UNIT- III: CENTROIDS, CENTER OF GRAVITY AND MOMENTS OF INERTIA

Center of Gravity and Centroid - Area and polar moment of inertia - Radius of Gyration - Parallel and Perpendicular Axis Theorems - Mass Moment of inertia – Problems on centroid and area moment of inertia of plane figures and buildup sections **(8)**

UNIT –IV: KINEMATICS OF PARTICLES

Displacements - Velocity and acceleration - their relationship, relative motion - Curvilinear motion - Kinetics of Particles – Linear and angular momentum - Equations of motion - Energy and momentum methods - Work and energy - Principle of Impulse and Momentum Impact **(8)**

UNIT V: DYNAMICS OF RIGID BODIES

General plane motion - Velocity and Acceleration - Absolute and Relative motion method - Equilibrium of rigid bodies in plane motion - D'Alembert's Principle - Principle of Work Energy Principle for a rigid body - Principle of impulse momentum for rigid bodies in plane motion. **(9)**

Course outcome:

Student will be able to

1. Solve the engineering problems in case of equilibrium conditions.
2. Calculate the reaction forces of various supports of different structures.
3. Solve the problems involving ladder, wedge and belt friction.
4. Determine centroid, center of gravity and moment of inertia of various surfaces and solids.
5. Solve the problems involving dynamics of particles and rigid bodies

Textbook:

1. Ferdinand P. Beer, E. Russell Johnston (2010), Vector Mechanics for Engineers: Statics and Dynamics (9th Edition), Tata McGraw-Hill International Edition.

References:

1. S.S. Bhavikatti, (2008), Engineering Mechanics, New Age International.
2. Irving H. Shames, (2003), Engineering Mechanics – Statics and Dynamics, Prentice Hall of India Private limited.
3. S. Timoshenko D.H. Young J.V. Rao, Sukumar Pati, Engineering Mechanics, McGraw Hill Education; 5 edition

Mode of evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year I Semester

18ME103 BASIC THERMODYNAMICS

L	T	P	C
2	1	0	3

Course Prerequisite: Differential Equations

Course Description:
Thermodynamics is one of the fundamental courses in the study of mechanical engineering. The principles of thermodynamics are applicable to a wide range of problems encountered in all branches of engineering. Also thermodynamics is an essential pre-requisite for subsequent courses in mechanical engineering like fluid mechanics, applied thermodynamics, heat transfer, gas dynamics, refrigeration and air conditioning, etc. This course is designed to equip the students with a thorough understanding of basic concepts of thermodynamics and with necessary skills and techniques to solve problems in thermodynamics through a systematic analysis using fundamental principles. The specific topics to be covered in the course include concepts of system and surroundings, energy, energy transfer by work and heat, properties of substances and property changes, first and second laws of thermodynamics.

Course Objectives:
1. To introduce the concepts of system, surroundings, energy interactions, thermodynamics properties of substances and to teach different techniques used for estimating the properties like gas laws and property tables
2. To explain the principles of work and energy.
3. To introduce the fundamentals of thermodynamic laws, concepts and principles.
4. To teach the systematic approach to be employed for effectively solving the problems in thermodynamics.
5. To explain the principles of various cycles and to apply the thermodynamic concepts in various applications like IC engines and Refrigeration and Air conditioning systems.

UNIT I: THERMODYNAMIC BASICS
Macroscopic versus Microscopic viewpoint, Thermodynamic system and control volume, Thermodynamic properties, processes and cycles, Homogeneous and heterogeneous systems, Thermodynamic equilibrium, Quasi-static process, Concept of continuum, Zeroth law of thermodynamics, temperature scale, Ideal gas, Work Transfer, Heat transfer, First law of thermodynamics, Specific heat, Enthalpy, Internal Energy, Steady flow energy equation and application, PMM1 and Steady flow energy equation. **(10)**

UNIT II: PROPERTIES OF PURE SUBSTANCES
Pure substance, Vapor-Liquid-Solid-Phase equilibrium in a pure substance, Independent properties of a pure substance, Phase boundaries, tables of thermodynamic properties, Thermodynamic Surfaces, p-v and p-T diagram for a pure substance, p-v-T surface, T-s and h-s or Mollier diagram for a pure substance, dryness fraction, Steam Tables, Charts of Thermodynamic properties, Measurement of steam quality. **(8)**

UNIT III: SECOND LAW OF THERMODYNAMICS AND ENTROPY

Qualitative difference between heat and work, cyclic heat engine, Kelvin-Planck statement of second law, Clausius' statement of second law, Refrigerator and heat pump, Equivalence of Kelvin-Planck and Clausius statement, Reversibility and Irreversibility, Carnot cycle, Reversed heat engine, Carnot's Theorem, Corollary of Carnot's theorem, absolute thermodynamic temperature scale and Efficiency of heat engine, Entropy, Inequality of Clausius, Temperature-Entropy plot, Entropy generation in an open and closed system and Entropy change in an Irreversible process. **(10)**

UNIT IV: THERMODYNAMIC PROPERTY RELATIONS AND GAS MIXTURES

Equation of state, Ideal gas, Real gas, Compressibility chart, Internal energy, enthalpy, entropy, specific heats and Gibbs free energy of gas mixture, Maxwell's Equations, TdS equation, Difference in heat capacities, Ratio of heat capacities, Joule-Kelvin Effect, Clausius-Clapeyron equation, Properties of atmospheric air, Psychrometric chart and Psychrometric process. **(9)**

UNIT V: THERMODYNAMIC CYCLES

Rankine cycle, Actual vapour cycle processes, Comparison of Rankine and Carnot cycles, Air standard cycles - Otto, Diesel, dual and Brayton cycles, Reversed heat engine cycle, Vapour compression refrigeration cycles. **(8)**

Course Outcomes:

On successful completion of the course, the student will be able to:

1. Define the fundamentals of the zeroth and first laws of thermodynamics and explain their application to a wide range of systems.
2. Apply the properties of steam to design steam systems.
3. Apply the second law of thermodynamics for the design of heat engine, heat pump and refrigerators. The student will also be able to Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
4. Explain the cycles on which IC engines, Gas turbines and refrigerator works.
5. Explain the importance of Tds relations and be able to use psychometric charts for the design of air conditioning systems.

Text Books:

1. Cengel, Y.A and Boles, M.A, Thermodynamics: An Engineering Approach, 5th ed., McGraw-Hill, 2006.

References:

1. Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.
2. Nag, P.K., Engineering Thermodynamics, 3rd ed., Tata McGraw-Hill, 2005.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year I Semester

18ME104 MATERIALS SCIENCE AND ENGNEERING

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
The purpose of this course is to introduce the student to enrich their knowledge on the materials science field. Begin with the microscopic level the structure at the atomic and their impact on the material properties are discussed. The relation between heat treatment, phases and alloying elements properties of materials is also highlighted. The course mainly discusses about the different types testing methods for materials. Final part of the course covers non-metallic materials such as ceramics and polymers.

Course Objectives:
1. To understand the relation between structure and properties of metallic materials.
2. To understand the strengthening mechanism of metals
3. To know the concept of phase transformation, phase diagrams and its influence on the properties of metals.
4. To learn the methods of improving properties by thermo, mechanical treatment.
5. To identify the importance of non-metallic materials like polymers, ceramics and composites, material standards and their applications.

UNIT I: STRUCTURE OF MATERIALS
Introduction: Historical prospective - importance of materials - Classification of Materials and its Properties. Bonding in solids: bonding forces and energies - primary and secondary bonding. Crystallography and Metallic structures: Unit cell - Crystallographic directions and planes, FCC, BCC, HCP, SC and other structure – miller indices, Linear and planar densities - close-packed crystal structures. Packing of atoms in solids. Packing factor **(9)**

UNIT II: CRYSTAL IMPERFECTIONS AND DIFFUSION.
Crystal Imperfections: Types, Vacancies and interstitials, Dislocations and grain boundaries. Diffusion: Fick's Law of diffusion – Diffusion mechanism – Steady state and non-steady state, factors affecting diffusion.
Dislocations: Dislocations and strengthening mechanisms of metals – Solid solution hardening – Precipitate and dispersion strengthening – Work hardening – The dislocation yield strength. **(9)**

UNIT III: HEAT TREATMENT PROCESS AND MECHANICAL PROPERTIES OF MATERIALS.
Introduction and Concepts: Classification of metal working process- Mechanical Properties of Metals: Mechanical properties of materials: Elasticity and Plasticity, Stress–Strain curve, Young's modulus – The yield strength, Tensile strength, Ductility, Brittleness, Malleability, Rigidity, Toughness, Resilience, Hardenability, Hardness, Hooke's Law – Linear and non-linear elasticity; True stress – strain curves for plastic flow – Plastic work – Tensile testing, the hardness test, compression testing, creep, fatigue and other testing methods.

Various Heat Treatment Process: Annealing, Normalizing, Quenching. Effect of Heat Treatment on material properties, Stress relief. Various stages of quenching and effect of quenching medium: Water, Oil and Air. Austempering, Martempering and Age Hardening. Case Hardening: Carburizing, Nitriding, Cyaniding, Carbo-nitriding, flame and induction hardening, vacuum and plasma hardening. Solidification, Nucleation and crystal growth.
(11)

UNIT IV: PHASE DIAGRAMS AND PHASE TRANSFORMATIONS
Phase diagrams: Solubility, Phases- Phase rule, and microstructure - phase equilibrium - Binary phase diagrams - Phase Transformations. Lever Rule and Gibbs phase rule. Fe-Fe_3C Phase diagram Phase Transformations: Isothermal transformation - TTT diagrams - Continuous cooling transformation. **(8)**

UNIT V: FERROUS, NONFERROUS & NONMETALLIC MATERIALS
Ferrous Materials: Effect of alloying additions in Steel (Mn, Si, Cr, Mo, V, Ti & W), Stainless steels and types, Tool Steels, HSLA, Types, structure and properties of Cast iron: White, Grey, Ductile, Malleable, CGI and Alloy cast iron. Nonferrous Materials: Brass, Bronze; Al, Cu, Zn and Pb and respective alloys. Industrial Applications.
Introduction to non-metallic materials- classification of polymers, ceramics and composites-structure and application of non-metallic materials **(8)**

Course Outcomes:
At the end of the course students will be able:
1. To develop deep knowledge of crystal structure and effect of structure on the properties of the materials.
2. To understand various imperfections in crystal, dislocation mechanisms and diffusion mechanism in materials.
3. Student will be able understand various mechanical properties of materials and its testing and need for heat treatment process in materials.
4. To understand the concept of phases and to construct the equilibrium diagrams, Fe-Fe_3C phase diagram and TTT diagrams
5. To recognize the properties and applications of nonmetallic materials and Ferrous materials.

Text Books:
1. W. Callister, “Materials Science and Engineering”, Wiley, 7th Edition, 2007.
2. S. H. Avner, “Introduction to physical Metallurgy”, McGraw Hill Education, 2nd Edition, 2007.

References:
1. George E. Dieter, Mechanical Metallurgy, SI Metric Edition McGraw Hill Book Company, London.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech II Year I Semester

18ENG201 ENGLISH COMMUNICATION - LISTENING & SPEAKING LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: 18ENG101

Course Description:
As the **s**tudents are being exposed to the global language 'English; it has become a widespread need. This course builds on what was offered in the first semester and facilitates deeper understanding into the mechanics of the English language, especially in regard to two particular skills, i.e. Listening and Speaking. This course is offered in order to help students cultivate and nurture a mind that "thinks in English." Intricate issues of pronunciation, modulation, timbre are dealt with in regard to Speaking and also the sub-skills of Listening, thus the whole course is entirely lab oriented.

Course Objectives:
This course enables students to –
1. Hone in on their listening skills
2. Grasp the differences between native level and mother-tongue influenced pronunciation
3. Develop crucial speaking skills
4. Enhance vocabulary for greater communicative impact
5. Overall development of thinking in the English language

UNIT I: Listening; Understanding key vocabulary; Listening for main ideas; Listening in detail; Syllable stress; Sentence stress; Presentation.
(12)

UNIT II: Vocabulary for important places (bank, library, restaurant, etc.); Prepositions for places; Stress determiners (this & that); Intonation.
(12)

UNIT III: Using background knowledge; Collocations; Pronouncing clusters of consonants (e.g. –gh, -ing, ph, ck); Mapping ideas; Pronunciation of phrases; Listening for opinion; Vocabulary and collocations for jobs
(12)

UNIT IV: Listening for lecture organization; Text organization features; Phrases with make; Evaluating and proposing ideas; Expressing attitudes
(12)

UNIT V: Identifying opposing viewpoints; Silent letters; Idioms; Fixed expressions; Phrasal verbs **(12)**

Course Outcomes:

At the end of the course, learners will be able to:

1. Listening with intent
2. Pronounce more fluently
3. Develop crucial thinking skills
4. Enhance vocabulary
5. Overall development in the English language

Suggested Reading/Textbook:

1. Sabina Ostrowska; *Unlock 3 series(B1): Listening & Speaking*; Published by: Cambridge University Press.

Reference:

1. Gary Buck; *Assessing Listening;* Cambridge University Press, 2010.
2. Adrian Doff, Craig Thaine, Herbert Puchta, et al; *Empower: Upper Intermediate (B2+)*; Published by: Cambridge University Press.
3. Josh Sreedharan; *The Four Skills for Communication;* Cambridge University Press, 2014.
4. William Strunk Jr; *The Elements of Style*; ITHACA, N.Y.; W.P. HUMPHREY, 2006.
5. Joseph Devlin; *How to Speak and Write Correctly*; ITHACA, N.Y.; W.P. HUMPHREY, 2006.
6. Miles Carven; *Listening Extra*; Cambridge University Press, 2008.
7. Jayashree Mohanraj; *Speak Well*; Orient Blackswan, 2013.
8. F. Kipple; *Keep Talking*; Cambridge University Press, 2013.
9. *www.cambridgeenglish.org/in/*
10. https://learnenglish.britishcouncil.org/en/english-grammar
11. https://www.rong-chang.com/

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination

B. Tech. II Year I Semester

18ME202 MATERIALS SCIENCE AND ENGINEERING LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: None

Course Objectives:
The objective of this course is to expose the students to a broad knowledge of experimental and analyzing techniques useful in Mechanical as well as a metallurgical engineering field. The subject introduces the correlation of properties of materials and their structure. It revises student's knowledge of crystal structure and phase diagrams of various alloy systems. This laboratory course offers practical knowledge of heat treatment applicable to ferrous materials and studies microstructural changes and hardness evaluation.

LIST OF EXPERIMENTS

1. Preparation and study of the micro-structure of various cast irons: White Cast Iron, Gray Cast Iron, Ductile Cast Iron and Malleable Cast Iron
2. Preparation and study of the micro-structure of metals like Iron, Al and their alloys and measurement of grain sizes.
3. Preparation and study of the microstructure of low carbon steels, Medium carbon and high carbon steels.
4. Experimentally analyzing the effect of quenching mild steel in air, water and oil on the hardness of the materials.
5. Experimentally analyzing the microstructure and hardness of various heat treatment process for steel: Annealing, Normalizing and Quenching.
6. Experimentally analyzing the hardenability of the mild steel by Jominy End Quench Apparatus.
7. Experimentally analyzing the effect of work hardening on steel by hardness measurements and its reversal by annealing.
8. Synthesis of Al_2O_3 pellet via powder metallurgy route, and microstructure study.
9. Synthesis of SiC single point lathe tool insert via powder metallurgy route.
10. Synthesis of Al – SiC Metal Matrix compounds via powder metallurgy process and microstructure study.

Course Outcomes:

1. The student will obtain knowledge on the microstructural analysis of various metals and alloys with regard to sample preparation via polishing and etching and use and analysis of optical microscopy.
2. This lab enables the student to select an analytical technique to evaluate and analyze the samples.
   Students learn to use the instruments and get exposed to specimen preparation, validation of the instrument, precise use of an instrument to accurately estimate the given samples.
3. Ability to perform different heat treatment operation and characterize the microstructure
4. Perform simple calculations to qualify materials properties and microstructural characteristics.
5. Synthesis of various ceramic and MMC via powder metallurgy.

Text Book:

1. Lab manual provided by the department

References:

1. Brandon D. G, “Modern Techniques in Metallography”, VonNostrand Inc. NJ, USA, 1986.
2. Prabhudev. K. H. “Handbook of Heat Treatment of Steels”, Tata McGraw-Hill Publishing Co., New Delhi, 1988
3. Sydney H. Avner, “Introduction to Physical Metallurgy”, Tata McGraw Hill, New Delhi, 1997.
4. William D. Callister, “Materials Science and Engineering” John Wiley and Sons, 8th Edition, 2009.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech. II Year I Semester

18ME203 3-D MODELLING LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: Engineering Graphics

Course Description:
The course is about the theory and technique of three-dimensional (3D) modeling utilizing appropriate software. Topics include the creation and modification of 3D geometric shapes; and rendering techniques; and use of camera light sources, texture, and surface mapping.

Course Objectives:
1. During the term of the course, students will learn to work within virtual 3-D space.
2. Build volumetric objects including: vertices, splines, polygons, primitive shapes and Sub Patch geometry.
3. Students will use these tools to build complex objects then learn the basic 3-D rendering tools and techniques.
4. The student will able to produce 2D drawing from the 3D part geometry to assure the proper dimensioning of the parts.
5. To make the students to understand and draw assemblies of machine parts and to draw their sectional views.

List of Experiments

1. Introduction to 3D modelling
3. Modelling of screw threads, keys and Fasteners
4. Assembly of Sleeve and Cotter Joint
5. Assembly of Socket and Spigot Joint
6. Assembly of Shaft Coupling
7. Assembly of Gib & Cotter Joint
8. Assembly of Knuckle Joint
9. Assembly of Universal Joint
10. Assembly of Screw Jack
11. Assembly of Plummer Block
12. Assembly of Simple Eccentric
13. Assembly of Machine Vice
14. Drafting

Course Outcomes:
The students after completing the course will be able to:
1. Identify of different types of bolts, nuts, welding joints screw threads, keys and fasteners.
2. Visualize and prepare detail drawing of a given object.
3. Draw details and assembly of mechanical systems.
4. Read and interpret given drawing.
5. Create 3-D models using any standard CAD software.

Text Books:
Lab manual provided by the department

References:

1. Gopalakrishnan K.R, "Machine Drawing", Subhas Stores, 2007

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech II Year II Semester

B. Tech II Year II Semester

18HUM101 ECONOMICS AND FINANCIAL ACCOUNTING FOR ENGINEERS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
The Engineering Economics and Financial Accounting aims to provide an insight into production, cost analysis, market structure, Accounting Basic concepts and financial Statement Analysis. The course is designed to give emphasis on the application of real life examples on various fundamental issues of economics and accounts. This course introduces the accounting system, principles, types of accounts, and financial statements etc. The ratio analysis and financial analysis are useful to know the position of financial statements. Funds flows statements and cash flow statements are explained to know the analysis of financial matters.

Course Objectives:
The course is intended to

1. Describe the nature of engineering economics in dealing with the issues of scarcity;
2. Know the supply, demand, production and cost analysis to analyze the impact of economic events on markets;
3. Explain the performance of firms under different market structures and Price determination in various market conditions.
4. Explain the accounting principles, types of accounting and preparation of final accounts; and
5. Describe the financial analysis through ratios, funds flow and cash flow statements.

UNIT I: DEMAND ANALYSIS
Scope and Significance of Economics- Understanding the problem of scarcity and choice - Elements of market Economy: Demand, Supply and Market Equilibrium- Theory of Demand, Elasticity of Demand, Supply and Law of Supply. **(10)**

UNIT II: PRODUCTION AND COST ANALYSIS
Production Function – Short-run and long- run production – Cost Analysis: Cost concepts - Cost Structure of Firms and output decision- Break-Even Analysis (BEA) – Managerial significance and limitations of BEA - Determination of Break Even Point (Simple Problems) **(9)**

UNIT III: MARKET STRUCTURE:
Classification of Markets - General Equilibrium and efficiency of Perfect competition, Monopoly, Monopolistic, Oligopoly, Duopoly – Price determination and various market conditions **(8)**

UNIT IV: BASICS OF ACCOUNTING:
Uses of Accounting - Book Keeping Vs Accounting - Double Entry System - Accounting Principles - Classification Of Accounts - Rules Of Debit & Credit. Accounting Cycle: Journal,

Ledger, Trial Balance. Final Accounts: Trading Account - Profit & Loss Account - Balance Sheet with Adjustments, (Simple Problems). **(9)**

UNIT V: BASICS OF FINANCIAL ANALYSIS

Ratio Analysis - Liquidity, Leverage, Solvency and Profitability Ratios - Interpretation of Financial Statements - Funds Flow Statement - Capital Budgeting **(9)**

Course Outcomes:

At the end of the course, students will be able to

1. Understand Engineering economics basic concepts,
2. Analyze the concepts of demand, elasticity, supply, Production, Cost Analysis and its essence in floating of an organization,
3. Compare different market structures and identify suitable market,
4. Demonstrate an understanding and analyzing the accounting statements, and
5. Demonstrate the ability to apply knowledge of accounting concepts through Financial Statements Analysis.

Text Books:

1. Case E. Karl & Ray C. Fair, “Principles of Economics”, Pearson Education, 8th Edition, 2007
2. Financial Accounting, S.N.Maheshwari, Sultan Chand, 2009
3. Financial Statement Analysis, Khan and Jain, PHI, 2009
4. Financial Management, Prasanna Chandra, T.M.H, 2009

References:

1. Lipsey, R. G. & K. A. Chrystal , “Economics”, Oxford University Press, 11th Edition, 2007
2. Samuelson P. A. &Nordhaus W. D. “Economics”, Tata McGraw-Hill 18th Edition, 2007
3. Financial Management and Policy, Van Horne, James,C., Pearson ,2009.
4. Financial Management, I.M.Pandey, Vikas Publications

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech Mechanical Engineering

B. Tech II Year II Semester

18BIO101 LIFE SCIENCES FOR ENGINEERS

L	T	P	C
3	0	0	3

Course Prerequisite: Basic knowledge about sciences up to intermediate or equivalent level.

Course Description: The course deals with basic concepts of life sciences, its impact on human & universe, biological systems and functions, human physiology and metabolism.

Course Objectives:
The course is intended to

1. Introduce the molecular basis of life.
2. Provide the basis for classification of living organisms.
3. Describe the transfer of genetic information**.**
4. Introduce the techniques used for modification of living organisms**.**
5. Describe the applications of biomaterials

UNIT – I: INTRODUCTION TO LIFE SCIENCES & LIVING ORGANISMS
Why we need to study Life Sciences? Comparison and differences of biological organisms with manmade systems (Eye & Camera, Bird flying & Aircraft), Biological observations of 18th Century that led to major discoveries. Classification of living organisms, Cellular basis of life, differences between prokaryotes and eukaryotes, classification on the basis of carbon and energy sources. **(10)**

UNIT – II: BIOMOLECULES & MACROMOLECULES
Molecules of life: Water, Sugars, Starch, Cellulose, Amino acids, Structure and functions of proteins (primary, secondary, tertiary and quaternary structure), Structure and functions of nucleotides, nucleic acids, DNA (single and double strand) & RNA, hemoglobin, antibodies and enzymes, Industrial applications of enzymes and Fermentation process. **(8)**

UNIT – III: HUMAN PHYSIOLOGY
Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation, Human physiology, Neurons, Synaptic and Neuromuscular junctions. **(8)**

UNIT – IV: GENES, DNA & RNA
Mendel's laws, gene mapping, Mitosis and Meiosis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation. Discuss the concept of complementation using human genetics. Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips. **(9)**

UNIT – V: METABOLISM
Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O

(Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Mechanism of Photosynthesis). **(10)**

Course Outcomes

After studying the course, the student will be able to:

1. Explain the differences between biological organisms and manmade systems and classify organisms
2. Interpret the relationship between the structure and function of proteins, nucleic acid and summarize the industrial applications of biomolecules
3. Explain the mechanism of respiration
4. Demonstrate the mapping of genes and explain the medical importance of gene disorders.
5. Apply thermodynamic and kinetic principles to biological systems

Text books:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2018.
2. Arthur T Johnson, Biology for Engineers, CRC press, 2011.
3. Cell and Molecular Biology by De Robetis and De Robertis.

Reference books:

1. Alberts Et. Al. The molecular biology of the cell, 6/e, Garland Science, 2014.
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
3. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech Mechanical Engineering

B. Tech. II Year II Semester

18ME105 MECHANICS OF SOLIDS

L	T	P	C
2	1	0	3

Course Prerequisite: Engineering Mechanics

Course Description: Fundamental principles of stress and stains, Temperature relations; Principal stresses and strains; Shear Forces and Moments diagrams for various types of beams with different types of loads; Flexural Stresses and Deflection of Beams**;** Torsion, deflections due to bending; Stability of equilibrium.

Course Objectives:

1. Student will understand the fundamental concepts of stress, strain and deformation of solids with applications to bars and beams
2. Student will understand the theory of elasticity including strain/displacement Hooke's law relationships
3. Student will understand shear forces and bending moments in various beams with different loads.
4. To create clear awareness to the student to concept of design of columns.
5. The knowledge of this subject will help in understanding the Design & Theory of Machines courses

UNIT I: FUNDAMENTALS OF STRESSES & STRAINS

Simple Stresses & Strains : Elasticity and plasticity – Types of stresses & strains–Hooke's law–stress, strain diagram for mild steel, Working stress – Factor of safety, Lateral strain, Poisson's ratio& volumetric strain Elastic moduli & the relationship between them, Bars of varying section ,Factor of Safety – composite bars, Temperature stresses. Strain energy, Resilience, Gradual, sudden, impact and shock loadings,

Principal Stresses: Principal Stresses, Strains with uniaxial and bi- axle conditions. Mohr's circle concepts, Mohr's circle for uniaxial and bi- axle stresses **(11)**

UNIT II: SHEAR FORCE AND BENDING MOMENT

Shear Force and Bending Moment: Definition of beam – Types of beams, Concept of shear force and bending moment. SF and BM diagrams for cantilever, simply supported and overhanging beams subjected to Point loads, UDL, UVL and combination of these loads, Point of contra flexure. Relation between S.F., B.M. and rate of loading at a section of a beam

(9)

UNIT III: FLEXURAL STRESSES & DEFLECTION OF BEAMS

Flexural Stresses: Theory of simple bending – Assumptions Derivation of bending equation: M/ I = f/y = E/R Neutral axis, Determination bending stresses – section modulus of rectangular and. circular sections (Solid and Hollow), I, T, Angle and Channel sections, Design of simple beam sections

Deflection of Beams: Introduction of deflection of beams, slope, deflection and radius of curvature Differential equation, for the elastic line of a beam Double integration and Macaulay's methods Determination of slope and deflection for cantilever and simply supported beams subjected to point load uniformly varying load. Mohr's theorems **(11)**

UNIT IV: TORSION

Torsion of Circular Shafts- Theory of pure torsion, Derivation of torsion equations; Assumptions made in the theory of pure torsion Torsional moment of resistance- polar section modulus **(7)**

UNIT V: BUCKLING

Introduction, elastic stability, Examples of instability, Elastic stability of flexible columns **(7)**

Course Outcomes:

The students after completing the course will be able to:

1. Estimate the principal stresses by analytical and Mohr's circle.
2. Analyze the distribution of shear force and bending moment for various types of beams under different load conditions.
3. Evaluate bending stresses in beams and calculate the deflection and slope of beams with different types of load.
4. Design shafts for pure torsion.
5. Analyze the elastic stability of flexible columns.

Text Book:

1. Mechanics of Materials by Gere and Timoshenko, C B S Publishers & Distributors, 2ndEdition,2004.

Reference Books:

1. Mechanics of Materials by Ferdinand P. Beer and E.Russel Johnston, McGraw Hill Education (India) publicationsEdition,2004.
2. Strength of Materials by S. Ramamrutham, Dhanpat Rai Publishers
3. Strength of Materials by R.K. Bansal, Laxmi Publishers, 5th Edition,2012.
4. Strength of Materials by R.K. Rajput, S.Chand& Company, 5th Edition,2012.
5. Strength of Materials by Dr. Sadhu Singh, Khanna Publishers, 10th Edition,2013.
6. Mechanics of solids and structures by Dr. R. Vidyanathan and Dr. P. Perumal, Laxmi Publishers

Mode of evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year II Semester

18ME106 MANUFACTURING PROCESS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
Manufacturing is the creation, through one or several processing operations, of components or products from basic raw materials. The effectiveness of process selection will be based on the inter-related criterion of design parameters, material selection and process economies.

Course Objectives:
1. Working principle of different metal casting processes and gating system.
2. Classification of the welding processes, working of different types of welding processes and welding defects.
3. Nature of plastic deformation, cold and hot working process, working of a rolling mill and types, extrusion processes.
4. Principles of forging, tools and dies, working of forging processes.
5. Classification, applications and manufacturing methods of plastics, ceramics and powder metallurgy

UNIT 1: METAL CASTING PROCESS
Casting & Moulding Process: Introduction to casting process, principles of gating, gating ratio, function and types of risers, defects in casting. Die casting – Types of die casting, centrifugal casting & Investment casting, and stir casting. Melting Furnaces: Induction furnace, Electric arc furnace, and cupola furnace. Testing of cast products **(8)**

UNIT 2: METAL JOINING PROCESS
Fabrication methods, general considerations, type of joints, edge preparations, type of welding process, electric arc, gas welding, bracing, soldering, inert gas welding, special type of welding – resistance welding, spot welding, thermit welding, plasma arc welding laser beam welding, TIG and MIG welding, submerged arc welding, friction stir welding, welding defects, Heat Affected Zone, Non-destructive testing methods, and applications of welding.
(9)

UNIT 3: SHEET METAL PROCESS
Introduction, Shearing, sheet metal characteristics and formability, blanking, piercing, forming, bending, drawing, deep drawing, spinning, rubber forming, hydro forming, superplastic forming, hot stamping, stretch forming, calculation of forces, spring back, progressive die, compound die, combination die, working of mechanical press, hydraulic press.
(8)

UNIT 4: BULK DEFORMATION PROCESS.
Forging – Introduction hot forging and cold forging, open die forging, impression die forging, closed die forging, upset forging, extrusion forging, calculation of forces.

Extrusion –Introduction – Hot extrusion, backward and forward extrusion, cold extrusion, extrusion defects, impact extrusion, design of extrusion dies, design considerations, extrusion equipment, and application of extrusion.

Rolling –Introduction – Flat rolling, friction forces, roll force and power requirements, different types of rolling process, defects in rolling, Types of rolling mills, die design and design considerations, calculation of roll force, torque and horse power, Application of rolling.

Drawing – Introduction – Calculation for drawing force, wire drawing, flat drawing, lubrication, die design for drawing, drawing process, die design, die materials, defects, residual stresses, types of drawing equipment, Application of drawing, advantages and limitations, calculation of draw stress and force. **(11)**

UNIT 5: POWDER METALLURGY

Introduction – Characteristics of engineering powders, particle size, distribution, packing, density, porosity, surface area etc. Production of metallic powders –atomization, chemical reduction, electrolysis, conventional pressing and sintering, secondary operation, sintering techniques, isostatic pressing, powder injection molding, power rolling, application of powder metallurgy **(9)**

Course Outcomes:

On successful completion of the course, the student will be able to:

1. Selection of suitable manufacturing process for a given product by pattern making, design of gating systems, preparation of molding and poring of molten metal for casting and defects etc.
2. Selection of metal joining process for different metal using different welding techniques and production of defect free products.
3. Production of components on sheet metal by using processes like blanking, piercing, forming, bending, deep drawing process.
4. Compare cold working and hot working processes using rolling, extrusion process, rolling and drawing process.
5. Making products from powder form by employing different techniques.

Text Books:

1. Kalpakjain S and Schmid S.R., Manufacturing Engineering and Technology, 7/e, Pearson, 2018.
2. Rao P.N., Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.

Reference Books:

1. Millek P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 4/e, John Wiley and Sons Inc, 2010.
2. Sharma P.C., A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
3. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1st Edition, Springer, 2010.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year II Semester

18ME107 THEORY OF MACHINES

L	T	P	C
2	1	0	3

Course Prerequisite: Engineering Mechanics

Course Description:
The objective is to study the relative motion, velocity, and accelerations of the various elements in a mechanism. In mechanical Engineering we come across number of mechanisms such as four bar/slider crank/double slider crank/straight line motion mechanism etc. Mechanism deals with only relative motions. Once we make a study considering for us also there it is called kinetics. The course first deals with mechanisms, their inversions, straight line motion mechanisms etc. Study of cams/gears are also introduced. Next, **t**he course gives an insight into the basic concepts of dynamic analysis of machines.

Course Objectives:
1. Introduce various basic mechanisms and their applications.
2. Familiarize velocity and acceleration in mechanisms.
3. Describe the cams and follower motions and importance of balancing.
4. Explain the importance of gyroscopic couples, gears and gear trains.
5. Introduce the equation of motion for single degree of freedom system

UNIT I: SIMPLE MECHANISMS
Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, mobility – Grashof's law, kinematic inversions of four bar chain and slider crank chains- Limit positions – Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line mechanisms- Universal Joint – Rocker mechanisms. **(9)**

UNIT II: VELOCITY ANALYSIS
Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations-kinematic analysis of simple mechanisms-slider crank mechanism dynamics-Coincident points-Coriolis component of acceleration. **(8)**

UNIT III: GYROSCOPE & GEAR PROFILE
Gyroscope: Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two wheeler, simple problems
Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting-helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics. **(9)**

UNIT IV: BALANCING & CAMS
Balancing of Rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods

Cams: Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions-cam profile- specified contour cams- circular and tangent cams- pressure angle and undercutting. **(10)**

UNIT V: VIBRATIONS

Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility, Torsional vibrations - two and three rotor systems. **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. Identify the different mechanisms and their inversions in real life applications.
2. Calculate the velocity and acceleration of simple mechanisms by graphical methods.
3. Analyse the effects of gyroscopic couple in ships, aero planes & automobiles and classify gears and gear trains and compute velocity ratio.
4. Estimate the unbalance mass in rotating machines using analytical and graphical methods and able to sketch the cam profiles for different follower motions.
5. Analyse free and forced vibrations of single degree freedom systems to avoid resonance. Understand different mechanisms and their inversions.

Text Book:

1. S.S.Rattan ,Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014

Reference Books:

1. F. Haidery, Dynamics of Machines, 5/e, Nirali Prakashan, Pune, 2003
2. J.E.Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014
3. P.L.Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.
4. Norton, R.L., Design of Machinery - An introduction to Synthesis and Analysis of Mechanisms and Machines, 2/e, McGraw Hill, New York, 2000.
5. William T. Thomson, Theory of vibration with applications, 4/e, Englewood Cliffs, N.J. : Prentice Hall, 1993.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year II Semester

18ME108 FLUID MECHANICS & HYDRAULIC MACHINERY

L	T	P	C
2	1	0	3

Course Prerequisite: Partial Differential Equations

Course Description:
Modelling and predicting the behaviour of fluid flow is an important part of many scientific and technological problems. Flow of fluid is an important aspect of atmospheric and oceanic circulation, combustion in engines, biological processes such as the flow of blood. From the days of Isaac Newton to the present day world, considerable progress has been made in the mathematical modelling of fluid flow. With the advent of enhanced computational ability, computational fluid dynamics has played a major role in solving complex fluid flow problems. In this course, the students are introduced to various fluid properties and to model fluids at rest. Flow of fluids is introduced to the students in two forms, namely, the Lagrangian and the Eulerian form. Eventually, both the integral and differential form of the governing equations of fluid dynamics are derived. Flow of fluids in closed conduits and over various geometries is also introduced. Basic design of hydraulic turbines and pumps are introduced to the students.

Course Objectives:
1. To provide a basic understanding of the properties and behavior of matter (fluids) by means of analytical equations.
2. To develop an understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
3. To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.
4. Determine the force applied by a jet on stationary and moving vanes.
5. To understand the working principle of hydraulic machinery like turbines and pumps.

UNIT I: FLUID PROPERTIES AND KINEMATICS OF FLUID FLOW
The Concept of a Fluid, Classification of fluid flows, System & Control volume, Density, Specific gravity, Thermodynamic Properties of a Fluid, Viscosity, Surface Tension, Capillarity, Vapor pressure and Cavitation. Lagrangian and Eulerian descriptions, material derivative, velocity and acceleration field, streamlines, path lines and streak lines.
Fluid statics: Barometer and atmospheric pressure, Manometry, Buoyancy and stability **(9)**

UNIT II: GOVERNING EQUATIONS OF FLUID FLOW
Reynold's transport theorem, Integral form of the conservation of mass for moving or deforming control volumes and steady flow processes, Integral form of Energy equation, Integral form of linear momentum equation, Integral form of angular momentum equation. Derivation of the Bernoulli equation **(8)**

UNIT III: INTERNAL AND EXTERNAL FLOW
Laminar and Turbulent flows, Entrance region, Laminar flow in pipes, Turbulent flow in pipes, Minor and Major losses. Orifice meter and Venturimeter.

Flow over flat plate, Boundary layer equations, Displacement, Momentum and Energy thicknesses, Momentum integral technique for boundary layers, Boundary layers with pressure gradients. **(9)**

UNIT IV: IMPACT OF JET VANES & HYDRAULIC TURBINES

Hydrodynamic force of jet striking stationary and moving vanes, flat and curved vanes, jet impinging centrally and tangentially.
Classification of hydraulic turbines- Impulse and reaction turbines; Basic equation of energy transfer in rotodynamic machines, specific speed; Components of Pelton turbine, Velocity triangles and power for Pelton turbine, Maximum efficiency of Pelton turbine; Types of reaction turbines, Components of Francis turbine, Velocity triangles, power and efficiency of Francis turbine. Kaplan turbine. **(10)**

UNIT V: HYDRAULIC PUMPS

Working principle and main parts of a centrifugal pump; Classification of centrifugal pumps; Static and Manometric head of a centrifugal pump; Efficiencies of centrifugal pump.
Main parts and working of reciprocating pump; Discharge, work done and power required to drive a reciprocating pump; Slip of a reciprocating pump; **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. Interpret the properties of fluids and their applications, determine differential pressure using manometric principles, calculate the buoyant forces and estimate the stability of floating and immersed bodies.
2. Distinguish between a system and control volume approach and will be able to use the governing equations based on integral approach for solving fluid flow problems.
3. Have a clear understanding of internal flow physics and capable of estimating the major and minor losses observed in pipe flows. Similarly, they will be able to assess various flow parameters in external flows with and without pressure gradients.
4. Assess the forces acting on vanes with varied geometries and point of jet impact. Further, they can differentiate different turbines and estimate the performance parameters of various turbine used in hydraulic power plants.
5. Differentiate different pumps and calculate their performance characteristics.

Text Books:

1. Cengel, Y.A, Cimbala, John, M., “Fluid Mechanics, Fundamentals and Applications”, McGraw Hill Education; Third edition (1 July 2017)
2. B.K. Venkanna, “ Fundamentals of Turbomachinery”, PHI Learning Private Limited,2018

References:

1. R. K. Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, Ltd., 2005
2. Robert W. Fox and Alan T. Mc Donald, "Introduction to Fluid Mechanics", John Wiley & Sons Private Ltd., 2009, 7th Edition.
3. James R. Welty, Charles E. Wicks and Robert E. Wilson, "Fundamentals of Momentum, Heat and Mass transfer", John Wiley & Sons (Asia) private limited., 2008, 5th Edition.
4. Frank M White, "Fluid Mechanics", Tata McGraw-Hill, 7th Edition, 2012.
5. Milton Van Dyke, "An Album of Fluid Motion", Parabolic Press, 12th Edition.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. II Year II Semester

18ME204 MECHANICS OF SOLIDS LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: None

Course Objectives:
The objective of this course is to expose the students to a broad knowledge of experimental methods and measurement techniques useful in Mechanical engineering.

Following is the list of experimental set ups on which experiments shall be conducted. Complete modalities of operation of the laboratory such as the exact titles of experiments, reports submission and evaluation methodology etc. shall be announced at the beginning of laboratory session.

LIST OF EXPERIMENTS

MOS Practicals:
1. Rockwell Hardness Testing & Brinell Hardness Testing
2. Tensile Test
3. Impact Testing
4. Torsion Test
5. Bending test on
    1. Simply supported beam
    2. Cantilever beam
6. Test on springs.
7. Compression test on UTM
8. Double shear test on UTM

Course Outcomes:
The students after completing the course will be able to:
1. Evaluate hardness value for various materials using Rockwell hardness tester
2. Plot the stress stain curve of a ductile material under tensile and compressive load using universal testing machine
3. Calculate the slope and deflection of simply supported beam under point load
4. Experiment on a spring to interpret the stiffness and shear modulus.
5. Apply the concept of impact loading and to determine impact values for various materials.

Text Book:
Lab manual provided by the department

Reference Book:
1. Mechanics of Materials by Gere and Timoshenko, C B S Publishers & Distributors, 2nd Edition,2004.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech Mechanical Engineering

B. Tech. II Year II Semester

18ME205 DYNAMICS & ELECTRICAL MACHINES LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: Electrical Engineering Laboratory

Course Objectives:

1. To equip students with understanding of the fundamental principles and techniques for Identify different types of dynamic systems and classify them by their governing equations
2. To develop a model of a mechanical system using a free body diagram
3. To develop equations of motion for translational and rotational mechanical systems
4. To develop an understanding of how property data is generated and reported.
5. To create a bridge between theoretical knowledge and application.

List of experiments - Dynamics Lab Practicals:

1. Study of gyroscopic effect and determination of gyroscopic couple
2. Watt governor
3. Proell governor
4. Porter governor
5. Hartnell governor.
6. Static and dynamic balancing of rotating masses
7. To verify the relation $t = 2\pi\sqrt{l/g}$ for a simple pendulum
8. Forced vibration of equivalent spring mass system
9. Longitudinal vibration
10. Torsional vibration of single rotor shaft system
11. Torsional vibration of two rotor shaft system
12. Single rotor system with viscous damping
13. Whirling speed of shaft
14. Determination of jump speed of cam-follower system

List of experiments – Electrical Machines Practicals:

1. Magnetization Characteristics of DC Shunt Generator. Determination of Critical Field Resistance and Critical Speed.
2. Brake Test on DC Shunt Motor. Determination of Performance Curves.
3. Load Test on DC Compound Generator. Determination of Characteristics.
4. Hopkinson's Test on DC Shunt Machines. Predetermination of Efficiency.
5. Fields Test on DC Series Machines. Determination of Efficiency.
6. Swinburne's Test and Speed Control of DC Shunt Motor. Predetermination of Efficiencies.

Additional Experiments:

1. Load Test on DC Series Generator. Determination of Characteristics.
2. Retardation Test on DC Shunt Motor. Determination of Losses at Rated Speed.
3. Separation of Losses In DC Shunt Motor.

Course Outcomes:

The students after completing the course will be able to:

1. Estimate the frequency response of 1DOF systems.
2. State the mode shapes of the 1DOF forced vibration systems.
3. Describe the equations of motions of forced damped vibration systems both analytical and graphical methods.
4. Analyze natural frequency of multi degrees of systems.
5. Describe the static and dynamic balancing of reciprocating engines.

Text Books:

Manual provided by the department

Reference Book:

1. S.S.Rattan ,Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech. II Year II Semester

18ME206 MANUFACTURING PROCESS LABORATORY

	L	T	P	C
Course Prerequisite: None	**0**	**0**	**3**	**1.5**

Course Description:

Production Techniques practical lab contains Metal casting, Welding, Mechanical Press working and processing of Plastics. These practical inculcates the skill to the students starting from preparing a wooden pattern to completion of a casting which also comprises different Sand testing techniques. Students will also get good skill on Welding and mechanical press working which will be helpful to get an employment in Industries.

LIST OF EXPERIMENTS

1. METAL CASTING LAB:
- a. Pattern Design and making - for one casting drawing.
- b. Sand properties testing - Exercise -for strengths, and permeability – 1
- c. Molding: Melting and Casting - 1 Exercise

2. WELDING LAB:
- a. Arc Welding: Lap & Butt Joint - 2 Exercises
- b. Spot Welding - 1 Exercise
- c. TIG Welding - 1 Exercise
- d. MIG welding – 1 Exercise
- e. Brazing – 1 Exercise

3. MECHANICAL PRESS WORKING:
- a. Blanking & Piercing operation and study of simple, compound and progressive press tool.
- b. Hydraulic Press: Operation – Forming exercise.
- c. Bending and other operations.

4. PROCESSING OF PLASTICS:
- a. Injection Molding
- b. Vacuum forming.

Course Outcomes:

This practical course is designed to enrich practical knowledge about common production techniques used in manufacturing. The students after completing the course will be able to:

1. Produce real time casting on their own
2. Prepare various joints by using various welding process
3. Perform blanking, piercing and forming operations on the sheet metal.
4. Prepare bottle with cape by using injection and vacuum forming.
5. Bend a pipe to the required angle.

Text Book:

1. Manual provided by the department

Reference Book:

1. Kalpakjain S and Schmid S.R., Manufacturing Engineering and Technology, 7/e, Pearson, 2018.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech III Year I Semester

B. Tech. III Year I Semester

18ME109 ENGINEERING ANALYSIS

L	T	P	C
2	0	2	3

Course Prerequisite: 18MAT101, 18CSE101, 18MAT107, 18MAT108

Course Description:
This course introduces the students to theory and practice of numerical analysis as it is applied to solving engineering problems. The computational techniques used for problems like finding roots of transcendental equations, solving systems of linear equations, determining eigen values, interpolation, curve fitting, integration, differentiation and solving differential equations are covered both through lectures as well as hands on practical sessions.

Course Objectives:
1. To introduce the basics of numerical analysis like Taylor Series, round off errors and truncation errors.
2. To familiarize students with various numerical methods used in engineering problem solving and their respective merits and demerits.
3. To train the students in writing computer codes using modern tools like Python or MATLAB for applying numerical techniques to engineering problems.
4. To instruct the students on selecting appropriate numerical technique to for a given engineering problem and apply it effectively.

UNIT I: BASICS AND NON-LINEAR EQUATIONS
Introduction to problem solving using numerical methods, Types of errors in numerical solutions, Taylor Series.
Finding roots of non-linear equations using Fixed point iteration, Bi-section, Newton-Raphson, and Secant methods. Convergence of these methods.
Newton's Method for system of non-linear equations **(9)**

UNIT II: SYSTEM OF EQUATIONS AND EIGEN VALUE PROBLEMS
Solution of linear system of equations using Gauss elimination method, Pivoting, Gauss Jordan method, Iterative methods of Gauss Jacobi and Gauss Seidel
Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices **(8)**

UNIT III: INTERPOLATION AND APPROXIMATION
Polynomial Interpolation-Lagrange's interpolation–Newton's divided difference
Piecewise interpolation–quadratic and cubic Splines
Curve Fitting – Least square regression for linear and non-linear curve fitting.
Fourier Transform – DFT **(8)**

UNIT IV: NUMERICAL DIFFERENTIATION AND INTEGRATION
Approximation of derivatives using finite differences, Richardson extrapolation and derivatives by interpolation.
Numerical integration using Trapezoidal, Simpson's 1/3 rule, Romberg's Method, Two point and three-point Gaussian quadrature formulae, Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules. **(10)**

UNIT V: SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS
Euler's method, Modified Euler's method, Runge-Kutta methods (second order and fourth order) and Adaptive Runge-Kutta methods for solving first order equations, Multi step methods).
Shooting method and finite difference method for boundary value problems. Introduction to solving Partial Differential Equations **(10)**

Course Outcomes:

1. Solve non-linear equations using appropriate numerical methods like bisection method, Newton-Raphson method etc.
2. Solve a system of linear and non-linear equations using iterative or direct techniques.
3. Select and apply suitable methods for approximation of functions using techniques like interpolation, curve fitting etc.
4. Evaluate numerical integration and differentiation using numerical methods.
5. Solve initial and boundary value problems in ODEs using appropriate methods.

Textbooks:

1. Steven Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw Hill Education, 3rd edition.
2. Jaan Kiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press, 3 edition.

References:

1. Numerical Methods for Engineers; Steven C. Chapra and Raymond P. Canale, 7th edition, McGraw Hill, 2014.
2. Introduction to Numerical Analysis, S.S. Sastry; Prentice Hall of India, 2012.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. III Year I Semester

18ME110 DESIGN OF MACHINE ELEMENTS

L	T	P	C
2	1	0	3

Course Prerequisite: None

Course Objectives:
1. To study fundamental concepts of Machine Design.
2. To analyze failure from static and fatigue loading.
3. To design bolted joints.
4. To design welded joints.
5. To design helical and Leaf springs.

UNIT I:
MACHINE DESIGN INTRODUCTION: General considerations of design, design process, Preferred sizes, Selection of engineering materials, properties, Manufacturing considerations in the design, Fits and Tolerance
DESIGN AGAINST STATIC LOAD: Factor of safety, Stress -Strain relation, Simple stresses, Torsional and bending Stresses, Design of simple machine parts, Cotter Joint, Gib and Cotter joint, Combined stresses, impact stresses. **(10)**

UNIT II:
VARIOUS THEORIES OF FAILURE: Maximum principal stress theory, Maximum shear stress theory, Maximum Distortion energy theory.
DESIGN AGAINST FLUCTUATING LOAD: Stress concentration factors, Fluctuating stresses, Endurance limit, Design for infinite and finite life, Goodman's line Soderberg's line. **(9)**

UNIT III:
DESIGN OF THREADED JOINTS: Types of threaded joints, Terminology of Screw threads, Analysis of bolted joints- Simple and eccentric loads, Torque requirement for bolt tightening. **(8)**

UNIT IV:
WELDED JOINTS: Introduction to welding, Weld symbols, Stresses in Welded Joints, Design of parallel and transverse fillet welds.
UNSYMMETRICAL WELDS: Axially loaded, Eccentric load and torsional loads in welds in Torsion. **(9)**

UNIT V:
MECHANICAL SPRINGS: Types of springs, Spring materials, Stress and deflections of helical Springs, Surge in springs, Examples based on simple analysis
LEAF SPRINGS: Multi leaf springs, Equalized stresses in spring leaves (nipping). **(9)**

Course outcomes:

Student will be able to

1. Describe general design principles like design process, material selection, manufacturing considerations, combined stresses, impact stresses, theories of failure, and factor of safety.
2. Evaluate simple components under cyclic loading using the concepts of stress concentration, notch sensitivity, endurance limit and Goodman and Soderberg criteria.
3. Design bolted joints subjected to direct loading and eccentric loading.
4. Design welded joints subjected Torsion bending and axial loading.
5. Design helical and leaf springs for various applications with considerations of stress-deflection relations and fatigue loading.

Text Book:

1. V.B. Bhandari, Design of Machine Elements, 4^{th} edition, Mc Graw Hill Education (India), New Delhi.

Data Book:

1. V.B. Bhandari, Design of Machine Elements, 4^{th} edition, Mc Graw Hill Education (India), New Delhi.

References:

1. Budynas R. G. and Nisbett J. K. Shigley's Mechanical Engineering Design, McGraw Hill, 9th SI Edition, New Delhi, 2011.
2. Norton Robert L., Machine Design: An Integrated Approach, Second Edition, Pearson Education Asia, New Delhi, 2001.
3. Hall A. S., Holowenko A. R. and Bennett M. D., Machine Design, McGraw Hill (Schaum's Outline Series), (SI Units), New Delhi, 2008.
4. M. F. Spotts, Design of Machine Elements, Prentice Hall of India, New Delhi

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. III Year I Semester

18ME111 MANUFACTURING TECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: Production Technology

Course Description:
The main objectives of this course are to present advanced information about metal cutting theory to students and to enhance the students' knowledge in production technology. The course includes basic concepts and definitions, tool materials, chip formation, mechanics of metal cutting, cutting forces, heat generation and dissipation, tool life, cutting fluids, surface roughness, machining process planning, machining economy and introduction of Automation.

Course Objectives:
1. Provide the basic concepts in mechanics of metal cutting, chip formation, various tool materials and tool life.
2. To train the students in the metal cutting domain so as to equip themselves with adequate knowledge about the various operations such as turning, shaping, planning, drilling, milling and grinding machines.
3. To apply knowledge to calculate the machining parameters for different machining processes and economics.
4. To develop fundamental knowledge on Advanced machining process.
5. To evaluate the machining cost during turning operation.

UNIT -I: THEORY OF METAL CUTTING
Overview of metal cutting, chip formation, chip thickness ratio, shear angle and its relevance, orthogonal and oblique cutting processes, types of chips, chip breakers, forces and energy calculations (merchant’s analysis), power consumed, tool wear, tool life, tool materials, cutting fluids, numerical problems. **(9)**

UNIT -II: MACHINE TOOLS AND MACHINING OPERATIONS
Turning, Milling, Planning, Shaping, Broaching, Sawing, Filing, Hole making operations: Drilling, Reaming, Boring, Tapping, Machining time calculations, High speed machining. **(8)**

UNIT -III: ABRASIVE MACHINING PROCESSES
Mechanics of grinding, effect of grinding conditions on wheel wear and grinding ratio, cutting conditions, temperature, power, specifications of grinding wheel, application considerations in grinding, grinding operations, machining time, numerical problems, honing, lapping, superfinishing, polishing and buffing. **(9)**

UNIT-IV: ADVANCED MACHINING PROCESSES
Need for advanced machining processes, classification, EDM, ECM, UM, AJM, LBM, EBM, IBM, CM - Process principle and mechanism of material removal, Process Parameters, Process Capabilities, Applications, Operational characteristics, Limitations. **(9)**

UNIT-V: ECONOMICS IN MACHINING AND AUTOMATION TECHNOLOGIES
Economic considerations in machining, cost of single pass turning operation, optimum cutting speed in turning for minimum cost, optimum cutting speed in turning for maximum production rate & profit rate, numerical problems. Introduction about Automation fundamentals, Adaptive control, Computer Numerical Control, Industrial Robotics, Sensor Technology

(10)

Course outcomes:
Upon successful completion of this course, the student will be able to:
1. Evaluate the cutting forces, power and specific energy and tool life in machining
2. Identify and select suitable machining operations for specific applications
3. Identify and select suitable abrasive machining processes for surface finishing of components
4. Select an advanced machining process based on the effect of various process parameters on the required performance criteria.
5. Evaluate cutting speed to minimize production cost and maximize production rate and understand the recent developments in Automation.

Textbooks:
1. Groover, Mikell P., Fundamentals of Modern manufacturing: materials, processes and systems, 4^{th} ed. John Wiley & sons, INC, 2010.
2. S. K. Hajra Choudhury, Nirjhar Roy, Elements of Workshop Technology: Machine Tools (Vol - 2), A. K. Hajra Choudhury, Media Promoters and Publishers Pvt. Ltd.
3. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology," Pearson Education, 7/e, 2013, New Delhi.
4. R.K.Jain &S.C.Gupta, Production Technology, Khanna Publishers

Reference books:
1. Roy A. Lindberg, "Processes and Materials of Manufacture," PHI, New Delhi, 2004.
2. P.N. Rao, Manufacturing & Technology: Foundry Forming and Welding, 3rd Ed., Tata McGraw Hill, 2003.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. III Year I Semester

18ME112 HEAT TRANSFER

L	T	P	C
2	1	0	3

Course Prerequisite: 18ME103, 18ME108

Course Description:
Fundamental concepts of heat transfer; steady-state and unsteady-state heat conduction; analytical and empirical relations for forced and free convection heat transfer; condensation and boiling; heat exchanger analysis and design; and Heat transfer by radiation.

Course Objectives:
1. To elucidate the fundamental mechanisms of heat transfer
2. To teach the governing laws of heat transfer by conduction, convection and radiation
3. To train the students in using the analytical and empirical methods for estimating heat transfer under different conditions.
4. To explicate the rudimentary aspects in heat transfer with phase change.
5. To introduce different approaches for solving sizing and rating problems in Heat Exchanger design

UNIT I: INTRODUCTION AND STEADY ONE-DIMENSIONAL CONDUCTION
Underlying physics and basic rate equations for conduction, convection and radiation modes of heat transfer; Relationship to Thermodynamics, Thermal properties of materials, Heat conduction equation in Cartesian, cylindrical and spherical coordinates; Boundary conditions and initial conditions. Simplification of conduction equations for one dimensional steady state conduction; Applications to plane wall, cylindrical shell and spherical shells, composite walls; Electrical analogy and overall heat transfer coefficient; conduction with heat generation.
(9)

UNIT II: EXTENDED SURFACES AND TRANSIENT CONDUCTION
Heat transfer from extended surfaces; governing equation and analytical solutions for different boundary conditions, performance and efficiency of fins. The Lumped heat capacitance model, governing equation, Biot number; One dimensional transient heat flow: applications to semi-infinite solid, plane slab, cylinders and spheres; Heisler charts. **(9)**

UNIT III: CONVECTION HEAT TRANSFER
Thermal and velocity boundary layers, convection heat transfer coefficient, laminar and turbulent boundary layers, boundary layer momentum and energy equations, non-dimensional parameters and their significance, Correlations for forced convection problems involving flat plates, cylinders; spheres and banks of tubes. Internal flows- mean velocity, mean temperature, entry and fully developed regions, correlations for heat transfer in laminar and turbulent pipe flows. Natural convection heat transfer on a vertical plate; governing equations, dimensionless numbers, empirical relations for natural convection on plates, cylinders and spheres.
(9)

UNIT IV: BOILING, CONDENSATION AND HEAT EXCHANGERS

Non-dimensional numbers in heat transfer with phase change, Boiling heat transfer modes, pool boiling, forced convection boiling, empirical correlations for boiling heat transfer, Condensation heat transfer mechanism, condensation on a vertical plate and vertical cylinders, film condensation inside horizontal tubes; dropwise condensation. Classification of heat exchangers, overall heat transfer coefficient, fouling factor, LMTD and NTU analyses of heat exchangers. **(9)**

UNIT V: RADIATION HEAT TRANSFER

Physical mechanism of Radiation, radiation intensity, black body radiation, Planck's distribution law, Wein's displacement law, Stefan Boltzmann law, Real surfaces, emissivity, absorptivity, reflectivity and transmissivity, Kirchoff's identity, grey surface, view factor between surfaces, reciprocity relation, heat exchange between grey surfaces and black surfaces, electric network analogy, radiation shields. Effect of participating media, Radiation combined with other modes of heat transfer. **(9)**

Course Outcomes:

1. Estimate heat transfer rate due to conduction, convection and radiation under simple conditions using Fourier's Law, Newton's Law, and Stefan-Boltzmann Law.
2. Calculate the temperature distribution and rate of heat transfer in one dimensional heat conduction problems (Cartesian, polar and spherical coordinates) like composite walls, cylinders, and extended surfaces.
3. Calculate temperature evolution in lumped and one-dimensional conduction systems using Newton's law of cooling, analytical methods and chart solutions.
4. Calculate the heat transfer and temperature distribution in external and internal fluid flow problems using the principles of momentum and thermal boundary layer, bulk mean temperature, mean temperature, phase change, Nusselt condensation theory and empirical Nusselt number correlations.
5. Design an appropriate heat exchanger, like condenser, evaporator, radiator etc., for a given heat transfer requirement using LMTD and NTU-ϵ methods.
6. Calculate heat transfer due to radiation under certain conditions using the concepts of black and grey bodies, shape factor and electrical network analogy.

Textbook:

1. F. P. Incropera & D. P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, 2001, 5th edition.

References:

1. Yunus Cengel, Heat and Mass Transfer: Fundamentals and Application, McGraw Hill
2. J.P. Holman, Heat Transfer, McGraw Hill, 2002, 9th Edition.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

B. Tech III Year I Semester

18ENG202 CORPORATE COMMUNICATION LABORATORY

L	T	P	C
0	0	2	1

Course Prerequisite: 18ENG102

Course Description:
English is practical and it is a must for any institution to provide students with opportunities to indulge in actively applying their language skills. Thus the Communication Skills Lab facilitates students with adequate opportunities to put their communication skills in use. It also accommodates peer learning by engaging students in various interactive sessions.

Course Objectives:
This course enables the student to
1. Develop their communicative competency
2. Focus on their interactive skills
3. Fortify their employability skills
4. Empower their confidence and overcome their shyness
5. Become effective in their overall performance in the industry

UNIT I: LISTENING & SPEAKING
Group discussion, Interview Skills, Presentation Skills, Role Plays, Small Talks, listening to and understanding Lectures, News, Discussions, Debates, Theatre, Movies, etc. **(9)**

UNIT II: READING & WRITING
Reading a plethora of writing from Newspapers to Philosophical Treatise, Understanding Graphics, Interpreting, Summarizing, Etc. **(9)**

UNIT III: VERBAL & NON-VERBAL ASPECTS
Speaking- introducing oneself - exchanging personal information- Language development- 'Wh'- Questions- asking and answering-yes or no questions-asking about routine actions and expressing opinions. **(9)**

UNIT IV: STORYTELLING & CONVERSATIONS
Listening-short texts-formal and informal conversations-participating in conversations- short group conversations- speaking about oneself- speaking about one's friend. **(9)**

UNIT V: BUSINESS ENVIRONMENT & ETIQUETTES
Sharing information of a personal kind; greeting; taking leave; Writing e-mails, memos, reports, etc. **(9)**

Course Outcomes:

At the end of the course, learners will be able to:

1. Read articles from magazines and newspapers
2. Participate effectively in informal conversations.
3. Introduce themselves and their friends and express opinions in English
4. Comprehend conversations and short talks delivered in English
5. Write short essays of a general kind and personal letters and emails in English.

Suggested Reading/Textbook:

1. Meenakshi Raman & Sangeetha Sharma; Technical Communication – Principles and Practice (2nd Edition-2014); Oxford University Press –2014
2. Michael Swan & Catherine Walter; How English Work (9th Edition); Oxford University Press - 2001

Reference:

1. Nutall J. C.; Reading Comprehension; Orient Blackswan
2. Jane Willis; Teaching English through English; Published by Longman Handbooks
3. www.cambridgeenglish.org/in/
4. https://learnenglish.britishcouncil.org/en/english-grammar
5. https://www.rong-chang.com/

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech. III Year I Semester

18ME207 FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY

L	T	P	C
0	0	3	1.5

Course prerequisite: 18ME108

Course Description:

It is intended that the student would learn to use different techniques to measure discharge and measure head losses through straight and bent pipes. He would also learn the performance evaluation of centrifugal and reciprocating pumps along with Pelton Wheel and Francis turbine

Course Objectives:

1. To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

Fluid Mechanics Practicals:

1. Calibration of Venturimeter
2. Calibration of Orificemeter
3. Impact of jet on vanes
4. Determination of friction factor for a given pipe line.
5. Determination of loss of head due to sudden contraction in a pipe line.
6. Turbine flow meter.
7. Flow through notches (Rectangular & V-type)
8. Verification of Bernoulli's theorem

Fluid Machines Practicals

1. Performance test on Pelton wheel.
2. Performance test on Francis turbine.
3. Performance test on Kaplan turbine.
4. Performance test on single stage centrifugal pump.
5. Performance test on multi stage centrifugal pump.
6. Performance test on reciprocating pump.

Course outcomes:

After completion of the course students will be able to

1. Verify the Bernoulli's theorem for incompressible flows.
2. Determine the co-efficient of discharge for a flow measuring devices like Venturimeter and Orificemeter.
3. Determine the co-efficient of vanes like flat and curved vanes.
4. Determine the performance and draw operating characteristic curves for Pelton wheel, Reciprocating pump and Multi-stage Centrifugal pump.
5. Determine the loss of head in pipe lines due to friction, sudden contraction, enlargement, bends and elbows.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech. III Year I Semester

18ME208 MANUFACTURING TECHNOLOGY LABORATORY

L	T	P	C
0	0	3	1.5

Course prerequisite: 18ME106

Course Description:
Parts manufactured by casting, forming, and various shaping processes often require further operations before they are ready for use or assembly. This lab involves various machining processes to remove some of material from the workpiece with machining allowances in order to produce a specific geometry at a definite degree of accuracy and surface quality.

Course Objectives:
1. To familiar of construction and working principles of different machine tools.
2. To study and acquire knowledge on various basic machining operations in different machines.
3. To know the applications of machines in real life manufacturing of components.
4. To train the students for producing complex components using different machines.
5. To identify different types of chips produced during machining.

LIST OF EXPERIMENTS:
1. Study of construction, working principle and operations of general-purpose machines: Lathe, drilling, milling, shaper, planer, slotter, surface grinder and tool and cutter grinder.
2. Job on step turning and taper turning on lathe machine.
3. Job on thread cutting and knurling on lathe machine.
4. Job on drilling and tapping.
5. Shaping a V- block on a given work piece using Shaping machine.
6. Keyway cutting using slotting.
7. Forming spur gear on a milling machine.
8. Grinding of single point cutting tool using tool and cutter grinder.
9. Grinding plane surface on a surface grinding machine.
10. Job on facing, turning, taper turning and chamfering operations on a CNC lathe machine.

Course outcomes:
After completion of the course students will be able to
1. Handle different machine tools and perform different operations.
2. Explain the field of application and working of various machines.
3. Differentiate conventional machines with CNC machines.
4. Fabricate various mechanical components by using different operations.
5. Understand the importance of surface finishing and material removal rate.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech III Year II Semester

B. Tech Mechanical Engineering

B. Tech III Year II Semester

18ENG102 ENGLISH COMMUNICATION - READING AND WRITING

L	T	P	C
2	0	0	2

Course Prerequisite: None

Course Description:
Students being exposed to the global language 'English' has become a widespread need. This course builds on what was offered in the first semester and facilitates deeper understanding into the mechanics of the English language, especially in regard to 2 particular skills, i.e. Reading and Writing. This course is offered in order to help students cultivate and nurture a mind that "thinks in English." Intricate issues of understanding academic texts, vocabulary needed to comprehend texts, evaluate, and analyze writing tasks, etc.

Course Objectives:
This course enables students to –
1. Hone in on their reading skills
2. Cultivate critical reading and writing skills
3. Develop crucial comprehension of texts, graphs and graphics
4. Enhance vocabulary for greater communicative impact
5. Overall development in the English language

UNIT I:
Reading for main ideas; Applying background knowledge to predict content; Skimming; Scanning; Making inferences; Understanding discourse **(9)**

UNIT II:
Identifying audience; Reading for detail; Using visuals; Academic vocabulary, collocations and synonyms **(9)**

UNIT III:
Scanning to find crucial information; Using critical thinking to identify purpose; Previewing; Topic related vocabulary; Writing an introduction; Essay structure; Descriptive paragraphs; Writing a conclusion. **(9)**

UNIT IV:
Analyzing essay questions; Writing a problem-solution based on graphs and graphics; Developing own ideas. **(9)**

UNIT V:
Writing cause-effect paragraphs; Evaluating diagrams; Brainstorming; Academic verbs and topical language. **(9)**

Course Outcomes:
At the end of the course, learners will be able to
1. Read and comprehend academic texts, graphs, diagrams and graphics
2. Develop crucial thinking skills
3. Write purposefully and effectively
4. Enhance vocabulary
5. Overall development in the English language

Suggested Reading/Textbook:
1. Matt Firth; Unlock 3 series; Published by: Cambridge University Press

Reference:
1. Liz Driscoll; Reading Extra; Cambridge University Press – 2004
2. Graham Palmer; Writing Extra; Cambridge University Press – 2004
3. Writing Tutor; Advanced English Learners' Dictionary, 9th Edition; Oxford University Press– 2012
4. https://www.nypl.org/blog/2012/11/28/11-great-free-websites-practice-english
5. *www.readbrightly.com/6-great-websites-teen-writers/*

Mode of evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. III Year II Semester

18ME113 CAD / CAM

Course Prerequisite: Zeal to Learn

L	T	P	C
3	0	0	3

Course Description:
The CAD/CAM course provides an understanding, importance and relevance to the fundamentals of design software usage and manufacturing processes for producing various products.

Course Objectives:
1. To understand the current viable cad hardware, software and fundamentals.
2. To learn graphics software.
3. To perform various CAD operations using software.
4. To learn basic understanding of Computer Numerical Controlled (CNC) machines,
5. To learn machining processes - milling and turning and write part programming using a combination of G Codes and M codes.

UNIT I: CAD FUNDAMENTALS, SKETCHING, PART MODULE.
Fundamentals - Hardware (Computer Devices-CRT, Rastar Scan, Random Scan Techniques, etc) Software (Solid Modelling, Solid Works, Catia, 3D Design Creo, etc). Introduction to Sketching, Tools and Commands in Sketch. Using Sketcher tools, a component has to be drawn. Generating, Editing and Modifying Drawings in CAD Software. Introduction to Part Module, Tools and Commands in Part Module. Using Part tools, a component has to be drawn. Working with Advanced Modeling tools (Sweep, Blend, Swept Blend). Generating, Editing and Modifying Drawings in CAD Software **(10)**

UNIT II: ASSEMBLY MODELING, WIRE FRAME MODELING
Introduction to Assembly Modeling, Analytical Properties, Relational Properties and Intersections, Data Transfer Formats. Generating, Editing and Modifying Drawings in CAD Software. Introduction to Wire Frame, Surface Modeling and Sheet Metal features Components. Introduction to CAD Data Exchange Formats-IGES, ACIS, DXF and STL, Geometric Dimensions and Tolerances (GD&T) **(8)**

UNIT III: INTRODUCTION TO CAM, MACHINING CENTER
Introduction to – Manufacturing Systems and their performance analysis, Introduction to automation, computer integrated manufacturing. Concepts of NC Systems, CNC Systems, DNC Systems, Advantages, Disadvantages and Limitations , Components of NC, CNC, DNC Machines - Types, Working and Importance of Slide Ways, Recirculating Ball Screw, Feedback devices (Transducers, Encoders), Automatic Tool Changers (ATC), Automatic Pallet Changer (APC), Spindle Drives, Axes Drives, Control Systems, Interpolations, Merits and Demerits, Machine Structure – Requirements and reasons. **(9)**

UNIT IV: TOOLING
Tool- Pre-setting – Concept and Importance, Qualified Tools- Definition, Need and Advantages. Tool holders and Changing Devices - Types and Applications. CNC- Turning and Milling Centers: Types, Features, Axes Nomenclature, Specification, Work Holding Devices – Types, Working and Applications. **(8)**

UNIT- V: PROGRAMMING

Manual Part Programming, Computer Aided Part Programming - Definition and importance of various positions like machine zero home position, work piece zero, and program zero, programming format and structure of part program. ISO- G Codes and M-codes for turning and milling meaning and applications of important codes. Simple and Complex part programming for turning and milling using ISO format having straight turning, taper turning (linear interpolation) and concave/ convex turning (circular interpolation), ISO format milling. Importance, types and applications and format for 1. Canned Cycles, 2. Macro, 3. Do Loops, 4. Subroutine. Need and Importance of various compensations: Tool length compensation, Tool radius compensation, Pitch error compensation, Tool offset. Study of CNC VMC part programming fundamentals and writing part program. Study of CNC – Turning part programming fundamentals and writing part program. Study and demonstration of Die Sinking EDM. Study and demonstration of RP Machine **(10)**

Course Outcomes:

1. Understand the engineering design process and its role in graphic communication process.
2. Use CAD software to generate and interpret a computer model - technical drawings of parts and assemblies according to engineering design standards.
3. To demonstrate a basic and advanced understanding of NC, CNC and DNC strategies.
4. To demonstrate a basic understanding of machining fundamentals including speed and feed calculations, tooling systems and work holding systems.
5. To demonstrate an ability to set-up, write part program using G- Codes and M- Codes to machine parts for CNC milling and turning.

Text Books:

1. SOLIDWORKS 2020 Basic Tools Getting Started with Parts, Assemblies and Drawings, Paul Tran SDC Publications.
2. SOLIDWORKS 2020 Reference Guide, David Planchard SDC Publications.
3. CAD/CAM Theory and Practice, Ibrahim Zeid and R. Sivasubramanian, Mcgraw Hill Education.

Reference Books

1. CAD/ CAM Principles & Applications, Rao, P. N. TMH.
2. CAD/CAM Theory and Practice, R. Sivasubramaniam, TMH.
3. Computer Aided Design and Manufacturing, Lalit Narayan, PHI.
4. CAD/CAM: Concepts and Applications, Chennakesava R. Alavala, PHI.
5. CATIA V5-6R2019 for Designers, Sham Tickoo, Purdue University, CADCIM Technologies.
6. Mechanism Design Essentials in 3DEXPERIENCE 2016x Using CATIA Applications, Nader G. Zamani.

Mode of evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech. III Year II Semester

18ME114 THERMAL ENGINEERING

L	T	P	C
2	1	0	3

Course Description:
This course forms the basis for all further thermal engineering courses to build upon. Those being – Steam and Gas turbines, Refrigeration and Air-Conditioning, IC Engines etc. One can fully understand and appreciate these courses better after a thorough study of thermal engineering

Course Objectives:
Specific objectives may be summarized as:

1. To expose the fundamentals of thermodynamics and to be able to use it in accounting for the bulk behaviour of the sample physical systems.
2. To integrate the basic concepts into various thermal applications like IC engines, gas turbines, steam boiler, steam turbine, compressors, refrigeration, and air conditioning.
3. To introduce students various conventional applied thermal systems and the corresponding thermodynamic design procedures for each of these systems.

UNIT-I: BOILER, CONDENSER & COMPRESSOR
Boilers: Classifications and working of boilers, boiler mountings and accessories, Draught and its calculations, air preheater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance.
Condenser: Classification of condenser, air leakage, condenser performance parameters.
Compressor: Classification and comparison, working principle, work of compression – with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors **(9)**

UNIT II STEAM TURBINES & NOZZLES
Steam Turbines : Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse and reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine.
Steam and Gas Nozzles: Flow through Convergent and convergent-divergent nozzles, variation of velocity, area and specific volume, choked flow, throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, Super saturated flow. **(9)**

UNIT-III REFRIGERATION & AIR-CONDITIONING
Refrigerants: Desirable properties, Common refrigerants used, Nomenclature
Refrigeration: Comparison of heat engine, heat pump and refrigerating machine, Unit of refrigeration and C.O.P, Simple vapour compression refrigeration cycle, Representation cycle

on T-S, P-h and h-s charts, Effect of Subcooling and Superheating, Air refrigeration Cycle, Vapor Absorption Cycle.

Air-Conditioning: Properties of moist air, Dry, wet bulb and Dew point temperature, Psychrometric chart, Psychrometric processes in air conditioning equipment. **(9)**

UNIT-IV GAS TURBINES & JET PROPULSION

Gas Turbine: Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with intercooling, reheat and regeneration and their combinations, Stage efficiency, Polytropic efficiency. Deviation of actual cycles from ideal cycles, Materials for Turbine.

Jet Propulsion: Introduction to the principles of jet propulsion, Turbojet and turboprop engines and their processes, Principle of rocket propulsion, Introduction to Rocket Engine. **(9)**

UNIT -V INTERNAL COMBUSTION ENGINES

I. C. Engines: Classification of IC engines, two stroke & four stroke, and SI & CI engines – comparison, Ideal and actual: Valve and port timing diagrams, Performance analysis of I.C Engines, Morse test, Heat balance.

Combustion: Combustion analysis, heating values, air requirement, Air/Fuel ratio, standard heat of reaction and effect of temperature on standard heat of reaction, Combustion efficiency, heat of formation, Adiabatic flame temperature, enthalpy of formation, enthalpy and internal energy of combustion, Combustion in SI and CI Engine, Knocking phenomenon and control. **(9)**

Course Outcomes:

Upon the completion of this course the students will be able to

1. Apply thermodynamic concepts to solve the problems on different industrial engineering components.
2. Understand the concept of steam turbines, nozzles and be able to solve the problems in steam turbines and nozzles.
3. Learning the working principles of various refrigeration cycles and acquire knowledge about the concept of psychrometry and various psychrometric processes for designing of refrigeration and air-conditioning.
4. Apply thermodynamic concepts to design the gas turbines and jet propulsion.
5. Explain the functioning and features of IC engines, components, auxiliaries, Combustion and evaluate the performance parameters of IC engines.

Text Books

1. Thermodynamics an engineering approach, by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub. Sixth edition, 2008.
2. R.K. Rajput, Applied Thermodynamics, 2nd Edition, Laxmi Publications.

References:

1. M J Moran and H N Shapiro, Fundamentals of Engineering Thermodynamics 3e, John Wiley, 1995.
2. I.C Engines by Ganeshan.V. Tata McGraw Hill, 4rth Edition. 2012.

Mode of Evaluation: Assignments, Mid Term Tests and External End Examinations.

B. Tech III Year II Semester

18ME209 ADVANCED MANUFACTURING LABORATORY

L	T	P	C
0	0	3	1.5

Course prerequisite: All types of machining process

Course Description:
The course work can show the prime importance of simulation software like ANSYS which enables to confidently predict the behavior of the product for different conditions. The use of G & M codes in CNC machines which are used in the manufacturing sector. Making products by EDM process, product using 3D printing and refrigeration and air conditioning.

Course Objectives:

1. To gain practical experience in Programming software systems from Siemens and Fanuc
2. To gain the knowledge and hands on experience for writing and operating of programs for CNC machines.
3. To gain knowledge and hands on experience in EDM m/c, Tribometer.
4. To learn knowledge and hands on experience on coding and operation of 3D printer
5. To have hands on experience on various experiments over Refrigeration & Air-Conditioning.

List of Experiments:

1) CNC lathe Machine:
Introduction of CNC lathe (Use G and M codes)
a. Programming for plain turning – facing, center drilling
b. Programming of step turning
c. Programming for step, taper and undercut process.
d. Programming for threading turning process.

2) CNC Milling machine:
Introduction to CNC Milling Machine (Use G code and M code)
a. Programming for up and down milling
b. Programming taper milling.
c. Programming for end milling.
d. Programming for profile milling

3) Electrical Discharge Machining
a. Study of Electric Discharge Machining.
b. Electric Discharge performance study on Material Removal Rate (MRR)
c. Identification of Process parameters and carbon deposition rate.
d. Analysis of Powder Mixed Electrical Discharge Machining and surface properties.

4) Pin on Disc Tribometer

a. Study of Pin on Disc Tribometer for Wear Measurement.
b. Identification of wear rate for various Loading Condition.
c. Analysis of velocity and its influence on velocity.
d. Wear rate variation under various environmental conditions.

5) 3 D Printing

a. Part orientation and painting.
b. Support structure generation.
c. Types of in fill while printing.
d. Post processing of printed components.

6) Metal Forming:

Practical on Vacuum forming.

Course Outcomes:

At the end of the training, students will be able to write program and produce products.

1. Student should be able to Write part programs for lathe and milling operations.
2. Student should be able to do produce products using CNC machines.
3. Student will be able to make products by EDM process.
4. Student will be able to do wear analysis using Pin on Disc Tribometer
5. Student will be able to do product by 3D printing process.

Text Books:

1. Lab manual provided by the department.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech III Year II Semester

18ME210 ROBOTICS LABORATORY

L	T	P	C
0	0	3	1.5

Course Prerequisite: Basic programming Skills

Course Objectives:
The objective of this course is to provide an experiential based learning platform to practically teach the concepts of IoT from basics to advanced by building projects and develop the skills needed for an exciting career in IoT. By successfully completing the experiments in this laboratory, the students would earn basic skills in making a robot move and control it using an embedded program

LIST OF EXPERIMENTS

1. Assembling and connecting DC motors and motor drivers to the microcontroller and controlling using Arduino
2. Connecting sensors to the microcontroller and data acquisition using Arduino
3. Developing smart irrigation system using the Arduino-Uno
4. Developing smart water monitoring system using the Arduino-Uno
5. Developing smart weather monitoring system using the Arduino-Uno
6. Developing smart building using IoT
7. Developing a line follower robot
8. Developing obstacle avoiding robot
9. Developing obstacle following robot using Arduino programming logic
10. Developing mobile controlled robot using Arduino programming logic
11. Developing gesture controlled robot using Arduino programming logic

Course Outcomes:

1. The student will be able to weather monitoring using IoT programming logic. Students will be able to set up ThingSpeak App.
2. Students will learn the concepts and working of soil moisture sensor. They will be able to interface soil moisture sensor with Arduino and reading data from soil moisture sensor. students will also develop smart water monitoring using IoT.
3. Students will learn DTMF Decoder and its working and also detect DTMF tones using mobile app programming logic for DTMF decoder
4. The student will be able to learn the placement and connection of IR sensors in Obstacle Detection Robots using Arduino and develop an obstacle avoider robot using Arduino programming logic
5. Students will learn accelerometers and their working. They will also learn to interface accelerometer with Arduino programming logic for gesture robot

Text Book:

1. Lab manual provided by the department

References:

1. Richard Grimmett, "Arduino Robotic Projects", PACKT Publishing Ltd.
2. Adeel Javed "Building Arduino Projects for the Internet of Things", Apress 2016

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech IV Year I Semester

B. Tech. IV Year I Semester

18ME115 ENGINEERING METROLOGY AND MEASUREMENTS

L	T	P	C
3	0	0	3

Course Prerequisite: Knowledge on dimensions, linear measurements etc.

Course Description: The course provides a comprehensive understanding on measurements of products, dimensioning with tolerances, various instruments used to measure angles, flatness, design of gauges for GO and NO GO measurements, checking the various profiles using shadowgraph, measurement of surface roughness using Talysurf roughness equipment, checking the dimension on gears, instruments used in aligning the machine tools.

Course Objectives:
The students will be able to:

1. Design part by providing tolerances and fits.
2. Study engineering parts inspection with various precision instruments.
3. Principles of measuring instruments and gauges and their uses.
4. Evaluation and inspection of surface roughness.
5. Inspection of spur gear and thread elements and machine tool testing to evaluate machine tool.

UNIT I: MEASUREMENTS
Systems of limits and fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types - unilateral and bilateral tolerance system, hole and shaft basis systems - interchangeability and selective assembly. Indian standard Institution system - British standard system, International Standard system for plain ad screwed work. **(9)**

UNIT II: INSTRUMENTS
Linear Measurement: Length standard, line and end standard, slip gauges - calibration of the slip gauges, Dial indicator, micrometers. Measurement of Angles and Tapers: Different methods - Bevel protractor - angle slip gauges - spirit levels - sine bar - Sine plate, rollers and spheres used to determine the tapers. Limit Gauges: Taylor's principle - Design of go and No go gauges, plug ring, snap, gap, taper, profile and position gauges. **(9)**

UNIT III: PROFILE MEASUREMENTS
Optical Measuring Instruments: Tool maker's microscope and its uses - collimators, optical projector - optical flats and their uses, interferometer. Flat Surface Measurement: Measurement of flat surfaces - instruments used - straight edges - surface plates. **(9)**

UNIT IV: SURFACE MEASUREMENTS
Surface Roughness Measurement: Differences between surface roughness and surface Waviness-Numerical assessment of surface finish - CLA, R.M.S Values - Rz values, Rz value, Methods of measurement of surface finish-profilograph, Talysurf, ISI symbols for indication of

surface finish. Measurement Through Comparators: Comparators Electrical and Electronic Comparators, pneumatic comparators and their uses in mass production. **(9)**

UNIT V: COMPONENTS MEASRUREMENTS

Screw Thread Measurement: Element of measurement - measurement of effective diameter, angle of thread and thread pitch, profile thread gauges. Gear Measurement: Gear measuring instruments, Gear tooth profile measurement. Measurement of diameter, pitch pressure angle and tooth thickness. Machine Tool Alignment Tests: Requirements of Machine Tool Alignment Tests, Alignment tests on lathe, milling, drilling machine tools. **(9)**

Course Outcomes:

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

1. Apply the knowledge for part design by providing fits and tolerance.
2. Choose instruments to inspect engineering parts by various gauges like plug, ring gauge etc.
3. Apply the instruments to measure flatness of components by contact and non-contact optical measuring instruments.
4. Choose appropriate instruments to measure surface roughness and measure using comparators.
5. Apply the knowledge to measure the profile gear, thread, angle.

Text Books:

1. Jain R. K., "Engineering Metrology", Khanna Publications, 2010.
2. Engineering Metrology by Mahajan I Dhanpat Rai Publishers

References:

1. Gupta. LC., "Engineering Metrology", Dhanpat Rai and Sons, 2000.
2. Beckwith T.G, and N. Lewis Buck, Mechanical Measurements, Addison Wesley, 1991,5th edition, ISBN:81- 7808-055-9.
3. Precision Engineering in Manufacturing by R.L.Murthy I New Age.
4. Engineering Metrology and Measurements by NV Raghavendra, L Krishnamurthy, Oxford publishers.
5. Engineering Metrology by KL Narayana, SciTech publishers.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

B. Tech. IV Year I Semester

18ME116 MACHINE LEARNING IN MECHANICAL ENGINEERING

L	T	P	C
2	0	2	3

Course Prerequisite: 14ME104

Course Description: Machine Learning is the study of how to build computer systems that learn from experience. This course on Machine Learning will explain how to build systems that learn and adapt using real-world applications. The objective of this course is to provide the students of mechanical engineering with the fundamental concepts in machine learning and popular machine learning algorithms. In this course, the standard and most popular supervised and un-supervised learning algorithms including linear regression, logistic regression, k-nearest neighbor, support vector machines are introduced. It is intended that the course is taught in a computer laboratory providing a hand-on approach of learning the course. It is anticipated that the example data sets that would be used to teach the concepts of machine learning would be of engineering applications. The course will be taught using Python.

Course Objectives:

1. Students who successfully complete this course will have acquired a sufficient understanding of the basic concepts and methods of machine learning to make use of some elementary machine learning techniques in the design of mechanical systems.
2. Develop an understanding of basic machine learning algorithms, their efficient implementations, and their applicability to different tasks
3. To make the students implement regression, KNN and support vector methods for classification and prediction.
4. Identify machine learning techniques suitable for a given problem

UNIT I: MANAGING AND UNDERSTANDING DATA

Introduction to machine learning, Supervised and Unsupervised Learning, Using the Scikit• learn Dataset, Using the Kaggle Dataset, Linearly Distributed Dataset, Clustered Dataset, Exploring the structure of data, Measuring the central tendency using mean, median and mode, Measuring the spread of the data using range, variance, standard deviation and quartiles, Visualizing numeric variables using box-plots and histograms, Understanding numeric data using uniform and normal distribution, Visualizing relationships using scatter plots, Examining relationships using two-way cross tabulations, Cleaning Rows with NaNs, Replacing NaN with the Mean of the Column, Removing Rows, Removing Duplicate Rows, Normalizing Columns, Removing Outliers, Tukey Fences, Z-Score **(9)**

UNIT II: LINEAR AND LOGISTIC REGRESSION

Types of Linear Regression, Using the Linear Regression Class for Fitting the Model, Making Predictions, Plotting the Linear Regression Line, Getting the Gradient and Intercept of the Linear Regression Line, Examining the Performance of the Model by Calculating the Residual Sum of Squares, Evaluating the Model Using a Test Dataset, Data Cleansing, Feature Selection, Multiple Linear Regression, Training the Model, Getting the Intercept and Coefficients, Plotting the 30 Hyperplane, Polynomial Regression, Formula for Polynomial Regression, Polynomial Regression in Scikit-leam, Understanding Bias and Variance, Plotting the 30 Hyperplane Understanding Odds, Logit Function, Sigmoid Curve, Examining the Relationship Between Features, Plotting the Features in 20, Plotting in 30, Training Using One Feature, Finding the Intercept and Coefficient, Plotting the Sigmoid Curve, Making Predictions, Training the Model Using All Features, Testing the Model, Getting the Confusion Matrix, Computing Accuracy, Recall, Precision, and Other Metrics, Receiver Operating Characteristic (ROC) Curve, Plotting the ROC and Finding the Area Under the Curve (AUC) **(9)**

UNIT III: CLASSIFICATION USING K-NEAREST NEIGHBORS (KNN)

Supervised Leaming: Introduction to K-Nearest Neighbors, Implementing KNN in Python, Plotting the Points, Calculating the Distance between the Points, Implementing KNN, Making Predictions, Visualizing Different Values of K, Using Scikit-Leam's K-Neighbors Classifier Class for KNN, Exploring Different Values of K, Cross-Validation, Parameter-Tuning K, Finding the Optimal K,

Unsupervised Leaming: Introduction to Unsupervised Leaming, Unsupervised Leaming Using K-Means, Implementing K-Means in Python, Evaluating Cluster Size Using the Silhouette Coefficient, Importing the Data, Cleaning the Data, Plotting the Scatter Plot, Clustering Using K-Means, Finding the Optimal Size Classes **(9)**

UNIT IV: SUPPORT VECTOR MACHINES

Introduction to Support Vector Machine, Maximum Separability, Support Vectors, Formula for the Hyperplane, Using Scikit-leam for SVM, Plotting the Hyperplane and the Margins, Making Predictions, Kernel Trick, adding a Third Dimension, Plotting the 30 Hyperplane, Types of Kernels, C, Radial Basis Function (RBF) Kernel, Gamma, Polynomial Kernel **(9)**

UNIT V: DEPLOYING MACHINE LEARNING MODELS

Deploying ML, Case Study, Loading the Data, Cleaning the Data, Examining the Correlation between the Features, Plotting the Correlation Between Features, Evaluating the Algorithms, Logistic Regression, K-Nearest Neighbors, Support Vector Machines, Selecting the Best Performing Algorithm, Training and Saving the Model, Deploying the Model, Testing the Model, **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. Import various available datasets and determine the statistical parameters of the data.
2. The students will also be able to clean and normalize the data and present the data using various visual techniques.
3. Apply linear regression to quantify the relationship between one or more predictor variable(s) and one outcome variable. The students will also be able to apply Logistic regression to predict the class of data based on one or multiple predictor variables

4. Apply the KNN techniques for classification and classify new cases based on a similarity measure.
5. Apply support vector machine algorithm for classification and regression problems
6. Understand different Machine Leaming problems deeply enough to select the best performing algorithm and also train and deploy the model

Textbooks:

1. Sebastian Raschka, "Python Machine Leaming", Packt Publishing Ltd, 2015

References:

1. Prateek Joshi, "Python Machine Leaming Cookbook", Packt Publishing Ltd, 2016
2. Yuxi (Hayden) Liu, "Python Machine Leaming By Example", Packt Publishing Ltd, 2017

Mode of Evaluation: Assignment, Mid Examination, End Examination

B. Tech. IV Year I Semester

18ME211 THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

Course Prerequisite: 18ME103 & 18ME112

Course Objectives:

1. To enable the students to do experimentation on heat transfer equipment and gain practical knowledge about heat transfer in thermal systems
2. To develop trouble shooting abilities of students for practical heat transfer systems.
3. To teach students how to measure heat transfer through various systems.

LIST OF EXPERIMENTS (Any Five of the two following Groups)

A) IC ENGINES:

1. Valve *I* Port Timing Diagrams of an LC. Engines
2. Performance Test on a 4 -Stroke Diesel Engines
3. Performance Test on 2-Stroke Petrol engine
4. Evaluation of Engine friction by conducting Morse test on 4-Stroke Multi cylinder Engine
5. Retardation and motoring test on 4- stroke engine
6. Heat Balance of an LC. Engine.
7. Air/Fuel Ratio and Volumetric Efficiency of an LC. Engines.
8. Performance Test on Variable Compression Ratio Engines, economical speed test.
9. Performance Test on Reciprocating Air- Compressor Unit
10. Study of Boilers
11. Dismantling *I* Assembly of Engines to identify the parts and their position in an engine.

B) HEAT TRANSFER:

1. Thermal conductivity of metal bar (brass)
2. Thermal conductivity of insulating powder
3. Overall heat transfer coefficient of composite slab apparatus
4. Thermal conductivity of insulating material through lagged pipe apparatus
5. Heat transfer coefficient in transient heat conduction
6. Heat transfer coefficient in natural convection
7. Heat transfer coefficient in forced convection
8. Efficiency and effectiveness of a pin-fin
9. Stefan Boltzmann constant for radiation heat transfer
10. Emissivity of gray body
11. Experiment on critical heat flux apparatus
12. Study of two- phase flow
13. Heat transfer in drop and film wise condensation
14. Performance test on parallel and counter flow heat exchanger

Course Outcomes:

IC ENGINES:

1. The students after completing the course will be able to:
2. Draw Valve/Port timing diagrams and estimate the various performance parameters for two stroke and four stroke IC engines.
3. Estimate the energy losses due to heat lost to various engine components.
4. Conduct performance test on Air compressors
5. Describe various types of boilers used in steam power plants
6. Describe the basic systems of IC engines such as fuel supply system, ignition system, cooling system etc.

HEAT TRANSFER:

The students after completing the course will be able to:

1. Estimate the thermal conductivity of solids and over all heat transfer coefficient of composite systems.
2. Estimate the convective heat transfer coefficient co-efficient for various internal and external flow situations
3. Estimate the emission characteristics of a surface for radiation heat transfer.
4. Demonstrate the mechanisms of boiling and condensation heat transfer.
5. Test practical heat transfer systems like heat exchanger, condenser, evaporator etc.

Text Books:

Lab manual provided by the department

Mode of Evaluation: Practical

Dept. of Mechanical Engineering

B. Tech. IV Year I Semester

18ME212 CAE LABORATORY

L	T	P	C
0	0	2	1

Laboratory Prerequisite: Finite Element Methods.

Course Description: The course work can show the prime importance of finite element software like FEAST^{SMT}/Ansys/ABAQUS, which enables to confidently predict the materials behavior under different types of mechanical loads and ambient conditions.

Course Objectives:

1. Understand and Analyze Basic Structural Analysis Problems.
2. Understand and Analyze Basic Thermal Analysis Problems.
3. Understand and Analyze Basic Vibration Analysis Problems.
4. Understand and Analyze Basic Buckling Analysis Problems.
5. Understand and Analyze Basic Contact Analysis Problems.

LIST OF EXPERIMENTS

1. **Structural analysis:**
   - (a) Static Analysis of a Cantilever Beam.
   - (b) Static Analysis of a Simply Supported Beam with Point Load.
   - (c) Static Analysis of a Simply Supported Beam with Uniformly Distributed Load.
   - (d) Static Analysis of a Fixed Beam Subjected to Axial Load.
   - (e) Static Analysis of a Planar Truss.
2. **Thermal Analysis:**
   - a) Conduction Analysis of Rectangular Plate with Specified Temperature.
   - b) Heat Transfer Analysis of Axi-Symmetric Plate with Convective and Radioactive BC.
3. **Vibration Analysis:**
   - a) Free Vibration Analysis of a Composite Rectangular Cantilever Plate.
4. **Buckling Analysis:**
   - a) Buckling Analysis of Cylindrical Shell.
5. **Contact Analysis:**
   - b) Non-linear Static Analysis with Contact.

Course Outcomes:

By the end of the laboratory, students can be able to do

1. Basic Structural Analysis Problems.
2. Basic Thermal Analysis Problems
3. Basic Vibration Analysis Problems
4. Basic Buckling Analysis Problems
5. Basic Contact Analysis Problems

Textbooks

1. Laboratory manual will be provided by the department of mechanical engineering.

Mode of Evaluation: Practical

Open Elective - II

Dept. of Mechanical Engineering

Open Elective - II

18MAT301 ADVANCED NUMERICAL METHODS

L	T	P	C
3	0	0	3

Course Description

This course reviews and continues the study of computational techniques for evaluating interpolations, derivatives and integrals; solving system of algebraic equations, transcendental equations, ordinary differential equations and partial differential equations. The course emphasizes on numerical and mathematical methods of solutions with appropriate error analysis. The students use MATLAB as the computer language to obtain solutions to a few assigned problems.

Course Objectives

1. To introduce computation methods of solving algebraic and transcendental equations.
2. To avail the basics of numerical techniques for solving the system of linear equations.
3. To familiarize the knowledge of interpolation and numerical calculus.
4. To use numerical calculus for solving ordinary differential equations.
5. To introduce the computational techniques for solving partial differential equations.

UNIT-I: Solutions of algebraic and Transcendental Equations

Introduction to MATLAB, errors, sources of errors, floating point arithmetic, significant digits, relative error, propagation of errors, how to avoid loss of significant digits, evaluation of polynomial.
Bisection method, False-position method, Secant method, Fixed-point iteration method, Newton's method – single and multiple roots, Order of convergence of the methods.
Exercises of Bisection method and Newton's method through MATLAB

(9)

UNIT-II: Solutions of system of Algebraic Equations

Gaussian Elimination, LU decomposition, Thomas algorithm for the tridiagonal systems, Norms-Euclidean, mini-maxi, Frobenius and 1-,2- and ∞-norms, Condition numbers and errors in computed solutions. Jacobi's method, Gauss-Seidel method, Power method for obtaining eigenvalues and eigenvectors of matrices.
Exercises of Gaussian Elimination and Gauss-Seidel method through MATLAB

(9)

UNIT-III: Interpolation & Numerical Calculus

Existence and Uniqueness of interpolating polynomial, Lagrange polynomials, Divided differences, Evenly spaced points, Error of interpolation, cubic spline, Inverse interpolation, Derivatives from difference table, Higher order derivatives, Trapezoidal rule, Simpsons rule, a composite formula, Gaussian Quadrature.
Exercises of Divided differences and Simpson's rule through MATLAB

(9)

UNIT-IV: Numerical Solutions to Ordinary Differential Equations

Taylor series method, Euler and Modified Euler's method, Runge-Kutta methods for initial value problems, Shooting method, Finite difference method for boundary value problems.
Exercises of Runge-kutta method and Shooting method through MATLAB

(9)

UNIT-V: Numerical Solution to Partial Differential Equations
Finite difference methods for one-dimensional Wave and Heat equations; Laplace and Poisson equations (five-point formula).
Exercises of Finite difference method (forward, central and backward differentiation) and Crank-Nicolson method through MATLAB

(9)

Course Outcomes
At the end of this course, students should be able to
1. Solve the system of algebraic and transcendental equations.
2. Apply the numerical techniques to find the solution to system of equations.
3. Calculate and analyze the rate of variations and numerical sum of such changes using numerical calculus relevant to the field of Engineering.
4. Find the accurate numerical solutions to ordinary differential equations representing some Engineering problems.
5. Compute the solutions for engineering problems represented by partial differential equations.

Text Books

1. Curtis F. Gerald, Patrich O. Wheatley, Applied Numerical Analysis, Pearson Education, 7th Edition, 2003.
2. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.

Reference Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
2. Burden and Faires, Numerical Analysis 7th ed., Thomson Learning, 2001.
3. Advanced Engineering Mathematics by E. Kreyszig, 10th ed., Wiley, 2010.
4. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven C. Chapra, 3rd ed., Mc Graw Hill, 2012.
5. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering, New Age International Ltd., 5th Edition, 2010.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Dept. of Mechanical Engineering

Open Elective - II

18MAT302 ENGINEERING OPTIMIZATION

L	T	P	C
3	0	0	3

Course prerequisite:18MAT101,18MAT106, 18MAT104, 18MAT108, 18MAT109.

Course description: Unconstrained and constrained optimization, Linear programming problem, transportation and assignment problems, dynamic programming problem, project management and queuing models.

Course objectives:

1. Understand the optimization techniques for solving engineering problems.
2. Formulate and solve linear programming problem.
3. Obtain the optimal solution for transportation and assignment problems.
4. Avail knowledge to solvedynamic programming problem using recursive relations.
5. Analyze the techniques of project management and queuing models.

Unit 1: Classical optimization. (9)

Introduction to optimization, unconstrained optimization with single variable and multi variable. Constrained multivariable optimization with equality constraints- Lagrange multipliers method, constrained multivariable optimization with inequality constraints - Kuhn-Tucker conditions.

Unit 2: Linear programming problem. (9)

Linear Programming Problem (LPP), Mathematical formulation, graphical solution, simplex method. Artificial variable technique - Big M-method and two phase simplex method.Duality, dual Simplex method.

Unit 3: Transportation problem and assignment problem. (9)

Transportation problem: definition and algorithm, transshipment problem. Assignment problem, travelling salesman problem.

Unit 4: Dynamic programming. (9)

Introduction, developing optimal decision policy, Dynamic Programming Problem (DPP) under certainty, DPP approach for solving LPP.

Unit 5: Project management and Queuing models. (9)

Network analysis: Network representation, Critical Path Method (CPM) and Project Evolutionary and Review Technique (PERT). Introduction to queuing system, single server queuing models (M/M/1) :(∞/FCFS), (M/M/1): (N/FCFS).

Course outcomes:

At the end of the course the students should able to

1. Understood the importance of unconstrained and constrained optimization to solve engineering problems.
2. Get an idea about the linear programming techniques.
3. Solve transportation andassignment problems in engineering situations.
4. Applythe Bellman principle of optimality to solvedynamic programming problem.
5. Analyze the problems of network analysis for project management and Queuing systems engineering & industry.

Text Books:

1. J K Sharma, Operations Research: Theory and Practice, Macmillan Publishers India Ltd, 5th edition,2013.
2. B.S. Grewal, Higher Engineering Mathematics, 43rd edition (2014), Khanna publishers.

References:

1. Hamdy A Taha, Operations Research: An Introduction, Pearson Education, 9/E, 2011.
2. FS Hillier and GJ Lieberman, Introduction to Operations Research, TMH, 8/E, 2006.
3. JC Pant, Introduction to Optimization: Operations Research, Jain Brothers, New, 6/E, 2004.
4. A Ravindran, DT Philips and JJ Solberg, Operations Research: Principles and Practice, John Wiley& Sons, Singapore, 2ndedition.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

Dept. of Mechanical Engineering

Open Elective - II

18PHY301 OPTICAL PHYSICS AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

The course will cover Geometrical optics, Aberrations, Physical Optics, Diffraction and Optical fibers.

Course Objectives:

1. Knowledge of basic principles and concepts in optics and the techniques used to deal with them.
2. Explain the limitations associated with spherical and chromatic aberration
3. Describe optical systems such as microscopes and telescopes with reference to parameters such as angular magnification and depth of field
4. Provide students with a working knowledge of optical physics, including interference, diffraction and physical optics.
5. Introduce construction and concepts of basic fiber optic communication system and to make the students learn about its important applications for societal needs.

UNIT I: INTRODUCTION

Corpuscular and wave theory, Fermat's principle, Matrices for translation, refraction and reflection, Unit and nodal planes, Eigenvalues and Eigenvectors.

(9)

UNIT II: ABERRATIONS AND OPTICAL INSTRUMENTS

Types of aberrations, Chromatic and monochromatic aberrations. Different types of monochromatic aberrations. Simple and Compound microscopes, Astronomical and Terrestrial telescopes. Ramsden's and Huygens' eye pieces.

(9)

UNIT III: WAVE OPTICS & INTERFERENCE

Huygens's principle, Superposition of waves, Fourier transforms, representation of slits and apertures, Two beam interference by Division of wave front. Applications of Interference, Nonlinear interaction of light with matter (self-study).

(9)

UNIT IV: DIFFRACTION & POLARISATION

Fraunhoffer diffraction, Diffraction from single slit, double slit & multiple slits, Fresnel half-period zones, Zone plate, Applications of diffraction, Polarization, Malus' law, double refraction. Applications of polarization.

(9)

UNIT V: FIBER OPTICS

Construction and working principle of optical fibers, Numerical aperture and acceptance angle, Types of optical fibers. Attenuation and losses in optical fibers, Analog and Digital optical fiber communication system. Applications of optical fibers in communications, sensors and medicine.

(9)

Course Outcomes:

Upon completion of this course the students shall be able to:

1. Recollect the fundamental characteristics of light and their mathematical principles.
2. Learn the principles of superposition, Interference and Diffraction
3. Understand nonlinear optics and photonics phenomena.
4. Be exposed to the application of optical techniques in cutting edge research areas.
5. Describe the basic laser physics, working of lasers and principle of propagation of light in optical fibers.

Text Book:

1. Optics by Ghatak, 4th Edition, Tata McGraw Hill (2011).

Reference Books:

1. Optics by Lipson, Lipson & Lipson, 4th Edition, Cambridge Univ Press (2010).
2. Optics by Hecht, 4th Edition, Addison-Wesley (2002).

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Dept. of Mechanical Engineering

Open Elective - II

18PHY302 LASER PHYSICS AND ADVANCED LASER TECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: Basic knowledge of atomic structure at intermediate (10+2) level is sufficient

Course Description:

Laser usage is rampant in various technological applications. Several fields gaining attention in the usage of lasers. This course covers the introduction to the theory and mechanism of laser action, various types of lasers and their applications and future use.

Course Objectives:

1. Make the student to understand the detailed principles of various lasers.
2. Profound understanding of different variety of lasers will provide them to think of superior selection and usage of lasers in practical technological applications.
3. Students are aware of latest developments in certain areas of Laser technology which have important applications for societal needs.
4. Explain how material processing is accomplished with lasers. Estimate laser operation parameters for material processing.
5. Exposure about Lasers applications in engineering, communications, spectroscopy and material process etc.

UNIT I: INTRODUCTION TO LASER TECHNOLOGY

Laser characteristics, The Einstein Coefficients, Absorption and Emission Cross Sections, Spontaneous and Stimulated emission of radiation, Population inversion, Methods of Population Inversion, Laser Rate Equations, stable two minor optical resonators, Mode selection, Gain in the regenerative laser cavity.

(9)

UNIT II: GASES AND LIQUIDS LASING MEDIUM

Energy levels & Radiative properties of Atoms and molecules**;** *Atomic lasers*: He-Ne laser, Argon Ion laser**;** *Molecular Lasers*: Carbon dioxide laser, Liquid energy levels and their radiative properties, Organic Dye laser.

(9)

UNIT III: SOLID STATE LASERS

Energy Levels in solids-dielectric medium, Solid-state lasing materials, Narrow line width laser materials, broad band line width laser materials, solid state lasers: Nd:YAG, Nd:YLF; Ti:Sapphire (introduction only)

Energy Levels in solids-semiconductor medium, direct and indirect band gap semiconductors, Semiconductor diode laser, Quantum dot lasers (Introduction only);

(9)

UNIT IV: PULSED OPERATION OF LASERS

Nanosecond: Q-Switching, Techniques of Q-Switching: electro-optic, Acousto-Optic. Femtosecond: Relationship between pulse duration and Spectral Width, Passive mode-locking, Active mode locking, Kerr lens mode locking, Amplification of femtosecond pulses.

(9)

UNIT V: LASER APPLICATIONS

Laser processing of materials: laser cutting, laser drilling, welding; Lasers in metrology- Accurate measurement of length, light wave communications; Laser spectroscopy: Laser fluorescence and Raman scattering

(9)

Course Outcomes

Upon completion of this course the students shall be able to:

1. Understand the principle of phenomenon of laser and identify the operating principle involved in various type of lasers.
2. Estimate stability requirements in producing laser light by different types of sources
3. Differentiate or list the various types of lasers and their means of excitation.
4. Assess (Identify) which laser would best meet the need for a particular industrial or research task.
5. Student can knowledge of latest technological developments in laser technology. Femtosecond laser etc.

Text books:

1. Laser Fundamentals: William T Silfvast. Cambridge Publication.
2. Laser Theory and Applications: A.K. Ghatak and K. Thyagarajan, Springer

Reference books:

1. Solid State Laser Engineering: Walter Koechner. Springer series in optical sciences.
2. Ultrafast Optics, Andrew M. Weiner
3. Laser spectroscopy: Demtroder
4. Laser Applications: Monte Ross
5. Femtosecond Laser Pulses Principles and Experiments: Claude Rulli`ere, Springer
6. Principles of Laser: O. Svelto
7. Laser Physics: Peter W Miloni, Joseph H Eberly.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18CHE301 INTRODUCTION TO PETROLEUM INDUSTRY

L	T	P	C
3	0	0	3

Course Pre-requisite: Basic Chemistry at Intermediate or equivalent level.

Course Description:
It deals with basic principles of petroleum engineering and the processes involved in petroleum industry.

Course Objective:
1. To get exposure to the basic concepts of petroleum refining.
2. To understand the basic properties of various fuels, additives and their importance.
3. To introduce the basic concepts of refining processes and technologies.
4. To familiarize the basic concepts of catalysis and various catalysts used in the refinery.
5. To understand the safety and environmental issues in petroleum industry

UNIT I: BASIC PROCESSES IN PETROLEUM REFINING AND FUEL TESTING
Source of Crude oils and types, Overview of refinery process, Atmospheric Distillation, Vacuum distillation, Desalter, Desulphurization, Cracking, catalysis, Effluent treatment plant(ETP). Properties and quality control of fuel: Density, Viscosity, Pour Point, Flashpoint, Fire Point, Octane Number, Cetane Number, Ductility, Water Content, Sulphur Analysis, Micro Carbon Residue Test(MCRT), Saturate, Aromatic, Resin and Asphaltene(SARA), High Frequency Reciprocating Rig(HFRR), Calorific Value.

(9)

UNIT II: CHEMICAL ADDITVES IN PETROLEUM INDUSTRY
Types of products in the refinery and their structural properties, Neutralizing amines, Corrosion inhibitors, Multifunctional additives, viscosity modifiers, drag reducing agents, antioxidants, Lubrication modifiers, Antifoam agents, Oil spill absorbers, Dispersants, Chemicals used for ETP plant.

(9)

UNIT III: ROLE OF HYDROPROCESSING AND FLUID CATALYTIC CRACKING IN PETROLEUM INDUSTRY
Hydrocracking reactions, Hydrocracking feedstock's, Modes of Hydrocracking, Effects of process variables, Hydro treating process and catalysts, Resid hydro processing, FCC Cracking, Catalyst coking and regeneration, Design for Fluidized-Bed Catalytic Cracking Units

(9)

UNIT IV: ROLE OF CATALYSTS AND BIOPROCESSES IN PETROLEUM INDUSTRY
Types of catalyst and their importance, Design and selection of catalyst. Catalytic processes. Bioprocesses: Introduction, Refining of petroleum using biodesulphurisation, Bioremediation, commercial processes for bioethanol, isopropanol.

(9)

UNIT V: SAFETY AND MANAGEMENT IN PETROLEUM INDUSTRY

Safety policy, Personal protective equipment, Different type of extinguishers, Types of gloves and their application, Hydrants and their role, Safety indicators, Safety contact, Environmental pollution, precaution and first aid, safety measures, Different elements and their role in Occupational safety and Management.

(9)

Course Outcomes:

At the end of the course, the students will

1. Be able to understand the overview of petroleum industry
2. Be able to understand the concepts of crude oil, types of crude oils, properties of fuels such as octane number, cetane number, viscosity, density etc. Instruments.
3. Be familiarized with importance and their use of chemicals involved in the petroleum industry.
4. Be familiarized with the processes involved in hydroprocessing and fluid catalytic cracking.
5. Be familiarized the types of catalysts and bioprocesses in the petroleum industry.
6. Understanding the PPE, different types of extinguishers, First aid, process safety and management in the petroleum industry.

TEXT BOOKS

1. Mohamed A. Fahim, Taher A. Al-Sahhaf and Amal Elkilani, Fundamentals of Petroleum Refining, Elsevier,2009
2. David T Day, Handbook of the Petroleum Industry, Volume 1, ISBN: 137595962X, Chizine Publ., 2017

REFERENCE BOOKS:

1. Sankara Papavinasam, Corrosion Control in the Oil and Gas Industry, Elsevier, 2013
2. Petroleum Engineering Handbook (Vol. 1 - VIII). Editor in Chief: Larry W. Lake, Society of Petroleum Engineers.
3. Srinivasan Chandrasekaran. Health, Safety and Environmental Management for offshore and Petroleum Engineers, John Wiley and Sons, U.K., ISBN: 978-11-192-2184-5, 2016.
4. S. P. Srivastava and Jenő Hancsók, Fuels and fuel additives, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.
5. Robert O. Anderson, Fundamentals of the Petroleum Industry–University of Oklahoma Pres, 1987.
6. James G. Speight, Handbook of Petroleum Product Analysis, John Wiley & Sons, Inc, 2015
7. Physical Chemistry by G.W. Castellan (Addison Wesley Publishing Company), 2004

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18CHE302 GREEN CHEMISTRY AND CATALYSIS FOR SUSTAINABLE ENVIRONMENT

L	T	P	C
3	0	0	3

Course Prerequisite: Basic Engineering Chemistry or equivalent level

Course Description:
This course aims to introduce the interdisciplinary concept for engineering's to enhance their knowledge that they need to contribute with relevance and confidence in developing green technologies.
This course covers feedstocks, green metrics and the design of safer, more efficient processes, as well as the role catalysts, solvents and green processes for nanoscience.

Course Objectives:

1. Learn an interdisciplinary approach to the scientific and societal issues arising from industrial chemical production, including the facets of chemistry and environmental health sciences that can be integrated to promote green chemistry
2. Sensitize the students in redesigning of chemicals, industrial processes and products by means of catalysis.
3. Understand the use of alternatives assessments in using environmentally benign solvents.
4. Emphasize current emerging greener technologies and the need of alternative energies.
5. Learn to adopt green chemistry principles in practicing nanoscience.

UNIT I: PRINCIPLES AND CONCEPTS OF GREEN CHEMISTRY

Introduction, Green chemistry principles, sustainable development and green chemistry, atom economy, atom economic: Rearrangement and addition reactions and un-economic reactions: Substitution, Elimination and Wittig reactions, Reducing Toxicity. Waste - problems and Prevention: Design for degradation.

(9)

UNIT II: CATALYSIS AND GREEN CHEMISTRY

Introduction to catalysis, Heterogeneous catalysts: Basics of Heterogeneous Catalysis, Zeolites: Catalytic cracking, ZSM-5 catalyst and high silica zeolites, TS1 Oxidation catalyst, Catalytic Converters, Homogeneous catalysis: Hydrogenation of alkenes using Wilkinson's catalyst, Phase transfer catalysis: Hazard Reduction, C–C Bond Formation, Oxidation Using Hydrogen Peroxide. Recycling of catalyst.

(9)

UNIT III: ORGANIC SOLVENTS: ENVIRONMENTALLY BENIGN SOLUTIONS

Organic solvents and volatile organic compounds, solvent free systems, supercritical fluids: carbondioxide, water - water as a reaction solvent, water based coatings, Ionic liquids as solvent.

(9)

UNIT IV: EMERGING GREENER TECHNOLOGIES AND ALTERNATIVE ENERGY SOURCES

Biomass as renewable resource, Energy: Fossil Fuels, Energy from Biomass, Solar Power, Fuel Cells(Hydrogen—oxygen fuel cell, SOFC and PEMFC), Photochemical Reactions: Advantages and Challenges of Photochemical Processes, Example-Caprolactum, chemistry Using Microwaves: heating, assisted Reactions, Sonochemistry.

(9)

UNIT V: GREEN PROCESSES FOR NANOSCIENCE

Introduction and traditional methods in the nanomaterials synthesis, Translating green chemistry principles for practicing nanoscience. Green Synthesis of Nanophase Inorganic Materials and Metal Oxide Nanoparticles: Hydrothermal Synthesis, Reflux Synthesis, Microwave-Assisted Synthesis, Other methods for Green synthesis of metal and metal oxide nanoparticles, Green chemistry applications of Inorganic nanomaterials

(9)

Course Outcomes:

Upon completion of this course the students should

1. Recognize green chemistry concepts and apply these ideas to develop respect for the interconnectedness of our world and an ethic of environmental care and sustainability.
2. Understand and apply catalysis for developing eco friendly processes.
3. Be in a position to use environmental benign solvents where ever possible.
4. Have knowledge of current trends in alternative energy sources.
5. Apply green chemistry principles in practicing green Nanoscience.

Text Books :

1. M. Lancaster, Green Chemistry an introductory text, Royal Society of Chemistry, 2002.
2. Paul T. Anastas and John C. Warner, Green Chemistry Theory and Practice, 4th Edition, Oxford University Press, USA 2005.

Reference Books :

1. Edited by Alvise Perosa and Maurizio Selva , Hand Book of Green chemistry Volume 8: Nanoscience, wiley-VCH
2. V.K. Ahluwalia , M. Kidwai, New trends in Green chemistry, 2004, Springer.
3. Benny Joseph, Environmental Science and Engineering, TATA Mc Graw Hill, New Delhi 2006.
4. Albert Matlack, Introduction to Green Chemistry, Second Edition CRC press, 2010

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18HUM301 INTELLECTUAL PROPERTY RIGHTS

L	T	P	C
3	0	0	3

Course Description: Intellectual property (IP) is a legal term that refers to creations of the mind. Examples of intellectual property include music, literature, and other artistic works; discoveries and inventions; and words, phrases, symbols, and designs. Under intellectual property laws, owners of intellectual property are granted certain exclusive rights. Some common types of intellectual property rights (IPR) are copyright, patents, and industrial design rights; and the rights that protect trademarks, trade dress, and in some jurisdictions trade secrets. Intellectual property rights are themselves a form of property, called intangible property.

Course Objectives: The course is intended to:

1. Explain the importance of Intellectual Property Rights, its protection and management;
2. Explain the types/tools of IPR;
3. Make aware the students to understand the commercialization of IPR;
4. Know the filing of patent rights, acts, rules & portfolio analysis, management, patent strategy; and
5. Create awareness about Right to Information Act (RTI), its powers, functions, penalties and appeal.

UNIT I: INTRODUCTION:
Intellectual property and its protection, WTO, TRIPS Agreement& its Protection

(9)

UNIT II: INTRODUCTION TO COPYRIGHTS
Copyright Principles – Copyright Law - Copyright ownership - Right to prepare derivative works – Rights of Distribution - Copyright Formalities and Registrations - Copyright disputes - International Copyright Law – Patent Trademark – Geographical indications

(9)

UNIT III: COMMERCIALIZATION OF IP ASSETS:
Contracting, Licensing, Assignment and technology transfer; Drawing up a business strategy IP rights in export markets; Ownership of rights by employees; Valuation of intellectual property rights.

(9)

UNIT IV: PROCEDURE FOR FILING PATENT IN INDIA AND OTHER COUNTRIES,
PCT filing, Patent Search, Patent Acts & Rules, Patent Infringement, Patent Portfolio analysis and management, Patent Strategy.

(9)

UNIT V: RTI

Introduction – Objectives – Obligation of Public Authorities – The Central & State information commission – Powers & Functions – Penalties & Appeal.

(9)

Course Outcomes:

At the end of the course, students will be able to

1. Understand the importance of Intellectual Property Rights, its protection and management.
2. Analyze and apply the types/tools of IPR.
3. Identify the process of commercialization of IPR.
4. Understand the procedure of filing of patent, acts, rules and portfolio analysis, management, patent strategy.
5. Apply the Right to Information Act (RTI) in real life situation.

Text Book:

1. Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, 4th Edition (2013) By **Deborah E. Bouchoux, Cengage Learning**

References:

1. Latest Research Papers

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18HUM302 HUMAN RESOURCE DEVELOPMENT

L	T	P	C
3	0	0	3

Course Description: The course content includes: Introduction to HRM, strategic human resource challenges, work flows, job analysis, managing diversity, concepts, goals, mechanism and system of HRD, recruitment and selection, downsizing and outplacement, appraising and managing employee performance, training, career development, managing compensation, rewarding performance, designing benefit plans, employee relation and employee discipline, and workplace safety and health.

Course Objectives: The course is intended to:

1. Explain the nature and scope of HRM, its functions, policies and strategies;
2. Describe the human resource planning, work analysis and importance in designing jobs;
3. Know the recruitment, selection and the process of performance appraisal;
4. Make the student to learn about training and development; and
5. Explain the industrial relations, trade unions, Ethics and fair treatment at work.

UNIT I: INTRODUCTION

Understanding the nature and scope of Human Resource Management- Definition, Functions / objectives, organization of department.

(9)

UNIT II: HUMAN RESOURCE PLANNING

Human Resource Planning- Factors affecting HRP, the planning process, managerial succession planning. Job Analysis, Methods of collecting job data, Competency based Job Analysis, Job design approach, contemporary issues in Job Description.

(9)

UNIT III: RECRUITMENT, SELECTION AND PERFORMANCE APPRAISAL

Recruiting and selecting employees-, Selection process, Barriers, selection in India. Performance Management, Process of Performance Appraisal, Methods of Performance Appraisal - Errors in Performance Appraisal.

(9)

UNIT IV: TRAINING AND DEVELOPMENT

Training v/s development – Training Methods - challenges in training - Career development – Reward Management – Performance Appraisal – Compensation Management.

(9)

UNIT V: INDUSTRIAL RELATIONS, TRADE UNIONS

Industrial Relations, Trade unions, resolving dispute- Labor Movement - Trade Union in India, Collective Bargaining: Process and Methods, Grievance: Sources and process of Redressal, Managing Ethical issues in Human Resource Management- Ethics and fair treatment at work.

(9)

Course Outcomes:

At the end of the course, students will be able to:

1. Understand the concept of HRM, its nature, scope, functions, policies and strategies;
2. Analyse human resource planning and apply in designing jobs;
3. Evaluate the recruitment, selection and the process of performance appraisal;
4. Understand the importance of training and development activities; and
5. Examine the industrial relations, trade unions, employee safety and health measures.

Text Books:

1. Aswathappa K., Human Resource Management- Text and Cases, Tata McGraw Hill, 6th Edition, 2010
2. Gomez-Mejia, L.R., Balkin, D.B., &Cardy, R.L. Managing Human Resource Management 6th edition, Pearson Edu. 2007.

References:

1. Garry Dessler, BijuVarkkey , Human Resource Management ,11th Edition, Pearson Education, 2009.
2. R. Wayne Mondy, Human Resource Management, 10th Edition, 2010

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective II

18HUM304 NATIONAL CADET CORPS

L	T	P	C
3	0	0	3

Pre-requisite: NCC B-Certificate

Course Description:
The main aim of this course is to mould the youth into responsible citizens of the nation. It helps to improve character and leadership qualities towards nation building. This course also motivates the youth to offer Selfless service to the society and nation. The course comprises Common subjects, Service subjects of NCC, societal aspects and basic organization of Indian Armed Forces.

Course Objectives:
This course enables the student to –

1. Get aware of NCC organization and general structure of Defence Forces.
2. Learn leadership and national integration.
3. Motivate towards to maintain Health and hygiene, personality development.
4. Learn elementary characteristics of disaster management, Field craft and Battle craft.
5. Acknowledge the Social activities, Communication and Military History.

UNIT I **10 hours**

INTRODUCTION TO NCC
Introduction, History of NCC , NCC Motto, NCC Flag, Aims of NCC, Cardinal points of NCC, Organization of defence forces in general, Organizational structure of Indian Army(Armed forces), Organizational structure of NCC, NCC Song, Incentives of NCC, Ranks in Army, Navy and Air Force, current representatives – Certificate Examination in NCC– Honours and Awards.

FOOT DRILL BASICS
Aims of Drill, Word of Commands, Attention, Stand at Ease, Turning Left, Right and Inclining at the Halt. Sizing, Forming up in three Ranks and Numbering, Open and Close March Order, Dressing the Squad, Saluting at the Halt, Getting on Parade, Falling Out and Dismissing, Marching, Guard of Honour.

UNIT II **10 hours**

LEADERSHIP
Meaning, Leadership Traits, Types of Leadership, Discipline & Duty of an Indian Citizen, Motivation, Code of Ethics, Perception, Communication, Customs of Services, Importance of Team Work, leaders(swami Vivekananda).

NATIONAL INTEGRATION
Meaning and Importance, Unity in Diversity, Indian History and Culture, Religion and Customs of India, India and its Neighbours, Contribution of Youth in Nation Building, Contribution of leaders in nation unification .

UNIT III **12 hours**

HEALTH AND HYGIENE
Structure and Function of Human Body, Hygiene and Sanitation, Preventable Diseases, First Aid, Yoga: Introduction and Exercises, Physical and Mental Health, Fractures: Types and Treatment.

PERSONALITY DEVELOPMENT

Introduction to personality development, Physical and social factors influencing / shaping personality, psychological and philosophical factors influencing / shaping personality, Self-awareness, SWOT analysis, mind set, interpersonal relationship and communication, effective communication, barriers of communication.

ENVIRONMENT AND ECOLOGY

Environment: Meaning, Global Warming, Acid Rain, Depletion of Ozone Layer, Conservation of Environment. Ecology: Introduction, Component of Ecological System, Forest Ecology, Wild Life, Pollution Control.

UNIT IV **10 hours**

DEFENCE AND DISASTER MANAGEMENT

Civil Defence: Meaning, Organization and its Duties, Civil Defence Services, Fire Fighting : Meaning, Mode of Fire, Fire Fighting Parties, Fire Fighting Equipment. Introduction, Classification of Disaster: Natural Disaster & Man Made Disaster, Disaster Management During Flood, Cyclone and Earth Quake, Assistance in Removal of Debris, Collection and Distribution of Aid Material, Message Services.

SOCIAL SERVICE ACTIVITIES (Social Service And Community Development)

Basics of Social Service, Weaker Sections in the Society and its Identification, Contribution of Youth towards Social Welfare, NGOs and their Role and Contribution , Social Evils, Drug Abuse, Family Planning, Corruption, Counter Terrorism, Eradication of Illiteracy – Aids Awareness programme – Cancer Awareness Programme.

UNIT V **10 hours**

COMMUNICATION

Types of communication, characteristics of wireless technology, Walkie/talkie, Basic RT procedure, Latest trends and development(Multimedia, video conferencing, IT)

MILITARY HISTORY

Biography of Indian Historical Leaders: Chatrapati Shivaji, Maharana Pratap, Akbar Famous Battles / Wars of India: Indo – Pak War 1971(all wars), Kargil War.(Categorise: before/ After independence)
Biography of Successful Leaders: General Patton, General Mac. Arthur, Field Marshal Sam Maneksha.

Course Outcomes:

At the end of the course, students will be able to:

1. Analyse the NCC structure and different ranks in Indian Armed Forces along with foot drill.
2. Notify the leadership traits and the need of national integrity towards nation building.
3. Instill respect and responsibility towards personal health and hygiene, develop dynamic personality with adequate qualities.
4. Identify different disasters and judging measurements on the ground.
5. Recognise various communication devices, analyse the Military Organization.

Text Books:

1. HAND BOOK OF NCC – “SANJAY KUMAR MISHRA, MAJOR RC MISHRA”, published by Kanti prakashan-2020.
2. NCC HAND BOOK - “SHASHI RANJAN & ASHISH KUMAR”, published by Goodwin Publications-2021.

Reference Books:

1. NCC Hand book – “R.Gupta’s”, Ramesh Publishing House-2021.
2 NCC (ARMY WING)- “R.Guptas’s”,RPH Editorial Board-2021
3 Hand Book Of N.C.C. – “Ashok Pandey”, Kanti Publications-2017

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination

Dept. of Mechanical Engineering

Open Elective - II

18CE301 GROUND IMPROVEMENT TECHNIQUES

L	T	P	C
3	0	0	3

Course Prerequisites: None

Course Description

Identification of problematic soils; ground improvement techniques; densification in granular soils; densification in cohesive soils; soil stabilization; confinement; reinforced earth; geosynthetics; improvement of expansive soils.

Course Objectives

1. To introduce engineering properties of soft, weak and compressible deposits, principles of treatment for granular and cohesive soils and various stabilization techniques.
2. To bring out concepts of reinforced earth.
3. Applications of geotextiles in various civil engineering projects.

UNIT I: DEWATERING & GROUTINHG

Introduction- Need for engineered ground improvement, classification of ground modification techniques; suitability, feasibility and desirability of ground improvement technique.

Methods of de-watering- sumps and interceptor ditches- wells- drains- Electro- osmosis. Objectives of grouting- grouts and their properties-grouting methods.

(9)

UNIT II: DENSIFICATION

In - situ densification methods in cohesionless Soils: - Vibration at the ground surface, Impact at the Ground Surface, Vibration at depth, Impact at depth. In - situ densification methods in cohesive soils: - preloading or dewatering, Vertical drains - Sand Drains- Sand wick geo-drains - Stone and lime columns - thermal methods.

(9)

UNIT III: STABILIZATION

Methods of stabilization-mechanical-cement- lime-bituminous-chemical stabilization with calcium chloride- sodium silicate and gypsum.

(9)

UNIT IV: REINFORCED EARTH & GEOSYNTHETICS

Principles - Components of reinforced earth - factors governing design of reinforced earth walls design principles of reinforced earth walls. Geotextiles- Types, Functions and applications - geo- grids and geo-membranes - functions and applications.

(9)

UNIT V: EXPANSIVE SOILS

Problems of expansive soils - tests for identification - methods of determination of swell pressure. Improvement of expansive soils - Foundation techniques in expansive soils - under reamedpiles.

(9)

Course Outcomes

After successful completion of the course, student will be able to

1. Identify basic deficiencies of various soil deposits and able to decide various dewatering methods to improve the soil.
2. Implement different techniques of soil densification.
3. Use admixtures in stabilizing the soil.
4. Use geo-synthetics materials in engineering applications.
5. Suggest different types of foundation techniques and methods to control swelling of soil

Text Books

1. Dr. Purushotham Raj, P., Ground Improvement Techniques, Laxmi Publications, New Delhi.
2. Dr. Sivakumar Babu, GL, An Introduction to Soil Reinforcement & Geosynthetics, Universities Press

Reference Books

1. Hausmann M.R., Engineering Principles of Ground Modification, McGraw-Hill International Edition, 1990.
2. Moseley M.P., Ground Improvement, Blackie Academic and Professional, Boca Taton, Florida, USA, 1993.
3. Xanthakos P.P., Abramson, L.W and Brucwe, D.A., Ground Control and Improvement, John Wiley and Sons, New York, USA, 1994.
4. Robert M. Koerner, Designing with Geosynthetics, Prentice Hall New Jercy, USA.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Dept. of Mechanical Engineering

Open Elective - II

18CE302 ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

Course Prerequisites: None

Course Description

The course will focus on Basic concept of Environmental Impact Assessment (EIA), EIA Methodologies, Impactof Developmental Activities and Land use in soil, water, and vegetation, Environmental Audit, Post Audit activities, The Environmental pollution Acts.

Course Objectives

1. To impart knowledge on Environmental management and Environmental Impact Assessment.
2. To give the student the brief knowledge about various legislations and audit protocols.
3. To give student knowledge about the framing of environmental audit through case studies.

UNIT I: CONCEPTS AND METHODOLOGIES IN EIA

Introduction - Elements of EIA - Factor affecting EIA -Impact evaluation and analysis - Preparation of Environmental Base map - Classification of environmental parameters. Criteria for the selection of EIA Methodology - EIA methods: Ad-hoc methods - matrix methods - Network method - Environmental Media Quality Index Method -overlay methods - cost/benefit Analysis.

(9)

UNIT II: IMPACT OF DEVELOPMENTAL ACTIVITIES

Introduction and Methodology for the assessment of soil and ground water - Delineation of study area - Identification of actives. Procurement of relevant soil quality - Impact prediction - Assessment of Impact significance -Identification and Incorporation of mitigation measures. EIA in surface water - Air and Biological environment.

(9)

UNIT III: IMPACT ON VEGETATION AND WILD LIFE

Assessment of Impact of development Activities on Vegetation and wildlife - environmental Impact of Deforestation - Causes and effects of deforestation.

(9)

UNIT IV: ENVIRONMENTAL AUDIT

Environmental Audit & Environmental legislation objectives of Environmental Audit - Types of environmental Audit - Audit protocol - stages of Environmental Audit - onsite activities - evaluation of audit data and preparation of audit report - Post Audit activities.

(9)

UNIT V: ENVIRONMENTAL POLLUTION ACTS

The water Act-1974 - The Air Act-1981 (Prevention & Control of pollution Act.) - Wild life Act- 1972 - Indian Forest Conservation Act-1980 -National Green Tribunal Act –2010 - Biological Diversity Act-2002.

(9)

Course Outcomes

The students after completing the course will be able to:

1. Utilize the various methods used in predicting environmental impacts.
2. Utilize site information to interpret impacts on land and groundwater.
3. Outline the environmental impacts of various development activities on existing ecosystem.
4. Utilize the procedures and various protocols involved in preparation of environmental audit report.
5. Utilize the implications of environmental prevention and protection acts in relation to environmental impact assessment.

Text Books

1. Anjaneyulu, Y., Environmental Impact Assessment Methodologies, B.S. Publication, Sultan Bazar, Kakinada.

Reference Books

1. Glynn, J. and Gary W. Hein Ke., Environmental Science and Engineering, Prentice Hall Publishers
2. Suresh K. Dhaneja Environmental Science and Engineering, S.K., Katania& Sons Publication, New Delhi.
3. Dr. Bhatia, H.S., Environmental Pollution and Control, Galgotia Publication (P) Ltd, Delhi.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18CE303 WATERSHED MANAGEMENT

Course Prerequisites: None

L	T	P	C
3	0	0	3

Course Description

Topic covers basic concepts of watershed, sustainable watershed management approached and practices, integrated watershed management and modelling, social aspect inwatershed management, quantification of water quality and quantity at the catchment outlet using modern techniques, drought, flood and storm management at catchment scale.

Course Objectives

1. To discuss various aspects of water resources development and management on watershed basis.
2. To proliferate the sustainable use and development of natural resources.
3. To enrich the students for change in the hydrological fluxes due altered physiographic condition (land use or elevation) on a watershed scale.
4. To improve the quantitative problem solving skills of the students for natural resources management.

UNIT I

CONCEPT OF WATERSHED: Concept of watershed - classification of watershed - introduction to watershed management - objective of watershed development - Hydrological cycle - water balance equation - different stakeholders and their relative importance - watershed management policies and decision making. **(9)**

FACTOR AFFECTING WATERSHED DEVELOPMENT: Morphological characteristics: linear - Arial and Relief aspect - land use - vegetation - soil and geological characteristics - Hydrology and geology and socio-economic characteristics. **(9)**

UNIT II

WATERSHED MODELING: Watershed delineation - modelling of rainfall - runoff process - Concept of integrated watershed management conjunctive use of water resources - Integrated water resources management. PRA - Private sector participation - Institutional issues - Socio-economy issues - Integrated development - Water legislation and implementations - Tools and emerging technologies for watershed management and planning. **(9)**

UNIT III

EROSION AND SEDIMENTATION: Types of erosion - factor affecting erosion - effect of erosion on land fertility and capacity - estimation of soil loss due to erosion: universal soil loss equation.

PREVENTION AND CONTROL TO EROSION: contour techniques - ploughing - furrowing- trenching - bunding - terracing - gully control - rockfill dams - check dams - brushwood dam - Gabion structure. **(9)**

UNIT IV

WATER HARVESTING: Rain water harvesting - catchment harvesting - harvesting structures - soil moisture conservation - check dams - artificial recharge from pond - percolation tanks.

FLOOD AND DROUGHT MANAGEMENT: Definition of flood - Flood frequency analysis: Weibul - Gumbel - and log Pearson methods.Definition and classification of drought - drought analysis techniques - drought mitigation planning.

MANAGEMENT OF WATER QUALITY: Water quality and pollution - types and Sources of pollution - water quality modeling - environmental guidelines for water quality.

(9)

UNIT V

COVER MANAGEMENT: Land use land cover change estimation through satellite imageries

- land capability classification - management of forest - agricultural - grassland and wild land - Reclamation of saline and alkaline soil. Classification of columns based on slenderness ratio - reinforcement & loading - Design of rectangular and circular columns subjected to axial load - (axial load + uni-axial bending) and (axial load + bi-axial bending). Different Types of Footings - Design of isolated - square - rectangular and circular footings.

INTEGRATED CROPPING SYSTEM FOR WATERSHEDS: Intercropping - mix cropping strip and terrace cropping - sustainable agriculture - cover cropping (biomass conservation) - horticulture - dryland agriculture and afforestation.

(9)

Course Outcomes

The students after completing the course will be able to:

1. Classify watershed and Identify factors to consider for watershed Development.
2. Apply the concepts of watershed development and planning
3. Evaluate the erosion rate and total amount of soil loss from a watershed
4. Select the flood and drought mitigation measures
5. Quantify the change in land use land/cover and its impact on hydrological processes.

Text Books

1. Kenneth N. Brooks Peter F. Ffolliott Joseph A. Magner. Hydrology and the Management of Watersheds. A John Wiley & Sons, Inc., Publication (4th Edition)
2. VVN, Murthy. Land and Water Management- Kalyani Pblication

Reference Books

1. JVS Murthy. Watershed Management. New Age International publisher.
2. A.M. Michel and T.P. Ojha. Hand Book on Agricultural Engineering, Volume 2.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18EEE301 INDUSTRIAL ELECTRICAL SYSTEMS

L	T	P	C
3	0	0	3

Course Prerequisite: 18EEE101

Course Description:
This course deals with basics of electrical wiring systems for residential, commercial and industrial consumers, and its representation with standard symbols and drawings, various components of industrial electrical systems and its sizing and control aspects of industrial electrical system using PLC and SCADA.

Course Objectives:

1. To understand the electrical wiring systems for residential, commercial and industrial consumers.
2. To learn the representation of systems with standard symbols and drawings.
3. To understand the various components of industrial electrical systems.
4. To analyze and select the proper size of several electrical system components.
5. To study the control aspects of industrial electrical system using PLC and SCADA

UNIT I: ELECTRICAL SYSTEM COMPONENTS
LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.

(9)

UNIT II: RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS
Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

(8)

UNIT III: ILLUMINATION SYSTEMS
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

(8)

UNIT IV: INDUSTRIAL SUBSTATION SYSTEMS

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

(8)

UNIT V: INDUSTRIAL SYSTEM AUTOMATION

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

(12)

Course Outcomes:

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

1. Discuss the various component representation involved in the design of electrical wiring for Low Tension.
2. Understand the guidelines for wiring of household and commercial buildings.
3. Understand the various components of illumination in industrial electrical systems.
4. Select the proper size of various electrical system components required for designing different electrical wiring systems.
5. Understand the control aspects of industrial electrical system using PLC and SCADA.

Text Books:

1. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.

Reference:

1. Web site for IS Standards.
2. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
3. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination

Dept. of Mechanical Engineering

Open Elective - II

18EEE302 INTRODUCTION TO MEMS

L	T	P	C
3	0	0	3

Course Prerequisite: 18EEE101

Course Description:
This course describes about manufacturing, modeling and applications of MEMS**.**

Course Objectives:

1. To know the fundamentals of MEMS materials, their physical properties and Principles of operation of MEMS devices
2. To know various MEMS microfabrication technologies.
3. To provide various MEMS technology for mechanical, optical, and chemical sensors and actuator

UNIT I: INTRODUCTION
Overview – History and industry perspectives – Working principles – Mechanics and dynamics –– Scaling law

(9)

UNIT II: MICRO SENSORS & ACTUATORS
Micro sensors: Pressure sensors, accelerometers, gyroscopes-Micro actuators: comb drive actuators – Micro-electromechanical systems

(9)

UNIT III: MICRO MANUFACTURING
Materials for MEMS and Microsystems- Micro fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition- Physical Vapour Deposition, Micro manufacturing: Bulk micromachining, surface micromachining, LIGA Process- Packaging.

(9)

UNIT IV: MODELING IN MEMS
Micro system design: Finite Element Methods-– Modeling of simulation – piezoelectric, Gyroscope

(9)

UNIT V: MEMS APPLICATIONS
Micro fluids-sensors for turbulence measurement and control, micro-actuators for flow control, RFMEMS- filters, Oscillators and phase shifters, Optical MEMS, micro robotics – Case studies

(9)

Course Outcomes:

At the end of the course, students will able to

1. Explain the fundamentals of MEMS materials, their physical properties and Principles of operation of MEMS devices
2. Analyze the Micro sensors and actuators and its fabrication
3. Explain the materials for MEMS and Microsystems
4. Design MEMS using microfabrication techniques
5. Explain the advantages of MEMS technology for mechanical, optical, and chemical sensors and actuator

Text Books:

1. Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2006
2. G.K. Ananthsuresh et al ,’Micro and Smart Systems’, Wiley, India, 2010

References:

1. NadimMaluf, “An introduction to Micro electro mechanical system design”, ArtechHouse, 2000.
2. Mohamed Gad-el-Hak, editor, “The MEMS Handbook”, CRC press Baco Raton, 2000
3. James J.Allen, micro electro mechanical system design, CRC Press published in 2005
4. Stephen D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination

Open Elective - II

18ECE301 BIO-MEDICAL ELECTRONICS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
This course provides the fundamental knowledge on applications of electronics in bio-medical signal measurements and processing, bio-medical instrumentation and imaging techniques.

Course Objectives:
This course enables students to
1. Acquire the basic knowledge on human physiology and biological transducers.
2. Learn about bio-electrodes and bio-amplifiers used in bio-signal acquisition.
3. Understand the working principle of bio-medical measuring instruments.
4. Study various types of imaging techniques used in medicine.
5. Learn the applications of medical instrumentation in designing artificial medical aids.

UNIT I: Human Physiology and Biomedical Transducers
Introduction to human physiology - Biomedical transducers for measuring displacement, velocity, force, acceleration, potential, dissolved ions and gases.

(9)

UNIT II: Bio-Electrodes and Amplifiers
Introduction to bio-potential, Bio-electrodes, Typical waveforms and characteristics of ECG, EMG and EEG, Bio-potential amplifiers for ECG, EMG and EEG – Lead systems and recording methods.

(9)

UNIT III: Biomedical Measuring Instruments
Measurement of blood pressure and temperature, Blood flow meter, Cardiac output measurement, Respiratory measurement, Blood cell counter, Impedance plethysmography.

(9)

UNIT IV: Medical Imaging
X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear imaging, Ultrasonic Imaging.

(9)

UNIT V: Prostheses and Aids
Pacemakers, Defibrillators, Heart-lung machine, Artificial kidney, Aids for the handicapped, Safety aspects.

(**9)**

Course Outcomes:

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

1. Understand the applications of biological transducers in medical field.
2. Analyze the design of bio-electrodes and bio-amplifiers.
3. Apply suitable measuring instruments to measure various medical parameters.
4. Understand and test various imaging techniques used in bio-medical diagnosis.
5. Analyze the applications of artificial medical aids.

Text Books

1. W.F. Ganong, Review of Medical Physiology, 26th Edition, Tata McGraw-Hill, New Delhi, 2019.
2. J.G. Websster, ed., Medical Instrumentation, 3rd Edition, Wiley India Pvt. Ltd. 2009.

Reference Books

1. A.M. Cook and J.G. Webster, eds., Medical Devices and Human Engineering, Taylor & Francis, 2014.
2. R.S.Khandpur, “Handbook of Biomedical Instrumentation”, 2nd edition, Tata McGraw-Hill, New Delhi, 2005.
3. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice-Hall, New Delhi, 2011.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18ECE302 VLSI DESIGN

	L	T	P	C
Course Prerequisite: None	3	0	0	3

Course Description

This course describes about various VLSI design methodologies, fundamentals of CMOS technology. It incorporates basics of MOSFET, CMOS processing technology, circuit characterization and performance estimation, combinational logic design, sequential logic design, logic families and VLSI Design flow.

Course Objectives

This course enables students to

1. Know the different VLSI Design Methodologies
2. Understand the characteristics of CMOS device
3. Study CMOS design rules
4. Designing of CMOS by considering the low power
5. Understand different types of CMOS circuit families

UNIT I: Introduction to VLSI design methodologies

Introduction to VLSI Design Methodologies, Scaling, CMOS Logic: Inverter, NAND Gate, NOR Gate, Combinational Logic, Compound Gates, Pass Transistors and Transmission Gates, CMOS Inverter Cross-section, Stick Diagrams. VLSI Design Flow, Complementary CMOS Inverter DC Characteristics, Beta Ratio Effects, Noise Margin.

(9)

UNIT II: MOS transistor theory

MOS Ideal I-V Characteristics, C-V Characteristics, MOS Small-signal Model, MOS Capacitance Models, MOS Gate Capacitance Model, MOSFET as a Switch, non-ideal I-V Effects: Velocity Saturation and Mobility Degradation, Channel Length Modulation, Body Effect, Sub-threshold Conduction, Junction Leakage, Tunneling.

(9)

UNIT III: CMOS technologies

CMOS Technologies: Background, Wafer Formation, Photolithography, Well and Channel Formation, Isolation, Gate Oxide, Gate and Source/Drain Formation, Contacts and Metallization, Passivation, Metrology. Scribe Line and Other Structures, MOSIS Scalable CMOS Design Rules, Micron Design Rules.

(9)

UNIT IV: Low power design

Delay Estimation using RC Delay Model and Linear Delay Model, Logical Effort, Parasitic Delay. Logical Effort and Transistor Sizing: Delay in a Logic Gate, Delay in Multistage Logic Networks, choosing the Best Number of Stages. Power Dissipation: Static Dissipation, Dynamic Dissipation, Low-Power Design. Interconnect: Resistance, Capacitance, Delay, and Crosstalk.

(9)

UNIT V: Circuit families

Circuit Families: Static CMOS, Ratioed Circuits, Cascade Voltage Switch Logic, Dynamic Circuits, Sense Amplifier Circuits, Bi-CMOS Circuits, Multiplexers, Sequential Static Circuits, Design of Latches and Flip-Flops.

(9)

Course Outcomes

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

1. Explain the VLSI design methodologies and basic CMOS circuits used in modern Integrated circuits applications.
2. Discuss the fundamentals of MOS transistor theory.
3. Discuss about the CMOS processing technology.
4. Discuss about the integrated circuit characterization and performance estimation.
5. Describe the different types of circuit families.

Text Books

1. J. P. Uyemura: Introduction to VLSI Circuits and Systems, Wiley.
2. Neil H.E. Weste, David Harris, Ayan Banerjee: CMOS VLSI Design, Third Edition, Pearson Education.

Reference Books

1. Philip E. Allen and Douglas R Holberg: CMOS Analog Circuit Design, Oxford.
2. Carver Mead and Lynn Conway: Introduction to VLSI systems, BS Publication.
3. Plummer: Silicon VLSI Technology, Pearson Education.
4. J. P. Uyemura: Chip Design for Submicron VLSI, Cengage Learning.
5. Neil H.E. Weste, Kamran Eshraghian: Principle of CMOS VLSI Design, Pearson Education.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18CSE301 OPERATING SYSTEMS

Course Prerequisite: Nil

L	T	P	C
3	0	0	3

Course Description:

This course will cover the tradeoffs that can be made between performance and functionality during the design and implementation of an operating system. Particular emphasis will be given to three major OS subsystems: process management (processes, threads, CPU scheduling, synchronization, and deadlock), memory management (segmentation, paging, swapping), and file systems.

Course Objectives:

1. To learn the mechanisms of OS to handle processes and threads and their communication
2. To give introduction to shell programming.
3. To learn the mechanisms involved in memory management in contemporary OS
4. To gain knowledge on distributed operating system concepts that includes architecture, Mutual exclusion algorithms, deadlock detection algorithms and agreement protocols
5. To know the components and management aspects of concurrency management

UNIT I: INTRODUCTION

Concept of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Case study on UNIX and WINDOWS Operating System. KORN SHELL PROGRAMMING:Basic Script Concepts,Expressions, Decisions: Making Selections, Repetition, Special Parameters and Variables, Changing Positional Parameters, Argument Validation, Debugging Scripts.

(9)

UNIT II: PROCESS CONCEPTS

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling.

(9)

UNIT III: PROCESS SYNCHRONIZATION AND DEADLOCKS

Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson’s Solution, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader’s & Writer Problem, Dinning Philosopher Problem etc. Deadlocks: Definition, Necessary and sufficient conditions for

Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

(9)

UNIT IV: MEMORY MANAGEMENT STRATEGIES

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition– Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging. Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

(9)

UNIT V: FILE SYSTEM:

File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance. Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.

(9)

Course Outcomes:

At the completion of the course the students will be able to:

1. Write shell scripts using korn shell.
2. Create processes & threads and implement the various process scheduling techniques.
3. Analyse the concurrent processing and deadlock situations.
4. Design algorithmic solutions to solve memory management problems.
5. Implement the different types of file management techniques.

Text Books:

1. Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.

References:

1. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
2. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison-Wesley
3. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
4. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18CSE302 E-LEARNING TECHNOLOGIES

	L	T	P	C
Course Prerequisite: Nil	3	0	0	3

Course Description:

The course provides a comprehensive understanding of the fundamental theory of E-learning and the Strategies of E-Learning .The relation between Models of E-Learning and Multi/Hyper Media for E-learning has been explained across various stages of learning techniques.

Course Objectives:

1. To enable the students to understand the concept of e-learning and integrating the technology.
2. To inculcate knowledge in planning the role of information technology in virtual classroom and university.
3. To make the students to understand the technology mediated communication and its applications.
4. To include knowledge in planning models of E-learning in in virtual classroom and university.
5. To make the students to understand the future of E-learning technology and its development.

UNIT I: CONCEPT OF E-LEARNING

Meaning, Evolution of E-Learning – Components of E-Learning – Virtual classroom: Teleconferencing, Audio and Video conferencing.

(9)

UNIT II: STRATEGIES OF E-LEARNING

Process of E-Learning: Knowledge Acquisition and Creation, Sharing of Knowledge, Utilization of Knowledge – E-Learning Instructional Grounds: Behaviourism, Cognitivism and Constructivism.

(9)

UNIT III: MODELS OF E-LEARNING

Role of Web-Based Instruction in Learning – Models of WBI: Instructional Design Model (ISD) & Hyper Media Design Model (HMD) – Computer Languages for Designing WBI – Future of E-Learning.

(9)

UNIT IV: MULTI/HYPER MEDIA FOR E-LEARNING

Concept, Meaning, Characteristics and Applications – Teaching Techniques through Multi/Hyper Media – Multimedia & Learning – Multimedia for Co-operative and Collaborative Learning Strategies – General Guidelines for Multi/Hyper Media Applications – Advantages & Disadvantages of Multi/Hyper Media.

(9)

UNIT V: FUTURE OF E-LEARNING TECHNOLOGY

21^{st}Century Education – Challenges of Distance Education – Electronic Media in Distance Education – Open Educational Resources / Open Learning – Internet in Distance Education – Virtual University System.E-Patashala, Indian Institutes Developing E-Content.

(9)

Course Outcomes:

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

1. Understand the concept of e-learning and integrating the technology.
2. Make the students to understand the technology mediated communication and its applications.
3. Understand the technology mediated communication and its applications.
4. Include knowledge in planning models of E-learning in in virtual classroom and university.
5. Make the students to understand the future of E-learning technology and its development.

Text Books:

1. Badrul Khan and Mohamed Ally(Edited), 2015, International Hand book of E-Learning:Volume-1 Theoretical Perspectives and Research, Routledge,.
2. Robyler , 2007, Integrating Educational Technology into Teaching, 4th Edition, Pearson Education India .
3. Richard Andrews and Caroline Heythornthwaite (Edited), 2007, The SAGE Hand Book of E-Learning Research, SAGE,Delhi.

References:

1. Bryn Holmes and John Gardiner, 2006,E-Learning Concepts and Practice, ,Pine Forge Press.
2. Y.R. Ramaiah , 2002,Distance Education and Open Learning, , Mittal Publications.
3. PradeepMandav, 2001, Visual Media Communication, Authorspress.
4. Michael D.Wiliams, Prentice Hall, 2000,Integrating Technology into Teaching and Learning: Concepts and Applications,.
5. Laura Parker Roerden, O'Reilly, 1997,Net Lessons: Web-based Projects for Your Classroom, Volume 1.
6. Paul F. Merrill, Allyn and Bacon, 1996,Computers in Education, 3rd Edition.
7. Joan Riedl, Allyn and Bacon, 1995,The Integrated Technology Classroom.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Open Elective - II

18CSE303 AI TOOLS, TECHNIQUES AND APPLICATIONS

Course Prerequisite: None

L	T	P	C
3	0	0	3

Course Description:
To understand the importance of AI and its applications, Machine learning and Deep Learning algorithms and smart solutions for various domains.

Course Objectives:
The objectives of this course are to

1. Expose fundamental concepts in AI
2. Demonstrate the capability to create simple AI applications using Natural Language Processing, Speech Recognition, Computer Vision, Pattern recognition.
3. Present various modeling and formulation techniques to solve problems using AI techniques.
4. Introduce state-of-art AI tools and techniques to solve various problems faced by Engineers in design and analysis.

UNIT I: FUNDAMENTALS OF AI
AI-Definition, Applications of AI, Search Strategies – BFS, DFS, Knowledge representation and reasoning – Knowledge based Agent, Wumpus World Environment, Logics.**Machine Learning:** Supervised Learning - Linear Regression, Logistic Regression, Unsupervised Learning – K-means clustering, Anamoly Detection, Reinforcement Learning. **(9)**

UNIT II: NLP AND BOT TECHNOLOGIES
Natural Language Processing: Natural language Understanding, Sentiment Analysis, Segmentation and recognition, Speech Recognition, Text-to-Speech, NLP in the cloud, NL Interface, **Chatbots:** Chatbot definition, Build a Chatbot, How has chatbot transformed user experience, Designing elements, best practices for chatbot development, **Virtual Assistants:** What is a Virtual Assistant? **(9)**

UNIT III: IMAGE PROCESSING &APPLICATIONS
What is Image processing?, Image Noise, Removal of Noise from Images, Color Enhancement,Fourier transforms, Feature detection and matching, Segmentation**,** Object detection, Face recognition, Recognition Databases and test sets. Application: Optical Character Recognition. **(9)**

UNIT IV: DEEP LEARNING
Introduction - Neural Networks, Deep Learning, Different types of Deep Neural Networks - CNN,RNN, forward propagation, Cost function, backpropagation.APIs using Softwares Tensorflow and Keras. **(9)**

UNIT V: SMART APPLICATIONS
Smart Agriculture, Smart Transportation and Autonomous Vehicles, Smart Homes, Smart Cities. **(9)**

Course Outcomes:
Upon the completion of the course, students able to

1. Understand the basic concepts and applications of Artificial Intelligence.
2. Design Chatbots based on the user requirements
3. Identify the features of digital images for analysis.
4. Implement the deep learning techniques using software tools.
5. Develop smart applications for various domains

Textbooks:

1. Tom Markiewicz& Josh Zheng,Getting started with Artificial Intelligence, Published by O'Reilly Media,2017
2. Stuart J. Russell and Peter Norvig,Artificial Intelligence A Modern Approach
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer 2010
4. Ian Goodfellow, Yoshua Bengio, Aaron Courvill, Deep Learning

Reference Books:

1. AurélienGéron,Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media,2017
2. A classical approach to Artificial Intelligence, Munesh Chandra Trivedi, Khanna Publications
3. Artificial Intelligence and Machine Learning, Chandra S.S. & H.S. Anand, PHI Publications
4. Machine Learning, Rajiv Chopra, Khanna Publishing House

Mode of evaluation: Assignments, Mid Term Tests, End Semester Examinatio

OPEN ELECTIVE – IV

Dept. of Mechanical Engineering

Open Elective - IV

18ENG301 CREATIVE WRITING

L	T	P	C
3	0	0	3

Course Description: The course functions as a broad-based introduction to various forms of creative writing, such as short fiction, poetry and drama. Short story writing is geared towards creative writing so that students learn about character, dialogue, voice, style and description in fiction. The course provides them with the opportunity to delve deeper into the analysis of selected short fiction and to work on stories of their own. Students explore the genre of poetry in-depth through their own writing and that of published poets. The study of playwriting involves many of the same focuses as short story writing, such as dialogue, character and plot. Students also experiment with writing these genres. The class is usually comprised of technique and style discussions, reading assignments and writing exercises.

Course Objectives:
This course enables the students to –
1. familiarize with different forms of writing: poetry, scene writing, vignette and feature writing.
2. To encourage reading and acquainting, appreciating and responding to different genres of writing.

UNIT I: Introduction to creative writing and reading. Poetry, Short Story, Drama, Fiction, Non Fiction, Feature Writing, etc. **(9)**

UNIT II: Poetry, Scenario writing, feature and vignette writing. Haiku, Object Poem, List Poem, Visual Poem, Nature Poem. Scanning a poem and understanding its meaning. **(9)**

UNIT III: Writing a scene, finding sources from which to draw ideas to write scenes, creating an effective setting for a scene to take place; creating strong, believable characters in a scene **(9)**

UNIT IV: Learning how a scene can drive the plot of a story, how to effectively use point of view to enhance a scene, how to write interesting and useful dialogue, self-editing own writing. **(9)**

UNIT V: Writing a vignette, finding sources from which to draw ideas to write a vignette, organizing one's time and ideas to produce a longer piece of writing. **(9)**

Course Outcomes:
At the end of the course, students will be able to:
1. Develop skills in reading, writing, and editing various literary genres.
2. Obtain an awareness of the role of analysis to inform appreciation and understanding of poetry.
3. Demonstrate the ability to read and respond thoughtfully.
4. Develop plot of the story and sketch characters with relevant dialogues
5. Obtain effective writing skills such as good essays and projecting scholarly ideas.

Text Book:

1. Tondeur, Louise. 2017. How to Think Like a Writer: A Short Book for Creative Writing Students and Their Tutors. Louise Tondeur

Reference Books:

1. Middleton, Daniel. 2012. The 7 Points of Write: An Essential Guide to Mastering the Art of Storytelling, Developing Strong Characters, and Setting Memorable Scenes. 711 Press

2. Kumar, Amrita. 2017. Kissing the Demon: The Creative Writer's Handbook. Harper Collins
3. Mastering Creative Writing: A Writer's Guide by Dahveed Bar-Daniel (kindle book) published :12 April 2017

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations.

Dept. of Mechanical Engineering

Open Elective- IV

18HUM303 ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
3	0	0	3

Course Description: The objective of this course is to inculcate in students the skills necessary to craft strategies and initiatives which can enable growth and sustainability in an entrepreneurial venture, to include the effective management of inventory, receivables, production, human resources, financial resources, and risk. Students will develop higher-level critical thinking skills, evidenced by analysis, evaluation, and synthesis.

Course Objectives: The course is intended to:

1. Explain the basic concepts of entrepreneurship and its role in Indian Economy;
2. Describe the SWOT analysis, promotional and financial aspects of entrepreneurship
3. Explain project planning and feasibility studies;
4. Make the students acquire knowledge about women entrepreneurship; and
5. Explain the rural entrepreneurship and role of NGOs and EDPs in India.

UNIT I: INTRODUCTION

Entrepreneurial competencies, attitudes, qualities, functions - Forms of Entrepreneurship - Types of ownership - sole trading, partnership and corporation – Role of Government in Entrepreneurship Development. **(9)**

UNIT II: PROMOTIONAL & FINANCIAL ASPECTS OF ENTREPRENEURSHIP

Idea generation– opportunities - SWOT Analysis - patents and trademarks, Intellectual Property Rights. Financial Aspects of the Entrepreneurship: Source of Capital, Debt capital, seed capital, venture capital - Informal Agencies in financing entrepreneurs, Government Grants and Subsidies, Types of Investors and Private Offerings. **(9)**

UNIT III: PROJECT PLANNING AND FEASIBILITY STUDIES

Concept of Project, Project Life Cycle -Project Planning, Feasibility Report – Project proposal & report preparation. Technical Feasibility and Economic Viability – sources of New Ideas. **(9)**

UNIT IV: WOMEN ENTREPRENEURSHIP

Scope of entrepreneurship among women – Promotional effects – Institutional framework - Successful cases of women entrepreneurs. **(9)**

UNIT V: RURAL ENTREPRENEURSHIP AND EDPS

Role of NGO's– Organizing EDPs – Social Entrepreneurship – startups – Entrepreneurship development among target groups of society. **(9)**

Course Outcomes:

At the end of the course, students will be able to:

1. Understand the concepts of entrepreneurship and its role in Indian Economy;
2. Compare and apply sources of different promotional and financial aspects;
3. Understand and analyze the feasibility study in project planning;
4. Find the women entrepreneurship development in India; and
5. Assess the rural entrepreneurship and strengthen the role of NGOs and EDPs.

References:

1. Entrepreneurial Development, S. Chand and Company Limited, S.S. Khanka, New Delhi, 2009.
2. Fundamentals of Entrepreneurship, H. Nandan, PHI, First/e, New Delhi, 2009.
3. Entrepreneurship, 6/e, Robert D Hisrich, Michael P Peters, Dean A Shepherd, TMH,2009.
4. The Dynamics of Entrepreneurial Development and Management, Vasanth
5. Desai, Himalaya,2009
6. Entrepreneurship Management – text and cases, Bholanath Dutta, Excel Books, 2009
7. Entrepreneurship – New venture Creation, Holt, PHI, 2009

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations.

Dept. of Mechanical Engineering

Open Elective – IV

18MAT303 GRAPH THEORY

	L	T	P	C
Course Prerequisite: Modern Algebra, Linear algebra	3	0	0	3

Course Description:

Graph theory is the core content of Discrete Mathematics. This course introduces in an elementary way some basic knowledge and the primary methods in Graph Theory also it is important in regarding to find out the mathematical structures from graph theory in concrete examples.

Course Objectives

1. To understand the fundamental definitions and properties of graphs.
2. To know the concepts of trees and spanning trees.
3. To learn about the matching and factors, connectivity.
4. To study the concepts of coloring of graphs, Planer graphs.
5. To introduce about the edges and cycles.

UNIT I: FUNDAMENTAL CONCEPTS

Graphs, path, cycles and trails, vertex degree and counting, directed graphs **(9)**

UNIT II: TREES AND DISTANCE

Basic properties, spanning trees, optimization and trees. **(9)**

UNIT III: MATCHING AND CONNECTIVITY

Matching and covers, algorithm and applications, Cuts and Connectivity, k-connetced graphs. **(9)**

UNIT IV: COLOURING OF GRAPHS AND PLANER GRAPHS

Vertex coloring, structure of k-chromatic graphs, Euler's formula, characterization of planar graphs. **(9)**

UNIT V: EDGES AND CYCLES

Line graphs and edge coloring, Hamiltonian cycles, planarity, coloring and cycles. **(9)**

Text Book:

1. Douglas B. West, Introduction to Graph Theory, Prentice Hall of India 2014.

References

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science. Prentice-Hall.
2. Frank Harary, Graph Theory, Narosa.
3. R. Ahuja, T. Magnanti, and J. Orlin, Network Flows: Theory, Algorithms, and Applications, Prentice-Hall.

Course Outcomes:

At the completion of the course the students will be able to:

1. Understand the basic terminology of graphs.
2. Determine the number of trees and spanning trees in a graph.
3. Find the matching and connectivity in graphs.
4. Learn about the concepts of coloring of graphs and Planer graphs.
5. Determine the number of edges and cycles of a graph.

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Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations.

Open Elective - IV

18MAT304 MATHEMATICAL MODELING AND NUMERICAL SIMULATION

L	T	P	C
3	0	0	3

Course Description:
This course introduces mathematical modeling and numerical simulation as tools for analyzing and solving real world problems. Here, data assimilation (DA) technique has been discussed to find the best estimate of the state by combining available information including model forecasts, observations and their respective errors. The accurate initial condition obtained by DA is used as input to numerical weather prediction (NWP) modules to improve the model forecast. Data visualization techniques allow engineering students to use their perception to better understanding of the implications of the data and their importance in many different fields.

Course Objectives:

1. To understand the overview of dynamic model system with dynamical and thermo-dynamical equations
2. To understand the basic concept and classification of partial differential equations and importance of initial and boundary value problem.
3. To introduce the development and use of modeling system in terms of scale and physical process.
4. To provide a conceptual and mathematical overview of the data assimilation.
5. To develop the skills for design and a comparative study between observed and modeled data.

UNIT I: BASIC CONSERVATION LAWS AND APPLICATIONS OF BASIC EQUATIONS

Total differentiation, Vectorial form of the momentum equation in rotating coordinates, Component equations in spherical coordinates, The continuity equation, The thermodynamic energy equation, Basic equations in isobaric coordinates, Balanced flow, Trajectories and streamlines, Thermal wind, Vertical motion **(9)**

UNIT II: NUMERICAL DISCRETIZATION OF EQUATIONS

Classification of partial differential equations (PDEs), Initial value problems, Finite difference method for space discretization, Boundary value problems: Heat, Wave and Laplace equations **(9)**

UNIT III: NUMERICAL MODELS AND PHYSICAL PROCESSES

Numerical models: Global, Regional, Mesoscale models, Parameterization of sub-grid scale physical processes: Planetary boundary layer, Moist microphysics physics, Cumulus convection, Radiation, Air-sea interaction processes, and Land-surface processes, Overview of interactions and parameterizations of these processes **(9)**

UNIT IV: DATA ASSIMILATION

Data assimilation: Empirical analysis schemes, Objective analysis schemes, Variational data assimilation techniques (unsteady three dimensional); Forecast error covariance; Dynamical and physical balance in the initial conditions; Quality control of observations; Atmospheric predictability; Concepts of chaotic systems and ensemble forecasting. **(9)**

UNIT V: DATA ANALYSIS AND VISUALIZATION

Introduction of WRF model and its Applications; Analysis of simulated and observed data sets through Grid Analysis and Display System (GrADS), MATLAB, and Excel software. **(9)**

Course outcomes

At the end of the course students are able to

1. Understand overview of dynamic model system and solve a set of dynamical and thermo-dynamical equations governing the state of the atmosphere.
2. Find accurate results through simulations by using proper and suitable representation of dynamical processes
3. Gain the knowledge of how and where to use the mathematical models in regional, mesoscale and global scales and develop an understanding of the physical processes
4. Compute the best estimate of the state by statistically combining model forecasts, observations, and their respective errors by using data assimilation technique.
5. Prepare the data for visualization and compare the results with observations.

Text books:

1. An Introduction to Dynamic Meteorology, Fourth Edition, by James R. Holtan, Elsevier Academic Press
2. Atmospheric Modeling, Data Assimilation, and Predictability, by Eugenia Kalnay (Cambridge University Press, 2003)
3. A description of the advanced research WRF version 3. Tech. Note, by Skamarock, W.C (2008).

References:

1. Dynamics, Volume 101, Second Edition: Physical and Numerical Aspects. Academic Press
2. Mark Z Jacobson. Fundamentals of Atmospheric Modeling, Cambridge University Press
3. James C. McWilliams. Fundamentals of Geophysical Fluid Dynamics, Cambridge University Press
4. Introduction to Grid Analysis and Display System (GrADS), by Guilherme Martins (2014), DOI:10.13140/RG.2.1.2594.2249.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations.

Dept. of Mechanical Engineering

Open Elective - IV

18PHY303 THIN FILM TECHNOLOGY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
Nucleation, crystallization, surface energy, various thin film coating processes including both physical vapour deposition such as evaporation, sputtering, pulsed laser deposition and chemical vapour deposition, spray coating, and other methods such as spin-coating, plasma polymerization, Langmuir Blodgett, transport phenomena in thin films, various properties of thin films, techniques and method to characterize thin films, current application of thin film, introduction to fabrication of thin film devices

Course Objectives:

1. To provide students with a comprehensive overview on the fundamentals of thin film preparation and characterization.
2. To enable the students to develop a thorough understanding of how core physics can be used to understand thin film deposition processes.
3. To establish the correlation between processing variables and materials characteristics and performance within the framework of key modern technologies.
4. To realize thin film applications to science and technology

UNIT I: PHYSICS OF THIN FILMS
Introduction - Role of thin films in devices - Thin film definition - Crystalline and amorphous films - Crystal defects - Nucleation and growth - film formation. **(9)**

UNIT II: THIN FILM DEPOSITION TECHNIQUES
Physical methods of films deposition-evaporation, e-beam, sputter deposition, pulsed laser, molecular beam epitaxy. Chemical methods of film deposition -Deposition of Inorganic films from Solutions-Chemical vapour deposition - Electrolysis, Anodization, Spray pyrolysis, Other techniques: Langmuir Blodgett and Spin Coating. **(9)**

UNIT III: PROPERTIES OF THIN FILMS
Structural-Optical-Electrical-Magnetic-Mechanical and Thermal properties of thin films. **(9)**

UNIT IV: CHARACTERIZATION OF THIN FILMS
Imaging Techniques (SEM, AFM, TEM) - Structural Techniques (XRD, Raman)-Optical Techniques (UV-Vis-NIR, PL)-Electrical Techniques (Hall Effect, IV, CV)-Magnetic Techniques (EPR, H-V curve)-Mechanical Techniques (Hardness testing)-Thickness measurement (profilometer, ellipsometry). **(9)**

UNIT V: APPLICATIONS OF THIN FILMS
Transparent conducting coating - Optical coating – Solar cells – Photocatalytic – Sensors - Superconductivity- Superhard coatings – Thin film transistors. **(9)**

Course Outcomes:
After a successfully completed course the students will be able to:

1. Discuss the differences and similarities between different vacuum based deposition techniques, evaluate and use models for nucleating and growth of thin films.
2. Asses the relation between deposition technique, film structure, and film properties.
3. Know the typical thin film applications.
4. Motivate selection of deposition techniques for various applications.

Text books:

1. Thin Film Deposition: Principles and Practice, *Donald L. Smith,* McGraw Hill, Singapore, 2001.
2. Maissel, L.I and Glang. R, "Handbook of thin film technology", McGraw Hill, 1970.

References:

1. Thin film phenomena / *Kasturi L. Chopra,* New York: McGraw-Hill, c1969.
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" Imperial College Press, 2004.
3. An introduction to physics and technology of thin films / *Alfred Wagendristel, Yuming Wang,* Singapore: World Scientific, c1994.
4. Thin film processes, *John L Vossen, Werner Kehn* editors, Academic Press, New York, 1978.
5. Thin film physics / *O.S. Heavens,* London: Methuen, c1970.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective – IV

18CHE303 INTRODUCTION TO NANO SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

Course Description

This is primarily a lecture course which brings together relevant knowledge from the disciplines of physics and chemistry to give students a fundamental understanding of the integrated multidisciplinary nature of Nanotechnology.

Objectives

To understand the emergence of nanoscience and technology through history.

1. The various process techniques available for nanostructured materials.
2. The role of nanotechnology in electronics how basic nano-systems work
3. To use physical reasoning to develop simple nanoscale models to interpret the behaviour of such physical systems

UNIT I: MOLECULE TO MATERIALS: BASICS OF NANOTECHNOLOGY

History & emergence (Feynman to present) of Nanoscience and Nanotechnology, Challenges in Nanotechnology. Atomic Structures: Rutherford and Bohr's model of atom. Bohr's model to Quantum: Wave function, Uncertainty principle, Orbital quantum numbers, Shape of the orbitals. Types of simple crystal structures, defects in crystals. **(9)**

UNIT II: TYPES AND SYNTHESIS OF NANOSTRUCTURES

Definition of a Nano system - Zero Dimensional (OD), One Dimensional (1D) - Two Dimensional (2D) - Three Dimensional (3D) nanostructured materials. Nanoscale building blocks, Top-down and Bottom-up approaches. Synthesis of Nanomaterials – Physical & Chemical methods: Chemical Vapour Deposition (CVD), Atomic Layer Deposition (ALD), Chemical Reduction, Co-precipitation, Emulsion Polymerization (Polymer and Organic NPs), Sol-Gel, Green synthesis of Nanoparticle (NP). **(9)**

UNIT III: PROPERTIES OF NANOMATERIAL

Thermal, Mechanical, Optical, Electrical and Magnetic properties of nanomaterials (Metal oxides, Ceramics, Nanocomposites, Semiconductors). Carbon age materials: CNTs, and other Carbon-based materials). Effect of size and shape on the properties of nanomaterials. **(9)**

UNIT IV: CHARACTERIZATION OF NANOMATERIALS

Structure: Powder XRD (SAXS); Composition: XPS; Thermal: TG-DTA; Optical & Electron microscopes: Atomic force microscopes (AFM), Scanning electron microscope (SEM), Transmission electron microscope (TEM); Magnetic characterization (SQUID). **(9)**

UNIT V: APPLICATIONS OF NANOMATERIALS

Molecular electronics and nano-electronics – LED applications, Quantum electronic devices - CNT based transistor and Field Emission Display – Biological (anti-bacterial, anti-fungal, anti-microbial) applications - Biochemical sensor - Membrane based water purification, Target based drug delivery system. **(9)**

Course Outcomes:

Upon completion of this course the students will be able to:

1. Understand the correlation between atomic, molecular structures and nanomaterials
2. Classify the types and synthesis the nanomaterials based on the needs of the society and environment.
3. Infer and interpret the properties of nanomaterials
4. Apply the knowledge of characterization tools towards making the sustainable engineering products.
5. Illustrate the application of various nanomaterials in daily life, industry towards the sustainable development.

Text Books:

1. M. Wilson, K. Kannangara, G. Smith, M. Simmons, and B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
2. C. N. R. Rao, A. Muller, and A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.
3. Kenneth J. Klabunde (Eds), Nanoscale Materials Science, John Wiley & Sons, InC, 2001.
4. C. S. S. R. Kumar, J. Hormes, and C. Leuschner, Nanofabrication towards biomedical applications, Wiley - VCH Verlag GmbH & Co, Weinheim, 2004.
5. T. Pradeep, Nano: The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.

References:

1. W. Rainer, *Nano Electronics and information Technology*, Wiley, 2003.
2. K. E. Drexler, *Nano systems*, Wiley, 1992.
3. G. Cao, *Nanostructures and Nanomaterials: Synthesis, properties and applications*, Imperical College Press, 2004.
4. P. Yang, Chemistry of Nanostructured Materials, World Scientific Publishers, 2005.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective - IV

18CHE304 COMPUTATIONAL METHODS IN MATERIALS SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisite:

Exposure to Introductory engineering mathematics, introductory materials science and introductory programming courses is preferred.

Course Description:

This course deals with various computational approach and mathematical methods to understanding and apply different concepts in materials science and engineering.

Course Objectives:

1. To get exposed to the basic concepts in Materials Science and Engineering.
2. To understand the basic concepts of Programming and Graphical plotting.
3. To introduce the basic concepts of Data types and handling of various data.
4. To familiarize the basic concepts of modelling and simulation.
5. To acquire and apply the current knowledge and trends in the field of Computational Materials Science.

UNIT I: INTRODUCTION TO COMPUTATIONAL MATERIALS SCIENCE AND ENGINEERING

Concepts in materials science and engineering; use of computers and freely available open source software to: data handling; understand concepts and solve problems of engineering interest. **(9)**

UNIT II: PROGRAMMING AND PLOTTING

Introductions to the advanced concept C programming language; open source software for numerical computations and visualization (gnuplot, GNU Octave, Scilab); introduction to the LaTeX software for report preparation along with other miscellaneous software and programs. **(9)**

UNIT III: DATA TYPES AND HANDLING TECHNIQUES

Classification, and understanding of data properties, data handling - plotting, fitting, functional forms, interpolation, and integration. **(9)**

UNIT IV: COMPUTATIONAL MODELING AND SIMULATIONS

Understanding the materials properties; atomistic and electronic modelling of materials; concepts in molecular dynamics and its application using Quantum ESPRESSO. **(9)**

UNIT V: CURRENT TRENDS IN COMPUTATIONAL MATERIALS SCIENCE

Applied materials for various engineering field; research literature exploration; real-time application of computational methods in materials science and engineering, mini-project. **(9)**

Course Outcomes:

At the end of the course, the students will be able to

1. Understand the importance and applications of computational methods in Materials Science and Engineering.
2. Be familiarized with the tools of the trade, namely programming and graphical plotting.
3. Be able to understand and access the various types of data sets and appropriately handle it to productively work with it.
4. Get the knowledge about handling various open source computational tools and their effective usage to do computational modeling and simulations.
5. Be familiarized with up to date trends in computational materials science by taking up real time research problems and provide solutions.

Text Books:

1. Computational Materials Science: An Introduction, Second Edition 2nd Edition, by June Gunn Lee, 2014
2. Materials science and engineering: an introduction, William D Callister, Sixth edition, John Wiley & Sons, 2013.
3. The C programming language, Brian W Kernighan and Dennis M Ritchie, Second edition, PHI Learning Private Limited, 2010.
4. Materials science and engineering: a first course, V Raghavan, Fifth edition, PHI Private Limited, 2008.
5. Physical metallurgy principles, Robert E. Reed-Hill, Second edition, Affiliated East-West Press Pvt. Limited, 2008.
6. An introduction to materials science and engineering, Kenneth M Ralls, Thomas H Courtney, and John Wulff, Wiley India Pvt. Ltd., 2011.

References:

1. Materials Science and Engineering,V Raghavan,Prentice-Hall India, 2004
2. Advanced Engineering Mathematics, E Kreyzig, Wiley-India,1999.
3. A Review of Computational Methods in Materials Science, International Journal of Molecular Sciences 10(12):5135-216

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Open Elective- IV

18CE304 GREEN BUILDING AND ENERGY CONSERVATION

L	T	P	C
3	0	0	3

Course Prerequisites: None

Course Description: The course covers various aspects of bioclimatic architecture like climate sensitive design, passive solar architecture, Water management, green building materials and construction techniques.

Course Objectives:

1. The course introduces concepts of sustainability and bioclimatic design in planning, construction and life of buildings.
2. This course intends to equip students with technical knowledge of energy-efficient green buildings
3. This course guide students, through projects, to apply concepts and ideas for the design of a green building by introducing them to green initiatives and ratings.
4. This course also initiates students in basics of functional design and drawing of the various buildings using the above concepts.

UNIT -I: GREEN BUILDING CONCEPTS

Introduction to bioclimatic architecture - Sustainability in building science and Functional planning - Orientation - Elements of building design and drawing – Building regulations and bylaws - Traditional and Vernacular Architecture - Climate zones - Design Charts - sun path diagram - Solar angles - Indices of thermal comfort - Vernacular buildings in different climate zones. **(9)**

UNIT-II: CLIMATE RESPONSIVE SCIENTIFIC PROCESS OF DESIGN

Introduction - various steps in Site planning - Plan form Building envelope Landform - Topography – vegetation - water bodies; Orientation - S/V ratio - P/A ratio - Walls, Fenestration - Roof and floors - Active and passive solar strategies - Passive solar architecture. **(9)**

UNIT-III: THERMAL FLOW IN BUILDINGS

Calculation of thermal conductance - Heat flow through different building elements - Ventilation and day lighting - Design and placement of openings - Water management in buildings - Techniques to recycle, reuse and harvest water. **(9)**

UNIT IV: GREEN BUILDING MATERIALS AND CONSTRUCTION

Material properties - Energy efficiency using various materials - emerging new materials Construction techniques - Techniques for roof, wall and foundations. **(9)**

UNIT V: ECONOMY OF GREEN BUILDING

Cost of building - operation and maintenance - Green building rating system - Evaluation criteria of LEED - TERI GRIHA case studies - Case studies in different climate zones. **(9)**

Course Outcomes:

1. An understanding on green building materials and construction techniques.
2. Knowledge on renewable energy and energy conservation through material usage.
3. A thorough understanding on designing green buildings

Text books:

1. Krishnan, A., Baker, N., Yannas, S., &Szokolay, S. (Eds.). (2001). Climate responsive architecture, a design handbook for energy efficient buildings. New Delhi: Tata McGraw–Hill Publishing Company.
2. TERI & ICAEN (InstitutCatalad'Energia). (2004). Sustainable building design manual (Vol. II). New Delhi: The Energy and Resources Institute(TERI) Press.

References:

1. Bureau of Indian Standards. (1995). SP:41, Handbook on functional requirements of buildings (other than industrial buildings) (First reprint ed.). New Delhi: Bureau of Indian Standards.
2. Indian Green Building Council, LEED-India. (2011). LEED 2011 for India- Green building rating system, abridged reference guide for new construction and major renovations (LEED India NC). Hyderabad: Indian Green Building Council.
3. Koenigsberger, O., ingersoll, T. G., Mayhew, A., &Skozolay, S. V. (2011). Manual of Tropical Housing and Building. Hyderabad: Universities Press.
4. Prabhu, Balagopal T S, K Vincent Paul, and C Vijayan. Building Design and Drawing. Calicut: Spades Publishers, 2008.
5. Szokolay, S. V. (2008). Introduction to Architectural Science – The Basis of sustainable Design (Second ed.). Architectural Press/Elsevier.
6. The Energy and Resources Institute (TERI). (2011). Green Rating for Integrated Habitat Assessment (GRIHA) manual. New Delhi: TERI press.
7. Journals: Energy and Buildings, Building and Environment, Other relevant publications.
8. National Building Code, Bureau of Indian Standards: New Delhi. 2005; Building Bye laws and building rules of selected Indian urban and rural areas
9. Swamy, N. K., & Rao, A. K. (2013). Building planning and Drawing, New Delhi, Charothar Publishing House

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Open Elective- IV

18CE305 ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisites: None

Course Description

The course covers demand, quality, treatment and distribution of water along with characterization, collection, low cost treatment of waste water and household drainage. Similarly, air pollution, noise pollution and solid waste management are also included.

Course Objectives

1. To explain water quality standards, treatment, distribution of drinking water
2. To analyze the characteristics of wastewater and discuss about various units of sewage treatment system.
3. To explain various impacts of air and various methods to control air pollution
4. To describe about solid waste generation, characterization, impacts and various management techniques
5. To discuss about generation and management of electronic waste.

UNIT I: WATER TREATMENT

Water- Sources of Water, quality issues, health impacts of contaminated drinking water, water quality requirement for different beneficial uses, water quality standards, water quality indices, water safety plans, Layout of water Supply systems, components of water supply system; Distribution system, working principle of various units of surface water treatment plant layout **(9)**

UNIT II: SEWAGE TREATMENT

Quantity of Sewage, Sewage flow variations. Sewage pumping; Sewerage, Sewer appurtenances, Storm Water; sewage disposal standards, pollution due to improper disposal of sewage, wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage, zero liquid discharge **(9)**

UNIT III: URBAN AIR POLLUTION AND CONTROL TECHNIQUES

Air - Composition and properties of air, source and impacts of air pollution-on human, vegetation and strucutres, types of air pollutants various air pollution control laws, National Ambient Air Quality Standards, Air Quality Index, Air pollution meteorology and dispersion, Principles and working of various air pollution control equipment- gravity settling chamber, cyclone separators, fabric filters and electrostatic precipitators. **(9)**

UNIT IV: MUNICIPAL SOLID WASTE MANAGEMENT

Municipal Solid Waste-Characteristics and Quantities, MSW Rules, Municipal Solid Waste Collection, Transportation, Segregation and Processing, compositing, recycling, disposal-landfilling and incineration. **(9)**

UNIT V: ELECTRONIC WASTE MANAGEMENT

E-Waste Generation, E-Waste Rules, Techniques for Recycling and Recovery – glass, plastics, ferrous and non-ferrious materials **(9)**

Course Outcomes

The students after completing the course will be able to:

1. Explain about impacts of drinking water contamination and various units of surface water treatment plant
2. Discuss about sewage generation and various methods of sewage treatment
3. Describe the impacts of air pollution and review various air control methods
4. Discuss about the impacts of solid waste and various solid waste management techniques
5. Explain the impacts and beneficial reuse of electronic waste

Text Books:

1. Birdie, G.S, Birdie, J.S., Water supply and sanitary Engineering, Including Environmental Engineering, Water and Air Pollution Laws and Ecology, Dhanpat Rai Publications, 1996.
2. Garg, S.K., Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2008.
3. Rao M and Rao H.V.N. Air Pollution, McGraw Hill Education, 2017.
4. Jagbir Singh and Ramanathan A. L., Solid Waste Management: Present and Future Challenges, I K International Publishing House Pvt. Ltd., 2009

Reference Books:

1. Punmia, B.C, Ashok K Jain, Arun K Jain., Waste Water Engineering, Laxmi Publications, 1998.
2. Peavy, H., Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International Editions, New York 1985
3. Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication
4. Metcalf & Eddy, Wastewater Engineering Treatment and Dispose, McGraw Hill Publication

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective- IV

18EEE303 ROBOTICS

L	T	P	C
3	0	0	3

Course Prerequisite: Control Systems

Course Description:
Robotics is an interdisciplinary area ranging from mechanical & electrical component design to advanced sensor technology, incorporating computer systems and Artificial Intelligence (AI). With advances in AI-techniques & computational power in recent years, it has become one of the most interesting area for multidisciplinary research, with lots of commercial applications already in market.

Course Objectives:
1. To know the fundamentals of Robotics & its Applications.
2. To make students capable of handling robot manipulator tasks in real, as well as in simulation environment.
3. To know about kinetic and Jacobian modeling
4. To know about sensors and actuators.

UNIT I: INTRODUCTION & TRANSFORMATION AND MAPPING
Evolution of Robots and Robotics, Laws of Robotics, Advancement in Robots, Robot Anatomy, Human Arm Characteristics, Design and Control Issues, Manipulation and Control, Sensors and Vision, Robotic Programming and Future Prospects. Coordinate Frames, Object Description in Space, Transformation of Vectors, Inverting a homogenous transform, Fundamental Rotation Matrices. **(9)**

UNIT II: KINEMATIC MODELS
Direct Kinematic Model- Mechanical Structure and Notations, Description of links and joints, Kinematic modelling of the Manipulator, Denavit - Hartenberg notation, Kinematic relationship between Adjacent Links, Manipulator Transformation Matrix. Inverse Kinematic Model- Manipulator workspace, Solvability of Inverse Kinematic model, Solution Techniques, Closed form solution. **(9)**

UNIT III: JACOBIAN AND DYNAMIC MODELLING
Differential motion and statics- Linear and Angular Velocity of a Rigid Body, Relationship between Transformation, Mapping Velocity Vector, Velocity propogation along links, Manipulator Jacobian, Jacobian Inverse, Jacobian Singularities, Static Analysis. Dynamic modelling- Lagrangian mechanics, Lagrange-Euler formulation, Newton-Euler formulation, Comparison of Langrange-Euler and Newton-Euler formulation, Inverse Dynamics**.** **(9)**

UNIT IV: ROBOT MANIPULATOR CONTROL AND PATH PLANNING (9)
Robot manipulator control- Introduction, Control of Puma Robot Arm, Computed Torque Technique, near minimum time control, Variable structure control, Non linear decoupled feedback control, Resolved motion control, Adaptive ControlPath/Trajectory Planning- Introduction, Joint space techniques, Cartesian space techniques, State space search, Problem reduction and use of predicate logic, Means-Ends analysis, Problem solving and robot learning, Robot Task Planning and Basic problems. **(9)**

UNIT V: SENSORS AND ACTUATORS

Range sensing, Proximity sensing, Touch sensors, Force and Torque sensing, Artificial Intelligence techniques using Neural Networks and Fuzzy control. **(9)**

Course Outcomes:

At the end of the course, students will able to

1. Understand the fundamentals of Robotics.
2. Analyze the mechanical structure and notations kinematic model.
3. Analyze the jacobian and dynamic modeling.
4. Explain the robot manipulator control and path planning.
5. Describe the various sensors and actuators.

Text Book:

1. Mittal, R.K. and Nagrath, I.J., Robotic and Control, Tata McGraw Hill, New Delhi, 2003.

References:

1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics Control, Sensing, Vision and Intelligence, McGraw Hill, 1988.
2. Craig, J.J., Introduction to Robotics: Mechanism & Control. Addison Wesley, 1986.
3. Paul, R.P., Robot Manipulator: Mathematics Programming & Control. MIT Press, 1981.
4. Pugh,A., RobotSensors, Vision Vol.-I.Springer Verlag, 1986.
5. Groover, M.P., Industrial Robotics Technology, programming & Application, McGraw Hill, 1986.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective – IV

18EEE304 ELECTRICAL SAFETY

L	T	P	C
3	0	0	3

Course Prerequisite: BEE

Course Description:
To provide a comprehensive exposure to electrical hazards, various grounding techniques, safety procedures and various electrical maintenance techniques.

Course Objectives:
1. To impart knowledge on electrical hazards and safety equipment.
2. To analyze and apply various grounding and bonding techniques.
3. To select appropriate safety method for low, medium and high voltage equipment.
4. To understand how to participate in a safety team.
5. To carry out proper maintenance of electrical equipment by understanding various standards.

UNIT I: ELECTRICAL HAZARDS
Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers and signs, safety tags, locking devices- voltage measuring instruments-proximity and contact testers-safety electrical one line diagram- electrician's safety kit. **(9)**

UNIT II: GROUNDING AND BONDING
General requirements for grounding and bonding- definitions- grounding of electrical equipment- bonding of electrically conducting materials and other equipment- connection of grounding and bonding equipment- system grounding- purpose of system grounding-grounding electrode system- grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment- grounding of low voltage and high voltage systems. **(9)**

UNIT III: SAFETY METHODS
The six step safety methods- pre job briefings- hot -work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation and approach distances- calculating the required level of arc protection-safety equipment , procedure for low, medium and high voltage systems- the one minute safety audit. **(9)**

UNIT IV: SAFETY TEAM
Electrical safety programme structure, development- company safety team- safety policy-programme implementation- employee electrical safety teams- safety meetings- safety audit-accident prevention- first aid- rescue techniques-accident investigation. **(9)**

UNIT V: MAINTENANCE OF ELECTRICAL EQUIPMENT

Safety related case for electrical maintenance- reliability centered maintenance (RCM) - eight step maintenance programme- frequency of maintenance- maintenance requirement for specific equipment and location- regulatory bodies- national electrical safety code- standard for electrical safety in work place- occupational safety and health administration standards.

(9)

Course Outcomes:

At the end of the course, students will able to

1. Describe electrical hazards and safety equipment.
2. Analyze and apply various grounding and bonding techniques.
3. Select appropriate safety method for low, medium and high voltage equipment.
4. Participate in a safety team.
5. Carry out proper maintenance of electrical equipment by understanding various standards**.**

Text Book:

1. Dennis Neitzel, Al Winfield,'Electrical Safety Handbook', McGraw-Hill Education , 4th Edition,2012.

References:

1. John Cadick, 'Electrical Safety Handbook', McGraw-Hill School Education Group, 1994.
2. Maxwell Adams.J, "Electrical safety- a guide to the causes and prevention of electric hazards",The Institution of Electric Engineers, 1994.
3. Ray A. Jones, Jane G. Jones, 'Electrical safety in the workplace', Jones & Bartlett Learning, 2000.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective – IV

18ECE303 NANO ELECTRONICS

L	T	P	C
3	0	0	3

Course Prerequisite: CMOS VLSI Design, Electronic Devices

Course Description:
This course provides an overview of Semiconductor Physics and carrier transport phenomenon. It illustrates Quantum Mechanics, & Nano-materials, Nanoscale MOSFET Transistors and their characteristics.

Course Objectives:
1. Apply the knowledge of Quantum physics to illustrate energy band structure.
2. Understand the basic physics of Kronig Penny Model.
3. Understand the fundamentals of operation of the main semiconductor electronic devices.
4. Understand and utilize the mathematical models and characteristics of MOS transistors for circuits and systems.
5. Understand and appreciate the nano-materials process.

UNIT I:
Introduction to nanotechnology, meso-structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. **(9)**

UNIT II:
Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig-Penny Model. Brillouin Zones. **(9)**

UNIT III:
Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.). **(9)**

UNIT IV:
Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics. **(9)**

UNIT V:
Band structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation. **(9)**

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand various aspects of nano-technology and the processes involved in makingnano components and material.
2. Leverage advantages of the nano-materials and appropriate use in solving practical problems.
3. Understand various aspects of nano-technology and theprocessesinvolved in making nano components and material.
4. Leverage advantages of the nano-materials and appropriate use in solving practical problems.

Text / Reference Books:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson,2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Materialand Novel Devices), Wiley-VCH,2003.
3. K.E. Drexler, Nanosystems, Wiley,1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press,1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley,2003

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Open Elective- IV

18ECE304 WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
This course introduces the concept of Wireless Sensor Network (WSN) to the students. It articulates the classification of WSN and related issues & challenges. It also describes different types of routing, MAC, dissemination protocols and explains design principles of wireless sensor networks.

Course Objectives:
1. Understand the concept of WSN, issues and challenges, classification of WSN.
2. Analyze and learn the classification of routing and MAC protocols.
3. Understand Dissemination protocol for large sensor network.
4. Design principles of WSNs.
5. Learn the hardware components & design constraints and Operating systems used in WSNs.

UNIT I
Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks. Mobile Ad-hocNetworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks. **(9)**

UNIT II
Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee. **(9)**

UNIT III
Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols. **(9)**

UNIT IV
Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication. **(9)**

UNIT V
Single-node architecture, Hardware components& design constraints. Operating systems and execution environments, introduction to TinyOS and nesC. **(9)**

Course Outcomes:

At the end of the course the students will be able to

1. Design wireless sensor networks for a given application
2. Understand emerging research areas in the field of sensor networks
3. Understand MAC protocols used for different communication standards used in WSN
4. Explore new protocols for WSN

Text/Reference Books:

1. WaltenegusDargie , Christian Poellabauer, " Fundamentals Of Wireless Sensor Networks Theory And Practice" , By John Wiley & Sons Publications ,2011
2. SabrieSoloman, " Sensors Handbook" by McGraw Hill publication. 2009
3. Feng Zhao, Leonidas Guibas, " Wireless Sensor Networks", Elsevier Publications,2004
4. Kazem Sohrby, Daniel Minoli, " Wireless Sensor Networks": Technology, Protocols and Applications, Wiley-Inter science.
5. Philip Levis, And David Gay "TinyOS Programming" by Cambridge University Press 2009

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective – IV

18CSE304 MOBILE APPLICATION DEVELOPMENT

L	T	P	C
3	0	0	3

Course Prerequisite: Java Programming and Basics of XML

Course Description:
This course is concerned with the development of applications on Android platform. Android is used as a basis for the development of mobile applications. This course starts with the basic concepts of Java, history of android and architecture. It introduces the major building blocks that are used to develop an android application with examples. It also covers the development of applications using widgets, events, networking. It provides ideas on sensors, their types and writing programs based on sensor classes for application development.

Course Objectives:
While studying this course student will be able to

1. Understand Android history and its fundamentals and know the building blocks of android
2. Get idea on the creation of android user interface and its testing mechanisms
3. Identify the usage of threads, broadcast receivers, indents, services and their working methodology
4. Know about the storage mechanism in android using SQLite and the usage of content providers
5. Recognize the usage of android widgets and sensors in android based applications

UNIT- I INTRODUCTION AND INSTALLATION OF ANDROID TOOLS
Android Overview – History – Android Versions - Android Flavors. **Android Stack**: Linux, Native Layer and Hardware Abstraction Layer (HAL) – ART - Application Framework: Native C++ Library – Applications: System and User Applications - **Installation and Use of Android Tools:** Installing the Android SDK - Anatomy of an Android Project - Drawable Resources – XML Introduction - Creating user interface using XML – Overview of Android Building Blocks – Logging Messages in Android . **(9)**

UNIT- II USER INTERACTION
Example. Input Components – Text View – Image View – List View and Alert Dialogues – Menus: Popup, Options and Context Menus – Screen Navigation through App Bar – Recycler View – Material Design – Testing the User Interface: Expresso – Screen Navigation using Intents: Definition – Usage of Intends – Creation of Indents with example program – Lists and Adapters–Types of Adapters – Examples using Adapters**.** **(9)**

UNIT- III THREADS, LOADERS AND ASYNCTASK LOADER, BROADCAST RECEIVERS, SERVICES
Threading in Android – AsyncTask – Loaders – AsyncTask Loader – Connecting to Internet: JSON - HTTP API, Apache HTTP Client, HTTP URL Connection - Broadcast Receivers: Custom Broadcasts – Broadcasting Intends and their related API - Boot Receiver - Alarms and

system services – Examples on alarms and services – Services: Services Life Cycle – Intent Service – Implementing Intent Service – Notifications: Managing Notifications. **(9)**

UNIT IV: SAVING, RETRIEVING AND LOADING DATA:
Android File systems and Files - Action Bar: Preferences and Action Bar - Shared Preferences – App Settings - Databases on Android - SQLite - Status Contract Class, Update Refresh Service – Cursors – Backups - Content Providers: Overview – Role of Content Providers - - Content Provider Example Program – Content Resolver **(9)**

UNIT-V APPLICATIONS WIDGETS, INTERACTION AND SENSORS
App Widgets: Creation of Application Widgets - Interaction and Animation: Live Wallpaper and Handlers - Sensors: Sensor API in Android - Motion Sensor, Position Sensor, Environmental Sensor, Sensor Values, Sensor Manager Class, Sensor Class, Sensor Event class, Sensor Event Listener interface, Compass Accelerometer and orientation Sensors, Sensor Examples **(9)**

Course Outcomes:
Upon successful completion of this course, students can able to:
1. Work on android basic components and Install android
2. Create User Interfaces with various Layouts and views using android building blocks
3. Work with Broadcast Receivers and Services
4. Create Database in Android, Store and Retrieve data using SQLite and Content Providers
5. Develop widgets, Wall papers for an android application and write programs based on Sensors

Text Books:

1. Android Programming-The Big Nerd Ranch Guide, Bill Philips, Christ Stewart, Kristin Mariscano, Big Nerd Ranch publishers, 3rd Edition
2. Android Programming for Beginners, John Horton, PACKT publishers
3. Learning Android , By Marko Gargenta& Masumi Nakamura, O'Reilly, II Edition
4. Android Application Development All in One for Dummies, Barry Burd, Wiley, 2nd Edition

Reference Books:

1. Android application Development-Black Book, Pradeep Kothari, dreamtech
2. Android Programming - Unleashed, B.M.Harwani, Pearson Education, 2013
3. Head First Android Development: A Brain-Friendly Guide, Dawn Griffiths and David Griffiths, O’Reilly, 2nd Edition
4. Android System Programming, Roger Ye, PACKT publishers
5. Programming Android,ByZigurdMednieks,LairdDornin,G.BlakeMeike& Masumi Nakamura, O'Reilly

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective – IV

18CSE305 SOFTWARE PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

Course Prerequisite: Nil

Course Description:
Software Project Management is generally seen as a key component of successful software projects. Together with software techniques it can produce software of high quality. This course deals with the decisions and actions related to planning, organizing, leading, and controlling programs and projects. Students are expected to gain a comprehensive understanding of Strategy, organization and leadership in managing projects and understanding of Processes, methods and systems used to plan, schedule and monitor projects.

Course Objectives:
1. To understand the basic concepts and issues of software project management.
2. To understand successful software projects that support organization's strategic goals.
3. Develop the skills for tracking and controlling software deliverables.
4. Match organizational needs to the most effective software development model.
5. Create project plans that address real-world management challenges.

UNIT I SPM CONCEPTS
Definition – components of SPM – challenges and opportunities – tools and techniques – managing human resource and technical resource – costing and pricing of projects – training and development – project management techniques. **(9)**

UNIT II SOFTWARE MEASUREMENTS
Monitoring & measurement of SW development – cost, size and time metrics – methods and tools for metrics – issues of metrics in multiple projects. **(9)**

UNIT III SOFTWARE QUALITY
Quality in SW development – quality assurance – quality standards and certifications – the process and issues in obtaining certifications – the benefits and implications for the organization and its customers – change management. **(9)**

UNIT IV RISK ISSUES
The risk issues in SW development and implementation – identification of risks – resolving and avoiding risks – tools and methods for identifying risk management. **(9)**

UNIT V SPM TOOLS
Software project management using Primavera & Redmine and case study on SPM tools. **(9)**

Course Outcomes:
Upon successful completion of the course, students will be able to
1. Maintain software projects and monitor software project process
2. Design and develop project modules and assign resources
3. Understand software quality and project management techniques
4. Comprehend, assess, and calculates the cost of risk involved in a project management
5. Use Primavera &Redmine software management tools.

Text Books:

1. Richard H. Thayer, “Software Engineering Project Management”, John Wiley & Sons, 2nd edition, 2001
2. Royce, Walker, “Software Project Management”, Pearson Education, 2002
3. Kelker, S. A., “Software Project Management”, Prentice Hall, 2003

References:

1. Software Project Management, Bob huges, Mike cotterell, Tata McGraw Hill, New Delhi,2002.
2. Software Project Management: A Concise Study, S. A. Kelkar, PHI.
3. Software Project Management, Joel Henry, Pearson Education.
4. Software Project Management in practice, PankajJalote, Pearson Education.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

Dept. of Mechanical Engineering

Open Elective – IV

18CSE306 SOFTWARE TESTING

L	T	P	C
3	0	0	3

Course Prerequisite: 20CSE112

Course Description:
This course aims to introduce the students to different methodologies in testing a program and its usage in building the testing tools. This course covers introduction to principles of software testing, path testing, transaction testing, dataflow testing, domain testing, path, path product, regular expressions with node reduction algorithm, functional testing, and logic based testing, state graph and its applications, graph matrices and its applications and case study of testing tools.

Course Objectives:
1. To study the Basic software debugging methods.
2. To enable the Students to understand various testing methodologies.
3. To study the procedure for designing test cases.
4. To enable the Students about the significance of software testing.

UNIT I: PRINCIPLES OF SOFTWARE TESTING AND PATH TESTING
Concepts and principles of software testing: Introduction: Purpose of Testing, Dichotomies, model for Testing, Consequences of Bugs, and taxonomy of Bugs. Structural Testing: Flow graphs and Path testing, Basics Concepts of Path Testing, Predicates, Path Predicates and Achievable Paths, Path Sensitizing, Path Instrumentation, Application of Path Testing. **(9)**

UNIT II: TRANSACTION FLOW TESTING AND DATAFLOW TESTING
Transaction Flow Testing: Transaction Flows, Transaction Flow Testing Techniques. Dataflow testing: Basics of Dataflow Testing, Strategies in Dataflow Testing, Application of Dataflow Testing. **(9)**

UNIT III: DOMAIN TESTING, PATHS, PATH PRODUCTS AND REGULAR EXPRESSIONS
Domain Testing: Domains and Paths, Nice & Ugly Domains, Domain testing, Domains and Interface Testing, Domains and Testability Paths, Path products and Regular expressions: Path Products & Path Expression, Reduction Procedure, Applications, Regular Expressions & Flow Anomaly Detection. **(9)**

UNIT IV: FUNCTIONAL TESTING, STATE, STATE GRAPHS AND TRANSITION TESTING
Functional Testing: Logic Predicates and Clauses, Logic Based Testing, Logic Expression Coverage Criteria, Active Clause Coverage, Inactive Clause Coverage, Infeasibility and Subsumption, Making a Clause Determine a Predicate, Structural Logic Coverage of Programs, Decision Tables, Path Expressions, KV Charts, and Specifications. State, State Graphs and Transition Testing: State Graphs, Good & Bad State Graphs, State Testing, Testability Tips. **(9)**

UNIT V: APPLICATIONS OF TEST CASE DESIGN

TestingObject-Oriented Software, Unique Issues with Testing OO Software, Types of Object-Oriented Faults , Testing Web Applications and Web Services, Testing Static Hyper Text Web Sites, Testing Dynamic Web Applications, Testing Web Services, symbolic testing, Concolic testing, Conclusions. **(9)**

Course Outcomes:

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

1. Understand the basic principles of testing, path testing and compare different path testing strategies.

2. Explain different transaction flow and data flow testing techniques.

3. Understand and identify various Domains testing strategies, methods and defining the method to find the regular expression used to find the testing paths.

4. Test the functions and state of the applications manually and by automation using different testing methods.

5. Apply and use software testing methods and various test tools.

Text Books:

1. Software testing techniques – Boris Beizer, Dreamtech, second edition.

2. Software Testing- Yogesh Singh, Camebridge.

3. Introduction to Software Testing, Paul Ammann and Jeff Offutt, Cambridge University Press, 2nd edition, 2016.

References:

1. The craft of software testing - Brian Marick, Pearson Education.

2. Software Testing, 3rd edition,P.C. Jorgensen, Aurbach Publications (Dist.by SPD).

3. Software Testing, N.Chauhan, Oxford University Press.

4. Effective methods of Software Testing, Perry, John Wiley, 2nd Edition, 1999.

6. Software Testing Concepts and Tools, P.Nageswara Rao, dreamtech Press.

Mode of Evaluation: Assignments, Mid Term Test, End Semester Examinations

DISCIPLINE ELECTIVE - I

Dept. of Mechanical Engineering

Discipline Elective - I

18ME401 PRODUCTION PLANNING AND CONTROL

L	T	P	C
3	0	0	3

Course Prerequisite: Zeal to learn the subject

Course Description:
The production planning and control course provides an understanding, importance and relevance to the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control and also the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

Course Objectives:
1. Describes the production facilities in the best possible manner along with the proper systematic planning of production activities.
2. Discuss the adequate arrangement of men, money, materials, machines tools, implements and equipment relating to production.
3. Articulates all the arrangements to remove possible obstacles in the way of smooth production.
4. Discuss about the production targets to be achieved by keeping in view the sales forecast.

UNIT I: INTRODUCTION
Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design. **(9)**

UNIT II: WORK STUDY
Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards. **(8)**

UNIT III: PRODUCT 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 **(8)**

UNIT IV: FORE CASTING AND PRODUCTION SCHEDULING
Forecasting – Importance of forecasting – Types of forecasting, their uses – General principles of forecasting – Forecasting techniques – qualitative methods and quantitative methods, Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates. **(10)**

UNIT V: INVENTORY CONTROL AND RECENT TRENDS IN PPC

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures, Two bin system -Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis-Recorder procedure-Introduction to computer integrated production planning systems- elements of JIT Systems-Fundamentals of MRP II And ERP. **(10)**

Course Outcomes:

The successfully complete of this course, Student will be able to:

1. Interpret the role and importance of manufacturing planning & control system processes.
2. Demonstrate manufacturing planning & control system processes in industry.
3. Compare good manufacturing planning & control system processes in industry.
4. Examine manufacturing planning & control system practices in industry
5. Understand the inventory control and its applications in manufacturing systems.

Text Books:

1. R. Panneerselvam, "Operations Research", Second Edition, PHI Learning Pvt. Ltd., 2006.
2. Martand Telsang, "Industrial Engineering and Production Management", First edi tion, S. Chand and Company, 2000.
3. James.B.Dilworth,"Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.

Reference Books:

1. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8thEdition, John Wiley and Sons, 2000.
3. KanishkaBedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
4. Melynk, Denzler, "Operations management – A value driven approach" Irwin Mcgraw hill.
5. Norman Gaither, G. Frazier, "Operations Management", 9th edition, Thomson learning IE,2007
6. Jain. K.C & L.N. Aggarwal, "Production Planning Control and Industrial Management", KhannaPublishers, 1990.
7. Chary. S.N. "Theory and Problems in Production & Operations Management", Tata McGrawHill, 1995.
8. Upendra Kachru, "Production and Operations Management – Text and cases", 1st Edition, Excel books 2007.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - I

18ME402 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
2	1	0	3

Course Prerequisites: 18ME108, 18ME112

Course Description: Computational fluid dynamics (CFD) has become an essential tool in analysis and design of thermal and fluid flow systems in wide range of industries. Few prominent areas of applications of CFD include meteorology, transport systems (aerospace, automobile, high-speed trains), energy systems, environment, electronics, bio-medical (design of life-support and drug delivery systems), etc. The correct use of CFD as a design analysis or diagnostic tool requires a thorough understanding of underlying physics, mathematical modeling and numerical techniques. The user must be fully aware of the properties and limitations of the numerical techniques incorporated in CFD software. This course aims to provide precisely these insights of CFD.

Course Objectives:
Specific objectives may be summarized as:
1. To give the students necessary exposure to the CFD techniques such that they can solve basic fluid flow problems using CFD
2. To understand mathematical characteristics of partial differential equations.
3. To learn computational solution techniques for various types of partial differential equations.

UNIT 1: GOVERNING EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS

Introduction and Philosophy of Computational Fluid Dynamics, Need for problem solving with CFD, Applications of CFD, Basic structure of a CFD code, Governing equations: Continuity equation, Momentum equation, Energy equation, Mathematical classification of partial differential equations: Parabolic, Elliptic and Hyperbolic equations, Well posed and ill posed problems, Initial and boundary conditions. **(9)**

UNIT 2: LINEAR SOLVERS AND FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS

Solution of discretised linear algebraic equations, Iteration method: Jacobi's method, Elimination methods: L-U decomposition technique, Tridiagonal matrix algorithm (Thomas' algorithm), Finite Volume Method for one-dimensional steady state diffusion, two-dimensional diffusion and three-dimensional diffusion problems. **(9)**

UNIT 3: FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS

Steady one dimensional convection and diffusion, Central differencing scheme, Properties of discretisation schemes, Assessment of the central differencing scheme for convection-diffusion problems, Upwind differencing scheme, Hybrid differencing scheme, Quick scheme.

(9)

UNIT 4: SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY COUPLING IN STEADY FLOWS

Introduction, Staggered grid, Momentum equations, The SIMPLE algorithm, Assembly of a complete method, SIMPLER and SIMPLEC methods. **(9)**

UNIT 5: TURBULENCE MODELLING AND GRID WITH APPROPRIATE TRANSFORMATION

Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Turbulence models: Mixing length model, The k-ε model, Reynolds stress equation model, Grid with Appropriate Transformation: General transformation of the equations, Metrics and Jacobian, Stretched (Compressed) grids, Boundary fitted coordinate systems, Elliptic grid generation. **(9)**

Course Outcomes:
1. Develop the basic governing equations for fluid and heat flow by examining the physical boundary conditions.
2. Construct the discretized equations according to the nature (i.e. elliptic, parabolic and hyperbolic) of the flow problem.
3. Solve the linear algebraic equations by direct and iterative methods.
4. Analyze and evaluate various finite volume based CFD schemes to solve convection-diffusion problems.
5. Apply the variations of SIMPLE schemes for incompressible flows.
6. Select an appropriate model for turbulence flow and method for grid generation.

Text Books:
1. John D Anderson, "Computational Fluid Dynamics", Tata-McGraw Hill Publisher, 1st Edition, 1995.
2. K Muralidhar & T Sundararajan, "Computational Fluid Flow and Heat Transfer", Narosa Book Distributors Pvt Ltd, 2nd Edition, 2009.
3. H K Versteeg& W Malalasekara, "Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education (Indian Reprint), 2nd Edition, 2007.

References:
1. S V Patankar, "Numerical Heat Transfer and Fluid Flow", Taylor & Francis, 1st Edition, 1980.
2. R H Pletcher, J C Tannehill& D A Anderson, "Computational Fluid Mechanics and Heat Transfer", CRC Press, 3rd Edition, 2012.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - I

18ME403 TOOL AND DIE DESIGN

L	T	P	C
3	0	0	3

Course Prerequisite: Design of Machine Elements, Manufacturing Technology, Machine Tools and Metrology

Course Description:
The course provides wide knowledge on component production through jigs for guiding the cutting tool to make hole and fixtures to locate the components while machining in various machines tools. The course will help to design press tools for sheet metal components like simple die, compound, progressive and combination dies. The course enhances the knowledge on different type mechanical presses, hydraulic press and press brakes.

Course Objectives:
The students will study and understand:

1. The metal cutting process, single point, multi point tools in various for components Production.
2. The fundamentals and functioning of locating, work holding and clamping devices.
3. Design principles of drill bushes, drill jigs for various industrial applications.
4. The design concepts and various fixtures used in different machine tools.
5. Design procedures of progressive, compound or combination dies for press working operations

UNIT I: DESIGN OF CUTTING TOOLS
Tool Design, Tool Design objectives, Challenges to the Tool Designer, Requirements of a Tool Designer, Overview of Metal cutting process, Tool materials, Introduction to cutting tools, Design of single point cutting tool, Design of Multipoint cutting tool-Drills, Milling cutters, broaches. **(10)**

UNIT II: WORK HOLDING DEVICES
Introduction, Functions of work holding devices, Basic principle of six-point location, Locating methods and devices, Principle of clamping and Types of clamps, Design considerations. **(8)**

UNIT III: DESIGN OF JIGS
Types of drill jigs, Drill bushes, General considerations in the design of drill jigs, Simple designs of Template, Plate, Channel, Box, Angle plate **(9)**

UNIT IV: DESIGN OF FIXTURES
Design principles, Types of fixtures, Fixtures for machine tools: Lathe, Milling, Boring, Broaching and Grinding, Inspection and Welding fixtures **(9)**

UNIT V: PRESS TOOL DESIGN
Press tools, Fundamentals of die cutting operations, Cutting action in punch and die operations, Centre of pressure, Design of piercing die, Design of blanking die, Progressive, Compound and Combination dies **(9)**

Course Outcomes:

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

1. Design a single and multi-point cutting tools.
2. Use relevant Locating and Clamping devices for components
3. Identify the relevant jigs for the given component with justification.
4. Choose and design a fixture for selected operations on machine tool
5. Select and design blanking, piercing die, compound die, combination die for various sheet metal components.

Text Books:

1. Donaldson C., Lecain G.H. and Goold V.C. (2007), Tool Design, 3rd edition, Tata McGraw- Hill Publishing Company Ltd., New Delhi.
2. F.W.Wilson.F.W. "Fundamentals of Tool Design", ASME, PHI, New Delhi, 2010.
3. Edward G. Hoffman (2004) Jigs and Fixtures Design, Thomson - Delmar Learning Series, Singapore.

References:

1. Joshi P. H., (2004) Jigs and Fixtures, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2. Jeff Lantrip, David A. Smith and John G. Nee, (2003) Fundamentals of Tool Design, 5th Edition, Society of Manufacturing Engineers.
3. Surendra Kenav and Umesh Chandra, Satyaprakashan, Production Engineering Design (Tool Design), New Delhi.
4. Amitabha Bhattacharya and Inyong Ham, Design of Cutting Tools use of Metal Cutting Theory, ASTME Publication, Michigan USA.
5. V.Arshinov, G.Alekseev, Metal Cutting Theory and Cutting Tool Design, MIR Publications.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - I

18ME404 FLUID POWER SYSTEMS

L	T	P	C
3	0	0	3

Course Prerequisite: 18MAT108

Course Description:
Fluid power systems are the systems that use pressurized fluids for generation, control and transmission of power. Such systems are extensively used in automobiles, heavy machinery and in control systems. This course is intended to provide the students with necessary background in the fluid power so that they acquire a working knowledge of the typical fluid power systems. The fundamental concepts required for design, analysis, application, operation and maintenance of fluid power systems will be covered.

Course Objectives:

1. To review the fluid mechanics principles that is relevant to fluid power systems
2. To teach basic components of fluid power systems and their working principles
3. To elucidate the working of hydraulic pumps, motors, valves, actuators and their use in hydraulic circuits
4. To elucidate the working of compressors, pneumatic actuators, valves and their use in pneumatic circuits.
5. To explicate the design and analysis of hydraulic and pneumatic circuits.
6. To describe the implementation logic control using fluid circuits
7. To present best practices in design, safe operation and maintenance of Fluid Power Systems

UNIT I: INTRODUCTION TO HYDRAULIC POWER
Pascal's law and problems on Pascal's Law, Continuity equation, Bernoulli's equation. Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps, Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.
Hydraulic Actuators and Motors: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.
(9)

UNIT II: CONTROL COMPONENTS IN HYDRAULIC SYSTEMS
Directional Control Valves – Symbolic representation, Constructional features, pressure control valves –direct and pilot operated types, flow control valves. Shock absorber .Hydraulic Circuit Design and Analysis: Control of single and double acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, and Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits. **(9)**

UNIT III: PNEUMATIC CONTROL

Characteristics of compressed air. Structure of Pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, and Lubricators. Pneumatic Actuators: Linear cylinders– Types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications. Rotary cylinder types construction and application. Design parameters, selection.

Pneumatic Control valves: Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications. **(9)**

UNIT IV: MULTI-CYLINDER APPLICATIONS

Coordinated and sequential motion control. Motion and control diagrams – signal elimination methods. Cascading method. Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications. Distribution of compressed air- Piping layout. **(9)**

UNIT V: ACCESSORIES AND MAINTENANCE OF FLUID POWER SYSTEMS

Conductor sizing for flow rate requirements, Hydraulic oils; Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting. Safety of Fluid Power Systems. **(9)**

Course Outcomes:

At the end of the course, student will be able to

1. Apply the basic fluid mechanics principles used in design and analysis of fluid power systems
2. Distinguish between different types of fluid power systems and know their relative merits and demerits
3. Design and analyze components of hydraulic systems like pumps, hydraulic motors, cylinders, valves and actuators.
4. Design and analyze components of pneumatic systems like compressors, valves and actuators.
5. Describe the working principles of controls for fluid power circuits.

Text Books:

1. Fluid Power with applications, Anthony Esposito, Fifth edition pearson education, Inc. 2000.
2. Pneumatics and Hydraulics, Andrew Parr. Jaico Publishing Co. 2000.

References:

1. Pinches, Industrial Fluid Power, Prentice hall
2. D. A. Pease, Basic Fluid Power, Prentice hall
3. J. J. Pipenger, Industrial Hydraulics, McGraw Hill
4. H. L. Stewart, Hydraulics and Pneumatics, Industrial Press

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Discipline Elective - I

18ME405 FINITE ELEMENT METHODS

L	T	P	C
2	1	0	3

Course Prerequisite: Mechanics of Solids

Course Description:
To understand the basic concepts of finite element methods and to analyse and solve structural, dynamic analysis, and heat conduction problems by applying finite element methods

Course Objectives:

1. To teach students the basic principles of finite element methods.
2. To teach students the basic implementation method of finite element methods
3. To teach students how to perform 1-D and 2-D structural analysis using finite element methods.
4. To teach students how to perform 1-D heat conduction analysis using finite element methods.
5. To teach students how to perform 1-D dynamic analysis using finite element methods.

UNIT I: INTRODUCTION TO FEM
Basic concepts, general description, application of FEM, advantages of FEM, basic element shapes, interpolation functions, principle of minimum potential energy, Galerkin method, basic equations of elasticity, strain displacement relations, solution of system of equations using Gauss elimination **(9)**

UNIT II: 1-D STRUCTURAL PROBLEMS
Axial bar element – stiffness matrix, load vector, temperature effects, quadratic shape functions , Analysis of plane trusses
Analysis of beams – Hermite shape functions, stiffness matrix, load vector **(9)**

UNIT III: 2-D PROBLEMS
Introduction to CST, iso-parametric element, shape functions, stiffness matrix and load vector, boundary conditions **(9)**

UNIT IV: 1-D HEAT TRANSFER ANALYSIS
Derivation of the basic differential equation, finite element solution for combined conduction and convection **(9)**

UNIT V: FEM FOR MODAL ANALYSIS
Lagrange’s equations, consistent and lumped mass matrices for bar and 2D truss Characteristic polynomial approach - Eigenvalues, Eigenvectors, natural frequencies, mode shapes for bars and 2D trusses **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. State the applications of FEM in various engineering fields
2. Calculate stresses and strains for one-dimensional problems using finite element methods
3. Analyse 2-D problems using FEM
4. Analyse and solve 1D heat transfer problems
5. Analyse the frequency response and find the mode shapes of bars and 2D trusses

Text Book:

1. Introduction to Finite Elements in Engineering, Chandraputla, A and Belegundu, PHI

References:

1. Finite Element Methods in Engineering, SS Rao, Pergamon A first course in Finite Element Method, Daryl L Logan, Cengage Learning

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Discipline Elective - I

18ME426 DESIGN THINKING AND PRODUCT INNOVATION

L	T	P	C
3	0	0	3

Course Prerequisite: Basic Engineering Mathematics and Physics

Course Description:
This course is an introductory course on Innovation and Design Thinking. It focuses on providing you with the knowledge and fundamental understanding of Creativity, Innovation, and some contemporary approaches to innovation including design thinking. The course will cover seminal models, key principles, and methods and techniques in innovation and design thinking, including their applications.

Course Objectives:
1. To Define Creativity and Innovation
2. Recognize the significance of innovation
3. Discuss both individual and contextual factors that are linked to creativity
4. Discuss key concepts and principles that guide innovative practices
5. Examine approaches to innovation practiced by various organizations

UNIT I: HISTORY OF MODERN DESIGN
An insight into design, History of Modern design: Early innovations industrialization, new materials, nature of design, work design for survival and survival through design **(9)**

UNIT II: DESIGN THINKING APPROACHES
Design thinking: Design thinking as a systematic approach to innovation, brain storming, visual thinking, design challenges, product development **(9)**

UNIT III: DECISION MAKING
Innovation, art of innovation, strategies for creativity, teams for innovation, design alternatives, decision making for new design **(9)**

UNIT IV: DESIGN THINKING APPLICATIONS
Design thinking for strategic innovation, application of design, thinking in business and strategy, linking design thinking solution to business challenges, enterprise creativity, competitive logic of business strategy, design thinking for start-ups **(10)**

UNIT V: DESIGN THINKING TECHNIQUES
Creative thinking techniques: Linear thinking, constraints in design, design thinking to meet corporate needs, designing today for tomorrow **(8)**

Course Outcomes:

The students after completing the course will be able to:

1. Grasp the fundamental capabilities in the methods used for practicing Design Thinking
2. Understand challenges and benefits of Design Thinking
3. Communicate clearly about Design Thinking
4. Innovate in multidisciplinary teams
5. Have a process and mindset suited to innovation and creative problem-solving

Text Books:

1. Tim Brown, "Change by Design" Harper Bollins (2009)
2. Idris Mootee, "Design Thinking for Strategic Innovation", John Willey & Sons (2013)

References:

1. Tom Kelley and Jonathan Littman, "The Art of Innovation", Harper Collins Business (2001)
2. Jimmy Jain, "Thinking for Startups", Notion Press (2018)
3. David Raizman, "History of Modern Design", Laurence King Publishing Ltd. Edition 2 (2010)
4. Tom Kelley and Jonathan Littman, " The Art of Innovation", Harper Collins Business (2001)
5. Michael Michalko, "Thinker Toys", Ten Speed Press (2006)

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

DISCIPLINE ELECTIVE – III

Dept. of Mechanical Engineering

Discipline Elective - III

18ME406 DESIGN AND ANALYSIS OF WELDED STRUCTURES

L	T	P	C
2	1	0	3

Course Prerequisite: None

Course Description: Design of welded structures is one of the important and critical area of mechanical engineering. This is an important course for both UG & PG level, which deals with fundamentals of welding design under static and fatigue loading**.** Residual stress and distortion characteristics in welding.

Course Objectives:

1. To provide the basic knowledge and importance of design, weldability of steels, different properties and failure theories.
2. To provide the basic knowledge of different welding symbols and terminology, different joints involved in welding.
3. To understand the concepts of different static loading conditions on welded joints.
4. To introduce the concept of fatigue or dynamic loading and its importance on welded structures.
5. To understand the concepts of residual stress and distortion in welded structures.

UNIT I:
Introduction to design, Engineering properties of steels, Weldability of structural steels, Carbon equivalent, Fatigue and creep properties of welded joints, Theories of failures; **(8)**

UNIT II:
Type of welds and weld joints, Description of welds terminology, Welding symbols, Edge preparation, Sizing of welds in structure, Type of connections in welded structures, Combined groove and fillet weld connections; **(8)**

UNIT III:
Weld calculations for lap, Butt and fillet welds, Analysis of connections for direct tension or compression and shear loading conditions, Resistance to moment by combined tension and compression; **(8)**

UNIT IV:
Fatigue fracture, Residual fatigue strength, Factors affecting fatigue life, Design of welded joints for fatigue loading, Methods for improving the fatigue strength of welded joints, Dynamic behavior of joints - stress concentrations, Fatigue behaviour of hollow section joints, Reliability analysis and safety factors applied to fatigue design. **(9)**

UNIT V:
Heat flow in welding, Effect of welding parameters on heat distribution, Calculation of peak temperature, Weld thermal cycle, Cooling rate and solidification time, Welding residual stresses - causes, occurrence, Residual stress distribution, Influence of residual stress in static and dynamic loading, Introduction to stress corrosion. Distortion in welding and factors affecting distortion **(12)**

Course Outcomes:
The focus of Design of welded structures is the fundamentals of welded joint design on the basis of strength and rigidity under both static and fatigue loadings. By the end of the course student should:

1. Have a fundamental knowledge of welded structures, its design principle, welding characteristics of steel and application of theories of failures in welded structures.
2. Have a clear overall picture about various welded symbols and terminology, different edge preparations for butt joint, different types of joints in welded structures and fillet with groove combination in welded structures.
3. Be familiar with various types of static loadings and their combinations for different welded joints.
4. Have a mastery of fatigue or dynamic loading on welded joints and concepts of stress concentration. Also, they will know how to apply them to the practical engineering problems;
5. Be able to know the concepts of heat distribution, residual stress, distortion and weld thermal cycle in different welded structures.

Text Book:

1. Rational Welding Design by Gray, T. G. F. and Spence, J., Butterworths, 1992.

Reference Books:

1. Welding Hand Book, Vol. 2 & 3, 9th Ed., American Welding Society, 2001.
2. Principles of Welding By Messler, R.W. Jr., John Wiley & Sons, 1999.
3. Parmer. R. S. "Welding Engineering and Technology", Khanna Publications, 1999
4. Bhattacharya.M, 'Weldment Design', Association of Engineers, 1991

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - III

18ME407 REFRIGERATION AND AIR CONDITIONING

L	T	P	C
2	1	0	3

Course Prerequisite: 18MAT103 & 18ME112

Course Description:
This course explains the principles of Refrigeration and Air-conditioning and help to design any Refrigeration and Air-conditioning system through comprehensive explanations of the fundamental principles. Ideally suited to those with a little or no knowledge of the subject. It also provides the criteria to select the refrigerant for a particular application. The course consists of different refrigeration cycles and understanding of psychrometry and psychrometric processes used for the purpose of air-conditioning.

Course Objectives:
1. The course is designed to give an in-depth study of theory of refrigeration and air-conditioning and their applications.
2. The techniques of analysis and design of refrigeration and air-conditioning systems will also be discussed.

UNIT_I: INTRODUCTION AND IDEAL CYCLES

Necessity and applications, Refrigerating machines, Comparison of heat engine, heat pump and refrigerating machine, Unit of refrigeration and C.O.P, Methods of refrigeration, Reversed Carnot cycle with gas and vapour as refrigerants, Limitations of reversed Carnot cycle with vapour as refrigerant, Air refrigeration: Reversed Brayton or Joule or Bell Coleman cycle, Open and dense air refrigeration systems, Refrigeration needs of aircrafts, Simple aircraft cycle, Boot-strap aircraft cycle, Problem solving. **(9)**

UNIT_II: VAPOUR COMPRESSION AND ABSORPTION REFRIGERATION SYSTEMS

Modifications in reversed Carnot cycle with vapour as a refrigerant, Simple vapour compression refrigeration cycle, Representation cycle on T-S, P-h and h-s charts – COP - Effect of sub cooling and super heating, Actual cycle of operation, Influence of various parameters on system performance, Use of p-h charts, Multi-pressure systems, Multi-stage compressor, evaporator and expansion valve, Simple vapour absorption system, Comparison with vapour compression refrigeration system, Properties of working fluids in vapour absorption systems, Estimation of maximum COP, Modifications to simple vapour absorption system. **(9)**

UNIT III: SYSTEM COMPONENTS AND REFRIGERANTS

Compressors: General classification, Comparison, Advantages and disadvantages, Condensers: Classification, Working, Evaporators: Classification, Working, Expansion Valves: Types, Working,
Refrigerants: Desirable properties, Common refrigerants used, Nomenclature. **(9)**

UNIT-IV: INTRODUCTION TO AIR-CONDITIONING

Properties of moist air, Thermodynamic wet bulb temperature, Psychrometric chart, Psychrometric processes in air conditioning equipment, Simple air-conditioning system and state and mass rate of supply air, Summer air-conditioning apparatus dew point, Winter air-conditioning **(9)**

UNIT-V: LOAD CALCULATIONS IN AIR CONDITIONING AND DUCT DESIGN

Fabric heat gain, Overall heat transmission coefficient, periodic heat transfer through walls and roofs, Internal heat gains, System heat gains, Break-up of ventilation load and Effective Sensible Heat factor, Cooling load estimate, Heating load estimate.
Classification of ducts, Governing equations used for the air flow analysis through ducts, Pressure losses in duct flows, Equivalent diameter for a rectangular duct, Methods of Duct design. **(9)**

Course Outcomes:
On successful completion of the course, the student will be able to,

1. Describe the ideal refrigeration cycles and applications of refrigeration systems.
2. Compute the COP and power requirement of vapour compression refrigeration system, vapour absorption refrigeration system.
3. Explain the working principles of various components of vapour compression refrigeration system.
4. Analyze air-conditioning processes using the principles of psychrometry.
5. Evaluate cooling and heating loads in an air-conditioning system.

Text Books:

1. Arora C.P. 'Refrigeration and Air-conditioning', 3rd Ed Tata McGraw Hill Co, 2000.
2. Domkundwar and Arora. 'Refrigeration and Air-conditioning', Dhanpat Rai & Co. (P) Ltd., 2010.

References:

1. Manohar Prasad, 'Refrigeration and air-conditioning', Wiley Eastern Ltd, 1983.
2. Roy J. Dossat, 'Principles of Refrigeration', 4th Ed. Pearson Education Asia, 2002.
3. Edward G. Pita, 'Air Conditioning Principles and Systems', 4th Ed. Pearson Education Asia, 2003.
4. W.F. Stoecker and J.W. Jones, 'Refrigeration and air-conditioning', 2nd Edition, McGraw-Hill, Inc. New Delhi.

Data Book: Refrigerant and Psychrometric Properties (Tables & Charts) SI Units, Mathur M.L. & Mehta F.S., Jain Brothers.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - III

18ME408 INTERNET OF MANUFACTURING THINGS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
The manufacturing industries are the significant sustainable sources for the modern society. Traditional manufacturing systems and relative management approaches need constant review and upgrade to meet the demands of modern complex products. Internet of Things (IoT), has potential to collect, process, analyze and communicate real time data, while enhancing overall productivity within given time frame with higher flexibility and transparency. This course tries to provide the essential knowledge to bridge the IoT and Manufacturing systems.

Course Objectives:
1. To provide the basic knowledge and importance of IoT and its logic and applications in Manufacturing Industry.
2. To provide the basic knowledge of real time information sensing and cloud computing in manufacturing system.
3. To understand the concepts of IoT enabled smart trolleys and assembly systems.
4. To provide basic understanding of real-time production performance analysis methods. and scheduling system.
5. To provide basic understanding of real-time, information driven production scheduling system.

UNIT I:
Introduction- Concept of IoT, Existing manufacturing paradigms and their limitations, Applications of IoT in Manufacturing System (MS), The Concept of IoT-MS and its limitations.
Overview of IoT-Enabled Manufacturing System- Overall architecture of IoT-MS, Integration framework of real-time manufacturing information, The work logic of IoT-MS, Core technologies in IoT-MS. **(9)**

UNIT II:
Real-Time(RT) Multisource Manufacturing Information Sensing System - Introduction, Overall Architecture of RT and multisource RMMISS, Deployment of multi-sensors, Multiple sensors manager, Multiple source manufacturing Information Capturing and Sharing, Case studies.
Cloud Computing-Based Manufacturing – Introduction, Overall architecture, Cloud Machine Model, MS-UDDI, Task driven manufacturing service method. **(9)**

UNIT III:
IoT-Enabled Smart Assembly Station- Introduction, RFID based applications and assistant services in assembly line, Overall architecture, Real-time: Status Monitoring, Production Guiding, Data Sharing, Production Requeuing.

IoT Enabled Smart Trolley– Material handling and real time strategy, RT-data capturing in manufacturing field, overall architecture, Real-time: Information capturing, Encapsulation, Exchange, Workflow based guidance. Two stage combination optimization method. **(9)**

UNIT IV:

Real-Time (RT) Production Performances Analysis Method- Real-time: Production monitoring technique, KPI analysis, Anomaly analysis. Overall architecture, Even hierarchy of critical event, HTCPN analysis. Real time production anomaly diagnosis **(9)**

UNIT V:

Real-Time Information Driven Production Scheduling System – Introduction, RT production scheduling, Agent technology, Manufacturing information monitor technology, Overall architecture, Equipment agent, Capability evaluation agent model, RT- scheduling agent model, Production execution monitor agent model. **(9)**

Course Outcomes:

The focus of this course is to study the inculcation of IoT in manufacturing systems and how the system turns smart. By the end of the course student should:

1. Be able to understand the fundamentals of IoT and its application in manufacturing systems.
2. Have a clear overall picture of multisource manufacturing information sensing system and cloud manufacturing.
3. Outline various methods of IoT enabled smart assembly systems and summarize the usage of smart trolleys
4. Make use of various RT- production performance analysis methods for test its applicability to real life problems.
5. Make use of various RT- information driven production scheduling system for test its applicability to real life problems.

Text Book:

1. Fei Tao, Y. Zhang, "Optimization of Manufacturing Systems Using the Internet of Things", 1st Edition, 2017, Academic Press, Elsevier.

Reference Book:

1. A. Gilchrist, "Industry 4.0: The Industry Internet of Things", 1st Edition, 2016, Apress.
2. M. Dastbaz, P. Cochrane, "Industry 4.0 and Engineering for a Sustainable Future", 1st Edition, 2019, Springer.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - III

18ME409 SOLAR ENERGY FOR PROCESS HEAT AND POWER GENERATION

L	T	P	C
3	0	0	3

Course Prerequisite: 14ME104&14ME112

Course Description:
This course discusses in details the theory and design aspects of various types of solar thermal collectors. Details of thermal performance of different thermal collector configurations are included. Emphasis has been given to the concentrating collector for power generation and the applications of solar energy for industrial process heat. Solar thermal energy storage through different mechanics and processes and discussed.

Course Objectives:
1. Describe the various aspects of solar radiation to analyse and estimate solar radiation at different locations.
2. Articulate the theories and parameters for designing solar energy system
3. Dissipate the knowledge for estimating different losses in solar energy systems

UNIT I: GENERAL INTRODUCTION AND SOLAR ENERGY
Overview of various renewable energy technologies, importance and historical development of solar energy applications, Environmental characteristics associated with solar energy utilization, Present Indian and international energy scenario of conventional and RE sources. Introduction to Solar energy, Global Energy Needs and Resources, solar energy conversion thermal conversion, photovoltaic conversion, limitations of solar energy conversion, Fundamentals of Solar Radiation, The Physics of the Sun and Its Energy Transport, Thermal Radiation Fundamentals, Sun–Earth Geometric Relationship. **(9)**

UNIT II: SOLAR RADIATION AND MEASUREMENT
Solar Radiation and measurement, Extraterrestrial Solar Radiation, Estimation of Terrestrial Solar Radiation, Instruments for Measuring Solar Radiation and Sunshine Detectors for Solar Radiation Instrumentation, Sun earth angles, solar hourly radiations-Radiations on Horizontal and inclined surfaces, solar energy measuring techniques. **(9)**

UNIT III: SOLAR ENERGY COLLECTOR
Engineering and technological considerations of various collectors used for solar energy harnessing, such as Flat-Plate Collectors, Tubular Solar Energy Collectors, Concentrating Solar Collectors, Parabolic Trough Concentrator, Central Receiver Collector, Compound-Curvature Solar Concentrators, Experimental Testing of Collectors, Performance of collectors: Characteristics of various collectors, Critical factors affecting the performance of various collectors, Different kinds of tests to assess the performance of collector. **(9)**

UNIT IV: SOLAR THERMAL ENERGY STORAGE
Thermal Energy Storage: types of thermal energy storage, Energy Storage: Sensible heat storage, Liquid, Solid, packed bed, Latent heat storage. Design of Storage System Selection of Storage Material, Energy Transport Subsystems, Piping Systems, Pressure Drop, Heat Loss, Heat Exchangers, and Storage systems used for SHWS applications. **(9)**

UNIT V: SOLAR HEATING AND COOLING SYSTEMS

Solar Water-Heating Systems, Natural Circulation, Forced-Circulation Systems Solar Air-Heating Systems, Thermal load estimations, Engineering and technological considerations of Analysis and design various Solar Space Cooling and Refrigeration, Passive Solar House: Passive Solar Heating, Cooling and Daylighting. **(9)**

Course Outcomes:

The successfully complete of this course, Student will be able to:

1. Understand the principles of operation of the broad spectrum of renewable energy Technologies and solar energy
2. Estimate or measure solar radiation at any location.
3. Design appropriate solar collectors required in various applications.
4. Discuss the importance of storage systems, types of thermal storage and alternate methods
5. Understand the principles of solar cooking, solar desalination, solar ponds, solar space heating, solar industrial process heating and solar power generation

Text Books:

1. F Kreith and J F Kreider: Principles of Solar thermal Engineering.
2. S P Sukhatme: Solar Energy

Reference Books:

1. J A Diffie and W A Beckman: Solar Engineering of Thermal processes
2. A B Meinel and F P Meinel: Applied Solar Engineering
3. Tiwari, G.N. and SayestaSuneja., Solar Thermal engineering Systems, Narosa Publishing House.
4. Duffie and Backuran, Solar Thermal Engineering. H.P. Gupta.,Solar Engineering

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Discipline Elective - III

18ME410 INDUSTRIAL TRIBOLOGY AND CORROSION

L	T	P	C
3	0	0	3

Course Prerequisite: Engineering Chemistry

Course Description:

Corrosion, erosion, wear and friction are central mechanisms for damaging a surface and thereby the integrity of a structure or a component. Tribology is the science of interacting surfaces in relative motion. This course deals with the most central topics within surface protection and tribology. The course deals with how to achieve desired lifetime of a component or construction by application of coatings, surface modification and/or lubrication.

Course Objectives:

1. To give awareness of most important surface degradation mechanism (corrosion and wear)
2. To expose the students to different types of corrosion.
3. To give in-depth idea of friction, wear, and lubrication.
4. To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
5. To introduce corrosion and wear testing techniques.

UNIT I: INTRODUCTION TO SURFACES ENGINEERING AND FRICTION

Engineering surfaces - Surface characterization, Contact of engineering surfaces: Hertzian and nonhertzian contact, Contact pressure and deformation in non-conformal contacts. Causes of friction, Stick-slip friction behaviour and friction instability, sliding and rolling friction, frictional heating and temperature rise. Friction measurement techniques. **(9)**

UNIT II: WEAR

Wear and wear types, Mechanisms of wear, Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components. wear measurement and controlling techniques-Fluid jet erosion test-Abrasive wear tester- rolling sliding wear tester- pin-on-disc wear tester- scratch testing- Wear Measurement /Quantification. **(9)**

UNIT III: LUBRICATION

Lubricants and their physical properties, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, oil emulsion, Selection of Lubricants, Hydrodynamic lubrication: Reynolds Equation, Infinite bearing, short bearing Elastohydrodynamic Lubrication: Principle and application, pressure - viscosity term in Reynold„s equation, Hertz theory, Ertel-Grubin Equation. **(8)**

UNIT IV: BASIC ASPECTS OF CORROSION

Introduction, Importance of corrosion, Economics of corrosion. Corrosion of Materials: Oxidation, Corrosion and wear. Basics of Thermodynamics and Kinetics of oxidation and corrosion. Pourbaix diagram, Polarization, Mixed potential theory. Passivity, Characteristics of passivation, degradation of composites. **(8)**

UNIT V: TYPES OF CORROSION

Fundamental of corrosion studies, types of corrosion, atmospheric, galvanic, pitting, crevice corrosion, intergranular corrosion and dealloying. Stress corrosion cracking, Season cracking, high temperature corrosion. Laboratory corrosion tests, corrosion monitoring methods. Cathodic and anodic protection: Principles, applications, advantages and disadvantages. Chemical methods of corrosion control: Use of inhibitors and coatings. **(11)**

Course Outcomes:

The students will be able to

1. Apply the basic theories of surface engineering to predictions about the frictional behaviour of contact surfaces
2. Understand the wear theories, types of wear, mechanism, factors and selection of materials.
3. Characterize features of rough surface and liquid lubricants as they pertain to interface sliding
4. Understand the surface degradation mechanisms
5. Solve problems involving various types of corrosion.

Text Books:

1. Introduction to Tribology, B. Bhushan, John Wiley & Sons, Inc., New York, 2002
2. An Introduction to Corrosion Science and Corrosion Inhibition,.N.Banerjee, ,Oxonian Press, P.Ltd., New Delhi, 1985.

References:

1. Engineering Tribology, PrasantaSahoo, PHI Learning Private Ltd, New Delhi, 2011.
2. Engineering Tribology, J. A. Williams, Oxford Univ. Press, 2005.
3. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control, Butterworth Heinemann, London, 2006

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

DISCIPLINE ELECTIVE – IV

Dept. of Mechanical Engineering

Discipline Elective - IV

18ME411 FUNDAMENTALS OF AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisite: 18MAT108

Course Description:
The detailed concept, construction and principle of operation of engine and various engine components, combustion, cooling and lubrication systems will be taught to the students. At the end of the course the students will have command over automotive engines and the recent development in the area of engines.

Course Objectives:
1. Penetrate deep into engine classification, construction and operation of IC engines with latest technologies
2. Grasp the importance SI and CI engine application in automobiles
3. Understand the performance parameters and testing methodologies
4. Understand the necessity of Ignition system SI engines
5. Understand the combustion process for both SI and CI engines, the concepts of Governors, Fuel pump, Fuel Injectors.

UNIT I: CONSTRUCTION AND OPERATION
Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles. Two stroke SI and CI engines – construction and working. Comparison of SI and CI engines and four stroke and two stroke engines. Engine classification, firing order. Otto, diesel and dual cycles. **(7)**

UNIT II: FUEL SYSTEMS
Air fuel ratio requirements of SI engines, Air fuel ratio and emissions, Working of a simple fixed venturi carburetor, Constant vacuum carburetor. Diesel fuel injection systems-Jerk pumps, distributor pumps, pintle and multihole nozzles, Unit injector and common rail injection systems. Injection pump calibration. Need for a governor for diesel engines. Description of a simple diesel engine governor **(8)**

UNIT III: COMBUSTION AND COMBUSTION CHAMBERS
Introduction to combustion in SI and diesel engines and stages of combustion. Dependence of ignition timing on load and speed. Knock in SI and CI engines. Combustion chambers for SI and CI engines. Direct and indirect injection combustion chambers for CI engines. Importance of Swirl, squish and turbulence. Factors controlling combustion chamber design.
(7)

UNIT IV: SUPERCHARGING, TURBOCHARGING AND ENGINE TESTING
Supercharging and Turbocharging, Different methods of turbocharging, Intercooling, Turbocharger controls including, waster gate, variable geometry, variable nozzle types. Dynamometers, Indicated thermal, brake thermal and volumetric efficiencies. Measurement of friction, Cylinder pressure measurement. Engine performance maps, Engine testing standards.
(8)

UNIT V: COOLING AND LUBRICATION SYSTEMS

Need for cooling, types of cooling systems- air and liquid cooling systems. Thermo syphon and forced circulation and pressurized cooling systems. Properties of coolants. Requirements of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. Properties of lubricants. **(7)**

Course Outcomes:

1. Grasp the basic engine terminologies
2. Describe SI and CI engine system application in automobiles.
3. Differentiate the fuel dynamics for SI and CI engines and define the key terms such as carburetion, injection, stoichiometric ratio, lean burn etc.
4. To design combustion chambers for SI /CI engines with reference to variable compression ratios
5. Analyze the combustion phenomenon within the combustion chamber and Determine the combustion behavior in SI and CI mode. The performance characteristics in both SI and CI engines theoretically / practically.

Text Books:

1. Ganesan V., "Internal Combustion Engines", Tata McGraw Hill, 2007
2. Ramalingam K.K., “Internal Combustion Engines”, Sci-Tech Publications, 2005.
3. Devaradjane. Dr. G., Dr. M. Kumaresan, "Automobile Engineering", AMK Publishers, 2013.

References:

1. Heisler, "Advanced Engine Technology" SAE Publication, 1995
2. Edward F. Obert "Internal Combustion Engines" 3 Edition, 1970
3. Gupta. H.N. "Fundamentals of Internal Combustion" Engines, reprint, PHI Learning Pvt. Ltd. 2006
4. Mathur and Sharma "Fundamental Combustion Engines" Dhanpat Rai and Sons, 2002
5. John B. Heywood, “Fundamentals of Internal Combustion Engines”, 1988

Mode of Evaluation: Assignment, Mid Examination, End Examination.

Discipline Elective - IV

18ME412 DESIGN OF PRESSURE VESSELS AND PIPING SYSTEMS

L	T	P	C
2	1	0	3

Course Prerequisite: 18ME104, 18ME105, 18ME110,

Course Description: Pressure vessels and associated piping connections are ubiquitous in almost every manufacturing, refining, power generation and food industries to name a few. It is intended to introduce to the student the design of pressure containing vessels and process piping using ASME Section VIII, Division1 and B31.3 respectively. The fundamentals provided through this course will enable the student to appreciate the safety measures that are taken during the design process and will enable him or her to pursue a career in the process equipment design.

Course Objectives:

1. Introduce the student with the vessel components design for internal and external pressure
2. Discuss the vertical vessel supports for various loadings
3. Introduce the student the concept of process piping analysis

UNIT I: SHELLS AND HEADS

ASME Section VIII, Division I overview, Allowable stresses, Types of design loads, Design load combinations, Weld joint examination requirements, Pressure testing of vessels and components, Design of cylindrical and spherical shells for internal and external pressure, Stiffening rings, Design of ellipsoidal, hemispherical, torispherical heads and conical transition sections for internal and external pressure, Minimum design metal temperature (MDMT), MAP, MAWP and test pressure **(8)**

UNIT II: FLANGES, COVERS AND OPENINGS

Integral flat plates, Design of flanges, Design of spherically dished covers, Design of blind flanges with and without openings, Gasket requirements, Bolt sizing, Bolt Loading, Bolt torque required for sealing flanges, Design of nozzles, Design of reinforced openings, Ligament efficiency **(7)**

UNIT III: HORIZONTAL VESSEL SUPPORTS AND WELDING

Design of horizontal vessel on saddles, Design of saddle supports for large vessels, Butt welds, Fillet welds, Groove welds, Plug welds, Design allowable stresses for welded joints, Stress concentration factors for welds, Defects and non-destructive examination of welds, Welding processes, Weld symbols **(7)**

UNIT IV: VERTICAL VESSEL SUPPORTS

Design of tall towers: Wind load, Period of vibration, Seismic load, Eccentric load, Weight of the vessel, Combination of stresses, Design of skirt support, Design of anchor bolts, Design of base ring, Skirt to base ring weld, Supports for Short Vertical Vessels: Stresses in vessels on leg support, Stresses in vessels due to lug support, Base plate, Base plate attachment weld **(8)**

UNIT V: PROCESS PIPING

Introduction to B31.3 code, Allowable stresses, Quality factors, Weld joint strength reduction factors, Design of straight pipe, for internal and external pressure, Pressure design of welded branch connections, Extruded outlet header, Bends, Elbows, Miter bends, Closures, Flanges, Blanks, Reducers, Design for sustained and occasional loads, Stress intensification factors, Flexibility analysis equations, Cold springing **(8)**

Course Outcomes:

The students after completing the course will be able to:

1. Design shells and heads of a pressure vessel for internal and external pressure.
2. Design flanges and dished covers for the pressure vessel and recommend the right bolt torque for proper gasket sealing.
3. Design saddle supports for horizontal vessels. Students would also be able to determine the vessel weld sizes for various loadings.
4. Design vertical pressure vessel supports for wind, seismic, eccentric loading and vessel weight.
5. Design piping and its welded branch connections for internal and external pressures as per B31.3 process piping code. Students would also be able to perform pipe flexibility analysis for simple pipe networks.

Text Books:

1. Henry H. Bedner, Pressure Vessels, Design Hand Book, CBS publishers and Distributors,
2. Browenell L.E and Young E.D. Process equipment design, Willey Eastern Ltd. India
3. Smith P, Fundamentals of Piping Design, Elsevier.

References:

1. Harvey J F, Pressure vessel design CBS publication
2. ASME Pressure Vessel and Boiler code, Section VIII Division 1
3. American standard code for pressure piping, B 31.1

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - IV

18ME413 DESIGN OF HEAT EXCHANGERS

L	T	P	C
2	1	0	3

Course Prerequisite: Thermodynamics, Fluid Mechanics, Heat Transfer

Course Description: Heat exchangers are equipment that facilitates the transfer of heat between a hot fluid and a cold fluid. Heat exchangers vary in size and type based on application. Heat exchangers are used in the process industry, power industry and refrigeration & air conditioning industry just to name a few. In this course, it is intended to provide a basic introduction to the thermal design of the various kinds of heat exchangers. The students are expected to apply the principles of thermodynamics, heat transfer and fluid mechanics during the design of heat exchangers.

Course Objectives:

1. To make the student understand the various types of heat exchangers available in the manufacturing and service industries based upon their types and applications.
2. By the end of this course, the student is expected to learn the basic thermal design of various kinds of heat exchangers
3. This course is designed to make the student understand the use and the thermal design of re-boilers
4. One of the objectives of this course is to provide the student with various tools to take an appropriate engineering judgement when choosing the right heat exchanger for a certain application.

UNIT I: HEAT EXCHANGER TYPES AND DESIGN METHODS

Classification of heat exchangers, selection of heat exchangers, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, effectiveness-NTU method for heat exchanger analysis, fouling, techniques to control fouling. **(7)**

UNIT II: DOUBLE PIPE AND SHELL & TUBE HEAT EXCHANGERS

Double Pipe Heat Exchanger: Thermal and hydraulic design of inner tube and annulus, Double pipe exchangers in series-parallel arrangements.

Shell & Tube Heat Exchangers: Shell types, Tube bundle types, Tube layout, Baffle type and geometry, Shell side heat transfer coefficient, Shell side pressure drop, Tube side heat transfer coefficient, Tube side pressure drop, Preliminary estimation of unit size, Rating of the preliminary design. **(7)**

UNIT III: CONDENSERS

Steam Power Plant and Process Condensers: Horizontal Shell-Side Condensers, Vertical Shell-Side Condensers, Vertical Tube-Side Condensers. Shell & Tube Condensers for Power Plant: Steam Turbine Exhaust Condensers, Feed Water Heaters, Air Cooled Condensers, Thermal Design of Shell & Tube Condensers. Direct Contact Condensers: Spray Condensers, Tray Condensers.

Condensers for Refrigeration and Air Conditioning Systems: In-Tube Refrigerant Condensation Heat Transfer, In-Tube Heat Transfer Augmentation, Shell-Side Refrigerant Condensation Heat Transfer, Shell-Side Heat Transfer Augmentation, Evaporative

Condensers, Cooling towers and Spray Ponds, Capacity of Cooling Towers and Spray Ponds, Natural Draft Cooling Towers, Forced Draft Cooling Towers, Induced Draft Cooling Towers. **(9)**

UNIT IV: EVAPORATORS AND REBOILERS

Process Evaporator Types: Horizontal Shell-Side Evaporator, Horizontal Falling-Film Evaporator, Horizontal Tube-Side Evaporator, Short-Tube Vertical Evaporator, Long-Tube Vertical Evaporator, Climbing-Film Evaporator, Vertical Falling-Film Evaporator, Agitated Thin Film Evaporator, Plate-Type Evaporator.

Reboiler Types: Internal Reboiler, Kettle Reboiler, Vertical Thermo-syphon Reboiler, Horizontal Thermo-syphon Reboiler

Evaporators for Refrigeration and Air Conditioning: Classification of evaporators based on natural or forced convection type, flooded or dry type, refrigerant flow inside the tubes or outside the tubes, salient features of: natural convection coils, flooded evaporators, shell & tube type evaporators, shell & coil evaporator, double pipe evaporators, Baudelot evaporators, direct expansion fin-and-tube type evaporators, plate surface evaporators, plate type evaporators, Chillers, thermal design aspects of refrigerant evaporators, enhancement of boiling heat transfer, concept of Wilson's plot. **(9)**

UNIT V: COMPACT HEAT EXCHANGERS

Characteristics of Compact Heat Exchangers, Construction Types of Compact Heat Exchangers, Tube-Fin Heat Exchangers, Continuous Fins on a Tube Array, Heat Transfer and Friction Factor Correlations for Crossflow over Staggered and In-line Finned Tube Banks, Fin Efficiency of Plain Continuous Fin on Circular Tubes, Plate-Fin Heat Exchangers, Fin Geometry Selection and Performance Factors, Correlations for j and f factors of Plate-Fin Heat Exchangers, Plate Heat Exchangers, Flow Patterns and Pass Arrangement, Plate Pattern, Gasket Selection, Thermo-hydraulic Fundamentals of Plate Heat Exchangers. **(8)**

Course Outcomes:

The students after completing the course will be able to:

1. Classify the various types of heat exchangers and understand the LMTD and Effectiveness-NTU methods for the thermal design of heat exchangers.
2. Understand the various components of the double pipe and Shell & Tube heat exchangers and perform an elementary sizing of these tubular exchangers.
3. Perform a basic design of condensers for power and Refrigeration & Air Conditioning industries.
4. Design evaporator coils for refrigeration & air conditioning applications and design re-boilers for process applications.
5. Perform an elementary thermal rating of Tube-Fin, Plate-Fin and Plate type heat exchangers.

Text Books:

1. A.P. Fraas and M.N. Ozisick "Heat Exchanger Design" , John Wiley & Sons
2. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" , John Wiley & Sons
3. Sadik Kakac and Hongtan Liu, "Heat Exchangers Selection , Rating and Thermal Design", CRC Press

References:

1. J.P. Gupta, "Fundamentals of Heat Exchanger and Pressure Vessel Technology" , Hemisphere Publishing Company, Washington
2. Taborek.T, Hewitt.G.F and Afgan.N, "Heat Exchangers, Theory and Practice", McGraw-Hill Book, Co..
3. J.D.Gurney and I.A. Cotter "Cooling Towers "
4. Arora and Domkundwar "Refrigeration and Air Conditioning" by, Dhanpat Rai and Sons

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - IV

18ME414 NON DESTRUCTIVE TESTING

L	T	P	C
3	0	0	3

Course prerequisite: Knowledge on welding process, casting of products, X ray techniques

Course descriptions:
This course provides students a synopsis of non-destructive and destructive evaluation methods that are used in evaluation of welds. This includes understanding the basic principles of various NDT methods, fundamentals, and discontinuities in different product forms, importance of NDT, applications, limitations of NDT methods and techniques and codes, standards and specifications related to non-destructive testing technology. Students also will be introduced to relevant quality assurance and quality control requirements in accordance with ASME, ASTM, AWS, BS, IBR standards.

Course Objectives:

1. To understand principle behind various NDT techniques.
2. To study about NDT equipment and accessories.
3. To learn working procedures of various NDT techniques.
4. To learn international inspection standards and specifications related to NDT techniques

UNIT I : SURFACE NON DESTRUCTIVE EVALUATION TECHNIQUES
Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects. Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials, Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism. **(8)**

UNIT II: THERMOGRAPHY AND EDDY CURRENT TESTING (ET)
Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation. **(8)**

UNIT III : ULTRASONIC TESTING
Fundamentals of ultrasonic waves, Generation of ultrasonic waves-piezo electric effect, Ultrasonic inspection methods-pulse echo method, through transmission method, resonance method, Study of A, B and C scan presentations, Interpretation for welds, castings etc, applications, various case studies, Inspection standards and specifications (ASME, ASTM, AWS, BS, IBR etc.) **(8)**

UNIT IV: RADIOGRAPHIC TESTING AND SAFETY
Basic principles of radiography- X rays and their properties, X ray generation, X ray absorption and scattering, Radiographic image-image formation and quality, image interpretation, radiography of weldments, Radiation safety- radiation detectors, radiation shielding. Interpretation for welds, castings etc, applications, various case studies, Inspection standards and specifications (ASME, ASTM, AWS, BS, IBR etc.) **(7)**

UNIT V: ADVANCED NDE TECHNIQUES
Acoustic emission testing: Basic principle, parameters, Kaiser-Felicity theory Phased array techniques- Principles of phased array inspection, Theory and principles of time of flight diffraction (TOFD), Synthetic Aperture Focusing Technique (SAFT), Electro Magnetic Acoustic Transducer (EMAT), Laser ultrasonics-Laser Shearographics, Structural health monitoring, Digital Radiography, Computed Tomography (CT). **(7)**

Course Outcomes:
After completion of course, students will be able to:
1. Know the different surface NDE techniques which enables to carry out various inspection
2. Perform inspection of samples and identify the defects using Theromgraphy and Eddy current testing
3. Understand basic knowledge of ultrasonic testing which enables them to perform inspection of samples
4. Differentiate various defect types and characterize them using radiography
5. Understand the recent developments in NDE and their application in various industries

Text Books:
1. Peter J. Shull "Non Destructive Evaluation: Theory, Techniques and Application" Marcel Dekker, Inc., New York, 2002.
2. Baldev raj, T Jeyakumar, M. Thavasimuthu "Practical Non-Destructive Tesitng" Narosa Publishing house, New Delhi, 2002.

Reference books:
1. Baldev Raj and B.Venkataraman, "Practical Radiology", Narosa Publishing House, 2004.
2. Krautkramer.J, "Ultra Sonic Testing of Materials", 1st Edition, Springer – Verlag Publication, New York, 1996.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

Dept. of Mechanical Engineering

Discipline Elective - IV

18ME415 TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description

Total quality management (TQM) is a philosophy, methodology and system of tools aimed to create and maintain mechanism of organization's continuous improvement. It involves all departments and employees for the improvement of processes and products. It helps to reduce costs, exceed needs and expectations of customers and other stakeholders of an organization. TQM encompasses the concepts of business and social excellence that is sustainable approach to organization's competition, efficiency improvement, leadership and partnership.

Course Objectives:

The students will be able to:

1. Study comprehensive knowledge about the principles, practices, tools and techniques of total quality management.
2. Gain knowledge on leadership, customer satisfaction, addressing customer complaints, team work, employee involvement, related to customer and supplier partnership.
3. Gather information on various tools and techniques, concept on Six Sigma, bench marking and Failure Mode Effective Analysis (FMEA).
4. Know the importance of Quality circle, Quality Function Deployment, Taguchi design and case studies related to TQM.
5. To be aware of international/national Quality awards.

UNIT I: INTRODUCTION

Introduction - Need for quality - Evolution of quality - Definition of quality – Quality control, Quality management and Quality Assurance - Definition of TQM – Basic concepts of TQM - TQM Framework - Contributions by Deming, Juran and Crosby – Dimensions of quality – Benefits of quality and Barriers. **(8)**

UNIT II: TQM PRINCIPLES

TQM principles - Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – Supplier partnership – Partnering, Supplier selection, Supplier Rating. **(8)**

UNIT III: TOOLS AND TECHNQUES I

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA. **(7)**

UNIT IV: TQM TECHNIQUES

Quality circles – Quality Function Deployment (QFD) – Design of Experiments-Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures. **(7)**

UNIT V: IMPELMENTATION OF TQM

Steps for Implementation of TQM, KAIZEN, 5S, JIT, POKAYOKE, I - Introduction to Robust Design, ISO Standards, Need for ISO 9000 and 14000 series, Quality Systems and Case studies. **(8)**

Course Outcomes:

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

1. Understand the various principles and practices of TQM to achieve quality.
2. Identify the various statistical approaches for Total Quality Control.
3. Demonstrate the TQM tools for continuous process improvement.
4. Adopt the importance of ISO and Quality systems.
5. Make use of the concepts of TQM to solve case studies

Text Books:

1. Dale H. BesterField, et al., Total Quality Management, Pearson Education Asia, Third Edition, Indian Reprint (2003).

References:

1. James R. Evans and William M. Lindsay, The Management and Control of Quality, (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition (2003).
3. Suganthi,L and Anand Samuel, Total Quality Management, Prentice Hall (India) Pvt. Ltd. (2006) Model.

Mode of Evaluation: Assignments, Internal Mid Examinations, End Examination.

DISCIPLINE ELECTIVE – V

Dept. of Mechanical Engineering

Discipline Elective - V

18ME416 MECHANICAL VIBRATIONS

L	T	P	C
2	1	0	3

Course Prerequisite: 18MAT108

Course Description:
This course is designed to acquaint the students with topics in vibrations. The emphasis is on application to common engineering situations and prepare students to tackle free and forced vibration problems. Free and forced (damped and undamped) Vibration Problems with different numerical methods, Instruments used in measuring the vibrations.

Course Objectives:

1. Perform vibration design of simple mechanical systems that can be approximated by one, two, or infinite degree of freedom systems.
2. Perform basic free vibration analysis of multi- and infinite-degree of freedom systems.
3. Demonstrate knowledge of simple methods of vibration control

UNIT I: FUNDAMENTALS OF VIBRATIONS
Basic Concepts of Vibration, Types of Vibrations, Basic Elements in vibrations, Springs, Springs in series and Parallel, simple problems in springs, Degree of freedom, Natural frequency of spring mass system and simple pendulum.
Damping, simple problems in vibrations. Types of damping, energy dissipated by damping (Viscous), friction or Coulomb damping, and structural damping. Damping ratio. Over damping system, Critical damping and Under damping system. Equation of motion of spring mass with damper. Simple problems **(9)**

UNIT II: SINGLE DEGREE OF FREEDOM SYSTEMS
Free vibration of an undamped systems, Free vibration of damped (viscous damper) systems, Logarithmic decrement, Torsional system with viscous damping, problems on single DOF System.
Single DOF forced undamped vibration systems and damped vibration Transient vibrations, vibration isolation. Critical speed of shaft, Rotating unbalanced problem,. Laplace Transformation methods, Transmissibility **(8)**

UNIT III: TWO DEGREE OF FREEDOM SYSTEMS
Free vibration of 2- DOF system, Analysis of Coupled pendulum, principle of coordinator, Normal modes, initial conditions, coordinate coupling, Principle of orthogonality. Numerical problems
Forced vibrations of two degree of freedom. Eigan values, Eigan vector, mode shapes, Dynamic vibration absorber, Problems. **(8)**

UNIT IV: MULTI DEGREE OF FREEDOM SYSTEMS & VIBRATION MEASURING INSTRUMENTS
Multi DOF free vibration systems, Eigen values and vectors, Matrix formulation, Multi Degree of Freedom forced harmonic vibration, Orthogonality relations, Numerical problems, Vibration measuring instruments. **(8)**

UNIT V: NUMERICAL METHODS
Energy method, Rayleigh method, Dunkerley's equation, principle of virtual work, Lagrange Equation of motion, Mechanics, Generalized Coordinates. **(7)**

Course Outcomes:
1. Perform free-vibration analysis of one degree of freedom systems.
2. Perform free-vibration analysis of two degree of freedom systems.
3. Perform free-vibration analysis of three degree of freedom systems.
4. Perform forced-vibration analysis of one and two degree of freedom systems
5. Design simple mechanical systems for vibrations and vibration measuring instruments.

Text Books:
1. Theory of Vibrations with Applications, William T. Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, Pearson, Sixth Ed.
2. Mechanical Vibrations, R.VenkataChalam, PHI Publlications.

References:
1. Mechanical Vibrations, Singiresu S Rao, Pearson, 4th Ed.
2. Mechanical Vibrations - Theory and Application", Francis S. Tse, Ivan E. Morse and Rolland T. Hinkle, Allyn and Bacon Inc. London, 1983.

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - V

18ME417 INTRODUCTION TO GAS TURBINE ENGINES

L	T	P	C
2	1	0	3

Course Prerequisite: 18ME103, 18ME108, 18ME112, 18ME114

Course Description: Gas turbine is the heart of a jet propulsion system and also used to develop shaft power for power generation. It is intended that the student learn the basic working process of gas turbines when being used for thrust generation and also for shaft power generation. Various parts of the gas turbine, namely, the compressor, turbine, combustion chamber etc. are incorporated into the course and a detailed mathematical modelling of these various accessories is part of the course. At the end of this course, the student will be equipped with the tools necessary to analyse the gas turbine using practical and jet propulsion cycles and also evaluate the performance of the compressors and axial turbines.

Course Objectives:

1. Introduce the student with the various types of cycles used for analysing gas turbines.
2. To make the student understand the working process of centrifugal and axial compressors in a gas turbine.
3. To determine the performance of an axial flow turbine in a gas turbine
4. To introduce the combustion chamber, inlet and nozzle systems of a gas turbine.

UNIT I: INTRODUCTION AND BASIC PRINCIPLES

Compressible flow machines, Energy transformation, Stagnation properties, Velocity of sound, Streamline, Streamtube, Mach number, Mach angle and Mach cone, Streamtube area-velocity relation, Normal shock wave, Oblique shock and expansion waves, flow with friction and heat transfer, flow in constant-area duct with friction. Open and closed cycle arrangements, Ideal cycle analysis, Simple gas turbine cycle, Heat exchange cycle, Reheat cycle, Reheat and Heat exchange cycle, Intercooled cycle, Intercooled cycle with heat exchanger, Intercooled and reheat cycle, Intercooled cycle with heat exchange and reheat, Ericsson cycle. **(8)**

UNIT II: GAS TURBINE CYCLES

Practical cycles and their analysis, Stagnation properties, Compressor and Turbine efficiency, Pressure or flow losses, Heat exchanger effectiveness, Effect of varying mass flow, Effect of variable specific heat, Mechanical losses, Cycle efficiency, Polytropic efficiency, Performance of actual cycle, Jet propulsion cycles, Ramjet engine, Pulsejet engine, Turboprop engine, Turbojet engine, Thrust equation, Specific thrust of the turbojet engine, Efficiencies related to Jet propulsion cycles, Thrust augmentation. **(7)**

UNIT III: COMPRESSORS

Centrifugal Compressor: Essential parts, principle of operation, Ideal energy transfer, Blade shapes and velocity triangles, Analysis of flow through compressor, Diffuser, Volute casing, Performance parameters, Losses in centrifugal compressors, Compressor characteristics, Surging and Choking.

Axial Flow Compressors: Geometry and working principle, Stage velocity triangles, Work done factor, Enthalpy-Entropy diagram, Compressor stage efficiency, Performance coefficients, Degree of reaction, Flow through blade rows, Flow losses, Stage losses, Pressure rise calculation in a blade ring, Performance characteristics, Comparison of axial flow compressors **(8)**

UNIT IV: TURBINES

Single impulse stage, Single reaction stage, Multistage machines, Velocity triangles of a single stage machine, Expression for work output, Blade loading and flow coefficients, Blade and Stage efficiencies, Maximum utilization factor for a single impulse stage, Velocity compounding of multistage impulse turbine, Pressure compounding of multistage impulse turbine, Reaction turbine, Multistage reaction turbines, Blade to gas speed ratio, Losses and efficiencies, Performance graphs. **(8)**

UNIT V: COMBUSTION, NOZZLE & INLET SYSTEMS

Combustion theory applied to gas turbine combustor, Factors affecting combustion chamber design, Factors affecting combustion chamber performance, Form of combustion system, Requirements of the combustion chamber, Process of combustion in a gas turbine, Combustion chamber geometry, Mixing and Dilution, Combustion chamber arrangements, Inlets, Subsonic inlets, Diffuser, Supersonic inlets, Exhaust nozzles. **(7)**

Course Outcomes:

The students after completing the course will be able to:

1. Develop a relationship for the energy transfer in a turbomachine and understand the concept of the degree of reaction.
2. Analyse the performance of practical gas turbine and jet propulsion cycles by taking into account the various losses in different components.
3. Analyse the flow through the centrifugal and axial compressor from inlet to outlet and also analyse the effect of impeller blade shape on the performance of centrifugal and axial compressor.
4. Analyse the performance of a multi-stage pressure compounded axial reaction turbine for various degree of reactions and draw the performance charts.
5. Evaluate the factors affecting the design of combustion chamber and also understand the various inlet types and evaluate the nozzle performance

Text Books:

1. V. Ganesan, Gas Turbines, Tata McGraw Hill Co., 3rd edition, 2010.

References:

1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, CRC Press (Taylor & Francis Group)
2. Cohen and Rogers, Gas Turbines Theory, Wesley Longman, 1996.
3. J.F. Lee, Theory and design of stream and gas turbine, McGraw Hill, 1954.
4. R. Yadav, Steam & Gas Turbines and Power Plant Engineering, Central Publishing House, 2004.

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - V

18ME418 DESIGN AND MANUFACTURE OF COMPOSITES

L	T	P	C
3	0	0	3

Course Prerequisite: Material Science and Engineering

Course Description:

Composite material consists of both fiber and matrix. This course is designed to understand the composite materials used in automobiles, aerospace, and chemical industries etc., Since the materials are selected based on specific strength/stiffness, corrosion resistance and complex designs, composite materials are gaining popularity over monolithic materials.

Course Objectives:

The student will be able to:

1. To grasp the basic theory of composite materials and their importance.
2. To learn the different types of fibres used as reinforcements in composite material.
3. To impart knowledge on polymer composites, processing methods and modelling of composites.
4. To understand the various matrix materials used as matrix in composite material.
5. To study the different type of manufacturing process for fabrication of composite materials.

UNIT I: INTRODUCTION

Introduction to Composites; Reinforcement and matrices; Types of reinforcements; Types of matrices; types of composites; Function of the Matrix and Reinforcement in Composites Matrices: Thermosets and Thermoplastic; Fibre Reinforcement; properties of composites in comparison with standard materials; applications of composites (metal, ceramics, and polymer matrix composites). **(7)**

UNIT II: MATRIX MATERIAL

Matrix Materials – Polymers, glass transition temperature, thermoplastics and thermosets plastics, stress – strain behaviour, epoxy, polyester, Polyether ether ketone (PEEK), polypropylene (PP), matrix materials – metals: structure, strengthening methods, properties of metals (aluminium, titanium, magnesium), matrix materials – ceramics: bonding and structure, fracture toughness, properties of ceramics (glass, alumina, silicon carbide), fibre – matrix interface: wettability, surface roughness, mechanical bonding, chemical bonding. **(8)**

UNIT III: PROCESSING OF POLYMER MATRIX COMPOSITES (PMC)

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding

– interfaces in PMCs – structure, properties and application of PMCs, modelling of unidirectional composites, composite density (mass & volume fraction), calculation of longitudinal modulus for unidirectional composites. **(8)**

UNIT IV: PROCESSING OF METAL MATRIX COMPOSITES (MMC)

Metallic matrices: aluminium, titanium, magnesium, copper – processing of MMCs: liquid state, solid state, in – situ fabrication techniques – diffusion bonding – powder metallurgy techniques – Interfaces in MMCs – mechanical properties – machining of MMCs – Applications. **(7)**

UNIT V: PROCESSING OF CERAMIC MATRIX COMPOSITES (CMC)

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques, chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs – mechanical properties and applications of CMCs – applications. **(8)**

Course Outcomes:

1. Classify the various matrix material and reinforcements for polymer matrix composites, MMC and ceramic matrix composites.
2. Developing the knowledge on processing, interfacial properties, and application of composites.
3. To get the thorough knowledge on manufacturing of polymer matrix composites.
4. Understanding the fabrication process of metal matrix composites.
5. Summarizing the various fabrication process of ceramic matrix composites.

Text Books:

1. Krishan K. Chawla, "Composite Materials: Science and Engineering", Second edition. Springer-Verlag, Newyork, 2010.

References:

1. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010.
2. Sanjay K. Majumdar, "Composites manufacturing- materials, product, and process engineering" CRC Press, 2001.
3. B.D. Agrawal L.J. Broutman and K. Chandrashekhara "Analysis and Performance of Fiber Composites", John Wiley & Sons, 2006.

Mode of Evaluation: Assignment, Midterm Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - V

18ME419 DESIGN OF POWER PLANT SYSTEMS

L	T	P	C
2	1	0	3

Course Prerequisite:

Course Description:
Classification of power plants. Components and layout of thermal, nuclear, hydroelectric power plants Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis, load factor, diversity factor. Power plant instrumentation and controls.

Course Objectives:

1. This course has been designed to make the students familiar with the power plant engineering and technology. It deals with the thermal, hydro, and nuclear power plants.
2. The course also discusses non-conventional power generation.
3. It also focuses on economic analysis, economic loading, load curve analysis will also be discussed.

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UNIT I: INTRODUCTION
Power scenario of India-sources of Energy-Resources and Development of power in India.
Steam power cycles: Steam power cycles, Efficiency improvement of stem power cycles, working of fluid or vapor power cycles. GT-ST power plant **(8)**

UNIT II: STEAM GENERATORS
Boilers, Efficiency improvement of boilers, Pollution control of boilers, Feed water treatment. Important fuels, Stoichiometry, Control of excess air, Draught systems **(7)**

UNIT III: STEAM TURBINES
Turbine blading, Electrical energy generation. Condenser, Feed Water, Circulating Water System. Nuclear Power Plant: Basics, Components and layout, Nuclear reactors Hydroelectric Power Plant: Components and layout **(8)**

UNIT IV: DIESEL ENGINE POWER PLANT
Components and layout -IC engines, types Gas Turbine Power Plants: Introduction-classification –construction – layout with auxiliaries Magneto Hydro Dynamics (MHD) systems- layout-types **(7)**

UNIT V: POWER PLANT ECONOMICS
Economics of power generation, economic loading of power stations. Load curve analysis, load factor, diversity factor Power plant instrumentation and controls.Non-Conventional Power Generation: Renewable energy sources, Solar and Wind based power generation & other sources for power generation. **(8)**

Course Outcomes:

The students after completing the course will be able to:

1. Know various types of power plants to be used for power generation,
2. Know various types of steam generators.
3. Know various types of steam turbines.
4. Type of fuel used for respective power plant, what exactly a stoker is, and how does it work.
5. The student should be able to know the different factors that may affect power plant economies, economic loading, and load curve analysis.

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Text Books:

1. P.K. Nag, Power Plant Engineering, Tata McGraw-Hill Publishing Company Ltd, Third Ed., 2008.

References:

1. Bernhardt G.A. Strotzki and William A. Vopat, "Power Station Engineering and Economy", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1960.
2. M.M. EI-Wakil, "Power Plant Technology", McGraw-Hill International Edition, 1984.
3. Domkundwar, "Power Plant Engineering", DhantpatRai and Co. (P) Ltd., New Delhi, 2001.

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - V

18ME420 OPERATIONS RESEARCH

L	T	P	C
2	1	0	3

Course Prerequisite: None

Course Objectives:
The course is intended to

1. Understand the concept of O.R and application for optimization using L.P model.
2. Apply different methods to solve transporting of goods at lowest cost and validate the methods.
3. Understand game theory and problem connected with scheduling of number of jobs.
4. Understand and solve problem to reduce waiting time at various stations.
5. Apply network and use the PERT and CPM techniques to optimize the project duration.

UNIT – I: INTRODUCTION TO OPERATIONS RESEARCH
Introduction to Operations Research (OR): OR definition, Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models.
Linear Programming (LP): Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Two–Phase Simplex Method, Special Cases of LP. **(8)**

UNIT – II: TRANSPORTATION
Introduction to Transportation Problem, Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem.
(10)

UNIT – III: SEQUENCING AND SHEDULING
Sequencing: Introduction to Job shop Scheduling and flow shop scheduling, Solution of Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, graphical method. **(9)**

UNIT – IV: QUEUING THEORY
Introduction to Queuing Theory, Arrival Pattern, Service Channel, Population, Departure Pattern, Queue Discipline, Birth & Death Process, Single Channel Models with Poisson Arrivals, Exponential Service Times with finite queue length and non-finite queue length; Multichannel Models with Poisson Arrivals, Exponential Service Times with finite queue length and non-finite queue length. **(8)**

UNIT – V: PROJECT MANAGEMENT
Network analysis- Network representation- Application of project management Project Scheduling – precedence diagram and PERT - expected time - optimistic time estimate - most likely time - pessimistic time CPM: Basic Difference between PERT and CPM, PERT / CPM Network Components and Precedence Relationship, Scheduling - Johnson's rule – Gantt charts-FCFS-SPT-LPT-EDD techniques. **(7)**

Course Outcomes

After studying the course, the student will be able to:

1. Understand the concept of O.R and application for optimization using L.P model.
2. Apply different methods to solve transporting of materials at lowest cost and validate the methods.
3. Solve the problems connected with sequencing and scheduling of number of jobs.
4. Understand and solve problem to reduce waiting time at various stations.
5. Apply knowledge in project management to reduce the project time by employing PERT and CPM techniques.

Text books:

1. Pannerselvam R., Operations Research, 2nd Edition, Prentice Hall of India, New Delhi, 2010.
2. Sharma S.D., Operations Research: Theory, Methods and Applications, 15th Edition, Kedar Nath Ram Nath, 2010
3. Taha H.A., Operations Research, 9th Edition, Prentice Hall of India, New Delhi, 2010.

Reference books:

2. Hiller F.S., and Liberman G.J., Introduction to Operations Research, 7th Edition, Tata McGraw Hill, 2010.
3. Sharma J.K., Operations Research: Theory and Applications, 4th Edition, Laxmi Publications, 2009.
4. Prem kumar Gupta and Hira, Operations Research, 3rd Edition, S Chand Company Ltd., New Delhi, 2003.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: Operations Research, A.R Publications, 2015.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

DISCIPLINE ELECTIVE – VI

Dept. of Mechanical Engineering

Discipline Elective - VI

18ME421 AUTOMATION AND ROBOTICS

L	T	P	C
3	0	0	3

Course Prerequisite: 18MAT108

Course Description:
Automation and robotics is mainly related to industry technologies. Automation and robotics with respect to industrial context, automation as a technology that is concerned with the applications of mechanical, electronic, and computer-based systems in the operation and control of production. Examples of this technology include transfer lines, Mechanized assembly machines, feedback control systems, numerically controlled machine tools, and robots. Accordingly, robotics is a form of industrial automation.

Course Objectives:
1. The student should understand some fundamental aspects of an overview of robotics & automation, including Components of the Industrial Robotics, arms, architecture, end effectors, actuators& feedback components.
2. Emphasis is placed on understanding motion analysis described mathematically.
3. The Manipulator Kinematics, D-H notation joint coordinates and world coordinates, forward and inverse kinematics are also considered in some detail.
4. The Differential transformation and Trajectory planning, different motions should be able to apply to the analysis of robotics.
5. The student should able to apply the knowledge to solve more complicated problems and study the effect of problem parameters and able to describe the construction and working of different types of robots.
6. The student should be prepared to continue the study and analyze the robotics to solve the complicated practical problems.

UNIT I: INTRODUCTION TO AUTOMATION
Need, Types, Basic elements of an automated system, levels of automation, hardware components for automation and process control, mechanical feeders, hoppers, orienteers, high speed automatic insertion devices. **(9)**

UNIT II: AUTOMATED FLOW LINES & ASSEMBLY LINE BALANCING
Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, qualitative analysis. Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines. **(9)**

UNIT III: INTRODUCTION TO INDUSTRIAL ROBOTS
Classification. Robot configurations, Functional line diagram, Degrees of Freedom. Components, common types of arms, joints, grippers.
Manipulator Kinematics: Homogeneous transformations as applicable to rotation and translation – DH notation, Forward and inverse kinematics. **(9)**

UNIT IV: MANIPULATOR DYNAMICS, TRAJECTORY PLANNING AND ROBOT PROGRAMMING
Differential transformation, Jacobians. Lagrange – Euler and Newton – Euler formations.

Trajectory Planning: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion – straight line motion. Robot programming – Types – features of languages and software packages. **(9)**

UNIT V: ROBOT ACTUATORS

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison. Position sensors – potentiometers, resolvers, encoders – Velocity sensors, tactile sensors, Proximity sensors.

Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection. **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. Demonstrate knowledge of Robotics and learning the design of such systems.
2. Demonstrate Cognitive skills (thinking and analysis).
3. Link the scientific concepts they are learning with real applications by giving live examples where the subject concepts are applied.
4. Understand the practical importance of Robot in industry and is of importance also for other advanced courses.

Text Books:

1. Automation, Production systems and CIM,M.P. Groover/Pearson Edu.
2. Industrial Robotics - M.P. Groover, TMH.

References:

1. Robotics, Fu K S, McGraw Hill.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering, Richard D. Klafter, Prentice Hall
4. Robotics, Fundamental Concepts and analysis – Ashitave Ghosal, Oxford Press
5. Robotics and Control, Mittal R K & Magrath I J, TMH.
6. Introduction to Robotics – John J. Craig, Pearson Edu

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - VI

18ME422 ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: 18EEE101

Course Description:
This course introduces the fundamental concepts, principles and analysis of Battery Management System in Electric Vehicles

Course Objectives:
1. To study the various aspects of batteries and parameters involved in BMS.
2. To learn the selection of BMS topology.
3. To understand the basic functionality of BMS.
4. To study the various design of BMS.
5. To understand the installation of BMS.

UNIT I: INTRODUCTION TO ELECTRIC VEHICLE
Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives **(7)**

UNIT II: INTRODUCTION TO TRACTION MOTORS:
Propulsion Machine Overview - DC Machines, AC Machines, Comparison of Traction Machines, A case study; Machine Specification - Four-Quadrant Operation, Rated Parameters, Rated Torque, Rated and Base Speeds, Rated Power, Peak Operation, Starting Torque; Characteristic Curves of a Machine - Constant-Torque Mode, Constant-Power Mode, Maximum-Speed Mode, Efficiency Maps. **(8)**

UNIT III: HYBRID ELECTRIC VEHICLE
Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance. **(6)**

UNIT IV: FUNDAMENTALS OF EV CONTROLLERS
Introduction to Control, Feedback Controller Design Approach, Modeling the Electromechanical System, The Mechanical System, The PM DC Machine, The DC-DC Power Converter, The PI Controller, Designing Torque Loop Compensation, Determining Compensator Gain Coefficients for Torque Loop, Designing Speed Control Loop Compensation, Determining Compensator Gain Coefficients for Speed Loop, Acceleration of Battery Electric Vehicle (BEV) using PM DC Machine, Acceleration of BEV using WF DC Machine. **(8)**

UNIT V: STORAGE & CHARGING

Different Batteries and Ultracapacitors; Battery characteristics (Discharging &Charging) Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods, Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

(10)

Course Outcomes:

At the end of this course, students will able to

1. Understand the various parameters involved in battery pack .
2. Classify the BMS based on functionality.
3. Understand the application of BMS in Electric Vehicle.
4. Interpret the design of BMS.
5. Execute the installation, testing of BMS.

Text Books:

1. John G. Hayes and A. Goodarzi, "Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles", Wiley Publication, 2018.

References:

1. K Wang Hee Nam: AC Motor Control & Electrical Vehicle Application, CR Press, Taylor & Francis Group, 2019
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Mode of Evaluation: Assignment, Written Examination

Dept. of Mechanical Engineering

Discipline Elective - VI

18ME423 ADDITIVE MANUFACTURING

L	T	P	C
3	0	0	3

Course Prerequisite: Pattern design and specifications.

Course Description:
Additive Manufacturing (AM) is an economically viable alternative to conventional manufacturing technologies for producing highly complex parts. This course involves concept of AM, different AM techniques, material science for AM, Post Processing of AM Parts, Process Selection and AM Applications in different fields.

Course Objectives:
The main objective of this course is to acquaint students with

1. Concept of AM
2. Various AM technologies.
3. Selection of materials for AM.
4. Material science for AM and post processing of AM parts.
5. Applications of AM in various fields.

UNIT I: INTRODUCTION TO ADDITIVE MANUFACTURING
Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies, AM Data Formats, AM Software's**.** **(8)**

UNIT II: ADDITIVE MANUFACTURING PROCESSES
Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, of Stereo lithography Apparatus (SLA), Solid ground curing (SGC). Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), Selective laser Sintering (SLS), Electron Beam melting (EBM). **(7)**

UNIT III: DIRECTED ENERGY DEPOSITION AM PROCESSES
Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. **(7)**

UNIT IV: MATERIALS SCIENCE & POST PROCESSING OF AM PARTS
Materials science for AM: Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship.
Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. **(8)**

UNIT V: PROCESS SELECTION, PLANNING, CONTROL AND APPLICATIONS OF AM

Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Additive manufacturing process plan: strategies Monitoring and control of defects, transformation.

AM Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. **(8)**

Course Outcomes: At the end of the course, the student shall be able to:

1. Understand the concept of AM.
2. Analyze and select a rapid manufacturing technology for a given component.
3. Select the directed energy deposition AM process for the given application.
4. Selection of materials for AM.
5. Explain the application of AM in various fields.

Text Books:

1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
2. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.

Reference Books:

1. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.
2. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, 2013.
3. L. Lu, J. Fuh and Y. S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 2001.
4. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM) processes of titanium alloy, lnTech, 2012.

Mode of Evaluation: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - VI

18ME424 ENERGY AUDITING

L	T	P	C
3	0	0	3

Course Prerequisite: 18ME103

Course Description:
This course covers the topics of energy audit and management in industrial processes. It provides an understanding of the basic concepts and exposure to the relevant international standards in the areas of interests before it focuses the strategies and procedures of carrying out energy audit and management. Using case studies throughout, the course will examine the techniques for energy audit, managing energy usage, analysis of factors affecting energy efficiency of plant, and cost benefit analysis of introducing alternative strategies and technologies.

Course Objectives:
1. Understand energy scenario and general aspects of energy audit.
2. To enable the students to understand the concept of energy management and energy management opportunities.
3. To understand the different methods used to control peak demand
4. Learn about methods and concept of energy audit.
5. Understand the energy utilization pattern including wastage and its management.
6. To understand the different methods used for the economic analysis of energy projects.

UNIT – I: GENERAL ASPECTS
Review of energy scenario in India, General Philosophy and need of Energy Audit and Management, Basic elements and measurements - Mass and energy balances, Scope of energy auditing industries, Evaluation of energy conserving opportunities, Energy performance contracts, Fuel and Energy substitution, Need for Energy Policy for Industries, National & State level energy Policies **(8)**

UNIT – II: ENERGY AUDIT CONCEPTS
Need of Energy audit, Types of energy audit, Energy management (audit) approach, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Duties and responsibilities of energy auditors, Energy audit instruments - Procedures and Techniques **(7)**

UNIT– III: PRINCIPLES AND OBJECTIVES OF ENERGY MANAGEMENT
Design of Energy Management Programmes, Development of energy management systems, Importance - Indian need of Energy Management, Duties of Energy Manager, Preparation and presentation of energy audit reports, Monitoring and targeting, some case study and potential energy savings **(7)**

UNIT -IV: THERMAL ENERGY MANAGEMENT

Energy conservation in boilers, steam turbines and industrial heating systems, Application of FBC, Furnaces, Thermic Fluid heaters: need and applications, Heat recovery and its limitations, Steam Utilization-Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery, Cogeneration and waste heat recovery, Thermal insulation, Heat exchangers and heat pumps, HVC industries-Building Energy Management. **(8)**

UNIT -V: SYSTEM AUDIT OF MECHANICAL UTILITIES

Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems.

Blowers types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers. Compressors, types & applications, specific power consumption, compressed air system, & economic of system changes. Energy Saving in Compressors & Compressed Air Systems.

Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers **(8)**

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand the basic concepts of energy audit and energy management.
2. Explain different types of energy audit, maximizing and optimizing system efficiency.
3. Summarize energy management systems, prepare and present energy audit report.
4. Identify energy saving potential of thermal and electrical systems.
5. Discuss the performance of various Mechanical utilities systems.

TEXT BOOKS:

1. Murphy, W. R., Energy Management, Elsevier, 2007.
2. Smith, C. B., Energy Management Principles, Pergamum, 2007.

REFERENCE BOOKS:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience publication).
4. Industrial Energy Management and Utilisation - L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988).
5. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
6. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993).

E-Learning: https://beeindia.gov.in/content/energy-auditors

Mode of Examination: Assignment, Mid Examination, End Examination

Dept. of Mechanical Engineering

Discipline Elective - VI

18ME425 ENTREPRENEURSHIP AND PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
This course is designed to ignite the entrepreneurship idea into the young minds of engineers. Gives the complete details to setup an enterprise which includes the generating the business ideas, writing a business plan executing the plan successfully.

Course Objectives:
The students after completing the course will be able to:

1. Understand the requirements of entrepreneurship as a profession.
2. Understand and develop the business plan.
3. Identify the various financial terms and conditions of new business venture.
4. Selection of plant location and choosing layout.
5. Analyse the market research for new ventures and small businesses.

UNIT I: INTRODUCTION
Introduction to Entrepreneurship Definition of Entrepreneur, Entrepreneurial Traits, Entrepreneur vs. Manager, Entrepreneur vs Intrapreneur. The Entrepreneurial decision process. Role of Entrepreneurship in Economic Development, Ethics and Social responsibility of Entrepreneurs. Opportunities for Entrepreneurs in India and abroad. Woman as Entrepreneur. Case studies about successful Entrepreneur. **(8)**

UNIT II : CREATING AND STARTING THE VENTURE
Sources of new Ideas, Methods of generating ideas. The Business Plan Nature and scope of Business plan, Writing Business Plan, Evaluating Business plans, Using and implementing business plans. Marketing plan, financial plan and the organizational plan, Launching formalities. Develop the business plan and evaluate with team. **(7)**

UNIT III: FINANCING AND MANAGING THE NEW VENTURE
Sources of capital, venture capital, angel investment, Record keeping, recruitment, motivating and leading teams, financial controls. Marketing and sales controls. E-commerce and Entrepreneurship, Internet advertising. New venture Expansion Strategies and Issues, Features and evaluation of joint ventures, acquisitions, merges, franchising. Case studies about entrepreneur who success or failure in their business based on the financial control. **(8)**

UNIT IV: PLANT LAYOUT
Choosing location and layout, Issues related to Selection of layout. Production and Marketing Management, Selection of production Techniques, plant utilization and maintenance. Case study about selection of site and plant layout for new business venture. **(7)**

UNIT V: MARKET ANALYSIS AND PROJECT MANAGEMENT
Designing the workplace, Inventory control, material handling and quality control. Marketing functions, market segmentation, market research and channels of distribution, Sales promotion and product pricing. Case studies on market analysis on entrepreneur perspective.

Project Organization- Project Planning, Monitoring, Control and Learning. Through life cycle and post-mortem analysis, Resource allocation, Risk and uncertainty, Budget constraints, Project feasibility, and Change management **(7)**

Course Outcomes:

At the end of the course, students should be able to

1. Describes the sources of new business ideas, methods to develop new ideas and use the problem solving techniques
2. Able to Write a business plan which includes Financial plan, Organizational Plan and Marketing Plan
3. Able to identify the financial sources for new business ventures
4. Able to select a plant layout and draw a plant layout
5. Design a work place and Analyze the market research for new business.

Text Books:

1. Entrepreneurship, Robert Hisrich, & Michael Peters, 5/e TMH.
2. Entrepreneurship, Dollinger, Pearson, 4/e, 2004.

References:

1. Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya Publ. House, 2004.
2. Harvard Business Review on Entrepreneurship. HBR Paper Back, 1999.
3. Entrepreneurial Management, Robert J.Calvin, TMH, 2004.

Mode of Evaluation: Assignment, Mid Examination, End Examination

MANDATORY NON-CREDIT COURSES

Dept. of Mechanical Engineering

Mandatory Course

18CHE901 ENVIRONMENTAL SCIENCES

L	T	P	C
2	0	0	0

Course Prerequisites: Basic knowledge about sciences up to intermediate or equivalent level.

Course Description: The course deals with basic concepts of environment, its impact on human, universe, consumption of energy sources, effects, controlling methods for pollution and the environmental ethics to be followed by human beings.

Course Objectives:

1. To make the students aware about the environment and its inter-disciplinary nature and to emphasize the importance of the renewable energy sources.
2. To familiarize the concept of Ecosystem and their importance.
3. To bring the awareness among students about the importance of biodiversity and the need for its conservation.
4. To make the students understand the adverse effects of environmental pollution, its causes and measures to control it.
5. To introduce the environmental ethics and emphasize the urgency of rain water harvesting along with water shed management.

UNIT I: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

Definition, Scope and Importance – Need for Public Awareness. Renewable energy Resources: Solar energy - solar cells, wind energy, tidal energy. Non-renewable energy resources: LPG, water gas, producer gas. Overgrazing, effects of modern agriculture – fertilizer and pesticides. **(6)**

UNIT II: ECOSYSTEMS

Concept of an ecosystem. Structure – functions – Producers, Consumers and Decomposers – Ecological succession – Food chains, Food webs and Ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystems: Forest, Desert and Lake. **(6)**

UNIT III: BIODIVERSITY AND ITS CONSERVATION

Introduction, Definition: Value of biodiversity: consumptive use, productive use, social, ethical and aesthetic values. Biogeographical zones of India. Threats to biodiversity: habitat loss, poaching of wildlife, Endangered and Endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. **(6)**

UNIT IV: ENVIRONMENTAL POLLUTION

Definition, Cause, effects and control measures of pollution – Air, Water, Soil and Noise. Solid Waste Management: Effects and control measures of urban and industrial wastes.

(6)

UNIT V: SOCIAL ISSUES AND THE ENVIRONMENT

Urban problems related to Water conservation, rain water harvesting and watershed management; Climate changes: global warming, acid rain, ozone layer depletion, nuclear accidents. Case Studies: Population growth, variation among nations and population explosion.

(6)

Course Outcomes:

At the end of the course, the students will be able to acquire
1. Ability to understand the natural environment, its relationship with human activities and need of the day to realize the importance of the renewable energy sources.
2. The knowledge of various ecosystems and their importance along with the concepts of food chains, food webs and ecological pyramids.
3. Familiarity with biodiversity, its importance and the measures for the conservation of biodiversity.
4. The knowledge about the causes, effects and controlling methods for environmental pollution, along with disaster management and solid waste management.
5. Awareness about the sustainable development, environmental ethics, social issues arising due to the environmental disorders.

Text Books:

1. Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press, 2005.
2. Environmental Studies by R. J. Ranjith Daniels and Jagdish Krishnaswamy, (Wiley Re-print version 2014).
3. Chemistry for Environmental Engineering/C.N. Sawyer, P.L. McCarty, G.F. Parkin (TataMcGraw Hill, Fifth Edition, 2003).
4. Environmental Chemistry by B.K. Sharma, (Goel Publishing House, 2014).
5. Environmental Studies by Benny Joseph (TataMcGraw Hill, Second Edition, 2009).

Reference Books:

1. Environmental Science & Engineering by Dr. A. Ravikrishnan, Hitech Publishing Company Pvt. Ltd. 2013.
2. Perspectives in Environmental Studies, Second edition, Anubha Koushik and C.P. Koushik, New Age International (P) Limited, Publishers, 2004.

Mode of Evaluation: Assignments and Mid Term Tests

Mandatory Course

18HUM902 INDIAN CONSTITUTION

L	T	P	C
2	0	0	0

Course Prerequisites:

Course Objectives:

The course is intended to:

1. To know about Indian constitution;

2. To know about central and state government functionalities in India; and

3. To know about Indian society.

UNIT I: INTRODUCTION

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

(6)

UNIT II: STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

(6)

UNIT III: STRUCTURE AND FUNCTION OF STATE GOVERNMENT

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature –Judicial System in States – High Courts and other Subordinate Courts.

(6)

UNIT IV CONSTITUTION FUNCTIONS

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments –Constitutional Functionaries - Assessment of working of the Parliamentary System in India.

(6)

UNIT V INDIAN SOCIETY

Society: Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

(6)

Course Outcomes:

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

1. Understand the functions of the Indian government; and

2. Understand and abide the rules of the Indian constitution.

Text Books:

1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.

2. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

3. Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.

4. K.L.Sharma, (1997) "Social Stratification in India: Issues and Themes", Jawaharlal Nehru University, New Delhi.

References:

1. Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.

2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

3. R.N. Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.

Mode of Evaluation: Assignments and Mid Term Tests

Dept. of Mechanical Engineering

Mandatory Course

18HUM903 ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

L	T	P	C
2	0	0	0

Course Prerequisite:
Basic understanding on Indian culture, traditions, and beliefs. Logistic approach towards learning.

Course Description:
This course deals with introducing and elaborating the importance and capabilities of the ancient, Indian Traditional Knowledge System in achieving heights of success and well-being towards humanity.

Course Objectives:
1. To get exposed to the basics of ITKS;
2. To understand the types and techniques used in Traditional Indian Medicine;
3. To introduce and elaborate the kind of art, architecture along with Vaastu Shashtra knowledge systems. To elucidate the product and construction technologies;
4. To familiarize the basic knowledge in ancient and traditional Astronomy and astrology along with aviation technologies in traditional knowledge systems; and
5. To acquire the knowledge on ancient contemporary world and IT revolution.

UNIT I: Indian Traditional Knowledge Systems (TKS) – Indian monuments; British Impact; Basics sciences - Philosophy and physical science; Indian physics; story of Kanada; Indian Chemistry; Indian Mathematics.

(6)

UNIT II: (Traditional Medicine)
Ayurveda – origin, texts, the three greater classics, three lesser classics, concepts; manifestation of creation; mental constitution; three Doshas; individual constitution, clinical process and proceedings; sushruta Samhita and its contents; shastrakarma; Yoga; and siddha.

(6)

UNIT III: Production and construction Technology; Art, Architecture and VastuShashtra; crafts and trade – Impact of Technology on society

(6)

UNIT IV: Astronomy and Astrology; Aviation technology in Ancient India - Vedic Astronomy; Eclipses, calculations using earths circumferences; Heliocentric theory of Gravitaton; vedic Astrology; Vaimanika Sastra and its ancient notes.

(6)

UNIT V: Information Technology in India – trends – Contemporary issues of IT Industry – Impact of IT on Indian society

(6)

Course Outcomes:
At the end of the course, the students will be able to:

1. Understand the basics of Indian Traditional Knowledge System and the origin of basic science and Mathematics,
2. Get familiarized with various traditional medical methods and their implications in the human betterment,
3. Understand various production and construction technologies along with art and architectural implications in TKS,
4. Get the knowledge Vedic astronomy and astrology and get to know the ancient aviation technologies, and
5. Understand the outreach of the TKS to the contemporary world and gain the Indian action in protecting the TKS along with IT revolution.

Text Books:

1. Traditional Knowledge System in India, Amit Jha, Atlantic publishers, 2009. ISBN: 978-81-269-1223-0.
2. Traditional Knowledge System & Technology In India, Basanta Kumar Mohantra, Pratibha Prakashan (2012), ISBN-10: 8177023101

References:

1. Online Materials

Mode of Evaluation: Assignments and Mid Term Tests

Dept. of Mechanical Engineering

Mandatory Course

18CE904 DISASTER MANAGEMENT

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Description:
The goal of this course is to expose the under graduate students regarding different types of disasters and preparedness needed to mitigate their effects. The course matrix will cover various natural, biological, chemical and emerging hazards and risks that may cause property, loss of lives, and livestock's. Thus, the future engineers will understand the social responsibility for the preparedness and mitigation of the damages caused by the disasters.

Course Objectives:
1. To make aware the students about disasters and their impact on living beings.
2. To ensure the students for the understanding on vulnerability, disasters, disaster prevention and risk reduction.
3. To gain a preliminary understanding of approaches for the Disaster Risk Reduction (DRR)
4. To enhance awareness of institutional processes available in the country for the disaster risk mitigation.
5. To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I: INTRODUCTION

Introduction, Etymology of disaster, Concepts and definitions: disaster, hazard, vulnerability, risks, Resilience, prevention and mitigation. **(6)**

UNIT II: TYPES OF DISASTERS

Types of Disaster; natural disasters (earthquakes, volcanoes, forest fires and explosions, heat and cold waves, floods, draught, cyclones, tsunami, landslides, soil erosion); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.), hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility. **(6)**

UNIT III: DISASTER IMPACTS

Disaster Impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

(6)

UNIT IV: DISASTER RISK MITIGATION MEASURES

Disaster Risk Reduction (DRR) - Disaster management- four phase approach; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications), DRR programmers in India and the activities of National Disaster Management Authority. Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction,

(6)

UNIT V: IMPACT OF DEVELOPMENTAL ACTIVITIES

Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, landuse changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

(6)

Course Outcomes:

The student will develop competencies in:

1. Understanding on the nature of disasters
2. Application of Disaster Concepts to Management
3. Analyzing Relationship between Development and Disasters.
4. Ability to understand Categories of Disasters
5. Realization of the responsibilities to society

Text Book:

1. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation

Reference Books:

1. http://ndma.gov.in/ (Home page of National Disaster Management Authority)
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
5. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003
6. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC

Mode of Evaluation: Assignments and Mid Term Tests

SYLLABUS for HONORS in MECHANICAL ENGINEERING

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech III Year I Semester

18HDME101 ADVANCED WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: Production Technology

Course Description:
Advanced Welding provides students with opportunities to effectively perform cutting and welding applications of increasing complexity used in the advanced manufacturing industry. Proficient students will build on the knowledge and skills of the Advanced Welding Technology such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding etc., and weld design, testing/inspection methods. Upon completion of the Advanced Welding Technology course, proficient students will be prepared to complete the American Welding Society (AWS) Entry Welder qualification and certification.

Course Objectives:

1. To impart knowledge regarding various advanced welding practices in industries
2. To understand the various parameters and requirements for welding processes
3. To know the comparative merits and demerits of various welding processes
4. To understand the right kind of welding technique suitable for various joints
5. To learn about the joint designs adopted in different types of welding techniques

UNIT -I: INTRODUCTION
Importance and application of welding, classification of welding process. Selection of welding process. Brief review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding, Resistance welding, Electroslag welding, Friction welding etc. Soldering & Brazing, Health & safety measures in welding. **(9)**

UNIT -II: ADVANCED WELDING PROCESSES
Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding/ Cladding, Underwater welding, Spray-welding / Metallizing, Hard facing. Case studies and applications - industrial, automotive and aerospace. **(9)**

UNIT -III: THERMAL AND METALLURGICAL CONSIDERATION
Thermal considerations for welding, temperature distribution, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification behaviour of fusion weld: structural zones, epitaxial growth, weld pool shape and columnar grain structures. Weldability of metals - steels, stainless steels, aluminium, copper, nickel and titanium alloys. **(9)**

UNIT-IV: MODELING AND SIMULATION OF WELDING PROCESSES
Thermal modelling and simulation of welding processes - governing heat transfer equations and boundary conditions for various types of welding processes. Estimation of cooling rates. Prediction of mechanical properties, micro/macrostructures of weldments and heat-affected zone. Prediction of weld defects such a crack, segregation, lack of fusion. Modelling and simulation of pulsed arc processes. Use of software for simulation. **(10)**

UNIT-V: WELD DESIGN AND TESTING

Types of welds & joints, joint design, welding symbols, weld defects and distortion and its remedies, inspection and testing of welds, use of imaging techniques for online monitoring, Introduction to Welding Procedure Specification & Procedure Qualification Record. **(8)**

Course outcomes:

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

1. Understand the fundamental principles of various welding processes
2. Identify suitable advanced welding process for specific application
3. Apply the knowledge of thermal and metallurgical characteristics on weldments
4. Develop the knowledge on modelling and simulation of various welding processes on the required performance criteria.
5. Apply the concept of design, inspection and testing of weldments in an industrial environment.

Text books:

1. AWS, Welding Handbooks (Vol. I & II)
2. Edward R. Bohnart, Welding Principles and Practices, Mc Graw Hill, 4th Edition, 2017
3. Nadkarni S.V, Modern Arc Welding Technology, Oxford IBH Publishers, 2014.
4. Parmar R. S, Welding Engineering and Technology, Khanna Publishers, Delhi – 2013

Reference books:

1. D. L. Olson, T. A. Siewert, S. Liu, G.R. Edwards, ASM Hand Book, Vol 06, Welding, Brazing and Soldering, ASM International, 2008.
2. Richard L Little, Welding & Welding Technology, Mc Graw Hill, 2008
3. Kou S, Welding Metallurgy, John Wiley Publications, New York, 2003, 2nd Edition
4. Grong O. Metallurgical Modelling of Welding, The Institute of Materials, 1997, 2nd Edition

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Certificate Agency:

http://advanceweldinginstitute.com

http://www.weldingtraininginstituteinindia.in (TWG Group)

http://iiwindia.com/

http://atimumbai.gov.in/parent/htmldoc/advance_welding.html

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech III Year I Semester

18HDME102 ADVANCED OPTIMIZATION TECHNIQUES

L	T	P	C
3	0	0	3

Course Prerequisite: Production Technology

Course Description:
Manufacturing is the creation, through one or several processing operations, of components or products from basic raw materials. The effectiveness of process selection will be based on the inter-related criterion of design parameters, material selection and process economies.

Course Objectives:
1. To understand the concepts of optimization and formulation
2. To study the various methods of optimality
3. To study the methods and algorithms of linear programming
4. To understand the multivariate and constrained optimization
5. To understand the various methods of advanced optimization techniques

UNIT -I: INTRODUCTION
Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms. **(8)**

UNIT -II: ADVANCED WELDING PROCESSES
ONE DIMENSIONAL SEARCH METHODS Optimality Criteria, Bracketing methods: Exhaustive search methods, Region - Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.
Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy’s (Steepest descent) method and Newton’s method. **(10)**

UNIT -III: THERMAL AND METALLURGICAL CONSIDERATION
LINEAR PROGRAMMING Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications. **(8)**

UNIT-IV: MODELING AND SIMULATION OF WELDING PROCESSES
MULTIVARIABLE OPTIMIZATION ALGORITHM Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method.
CONSTRAINED OPTIMIZATION ALGORITHM Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method. **(10)**

UNIT-V: WELD DESIGN AND TESTING
ADVANCED OPTIMIZATION TECHNIQUES Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, Advanced GAs, Differences between GAs

and traditional methods. Simulated annealing method, working principles. Particle swarm optimization method, working principles. **(9)**

Course outcomes:

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

1. Can be able to develop and formulate the objective functions based on the constraints.
2. Application of One dimensional search methods and Gradient based methods to solve optimization problems.
3. Solving the Linear programming problems by applying the suitable method.
4. Deriving the optimality criterion and solving the constrained optimization problems.
5. Apply the various advanced optimization techniques for finding the optimal solutions.

Text books:

1. Optimization for Engineering Design - Kalyanmoy Deb.
2. Optimization Theory and Applications - S.S. Rao.

Reference books:

1. Analytical Decision Making in Engineering Design - Siddal.
2. Linear Programming – G. Hadley

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech III Year I Semester

18HDME103 COMBUSTION AND EMISSIONS

L	T	P	C
3	0	0	3

Course Prerequisite: 18ME103, 18ME108, 18ME210

Course Description:
This course builds on the concepts learned in Thermodynamics, fluid mechanics and heat transfer to delve into the underlying concepts in the specialized subject of combustion of fuels and generation of emissions. These learning from this course is essential for students looking to pursue career in energy sector which employs mechanical engineers in significant numbers. The topics covered include thermodynamics and equilibrium consideration of combustion, analysis and mathematical modelling of laminar premixed and diffusion flames, evaporation of liquid flames, turbulence and its influence on combustion, combustion of solid fuels, emissions and their control.

Course Objectives:

1. To introduce the basics concepts in the specialized topic of combustion.
2. To explicate the underlying phenomena involved in the combustion of fuels.
3. To shed light on the complex interplay between the fluid flow, mass transfer, heat transfer, phase change and chemical kinetics in a combustion system.
4. To expound on the origins of emission generation in combustion systems and ways to control them.
5. To lay the necessary foundation for the student to take up problems in design of combustion systems.

UNIT I: THERMODYNAMIC, MASS TRANSFER AND KINETIC ASPECTS
Review of property relations, stoichiometry, reactant and product mixtures, adiabatic flame temperatures, chemical equilibrium, equilibrium products of combustion
Rudiments of mass transfer, liquid-vapor interface boundary conditions, droplet evaporation
Global versus elementary reactions, elementary reaction rates, oxides of nitrogen formation **(9)**

UNIT II: LAMINAR FLAMES AND THEIR ANALYSIS
Constant pressure and constant volume fixed mass reactor, well stirred reactor, plug flow reactor, applications to combustion system modelling. Conservation equations for mass, momentum, energy and any generic scalar.
Premixed flames, simplified analysis, factors influencing flame velocity and thickness, flame speed correlations for selected fuels, quenching, flammability and ignition, flame stabilization.
Diffusion flames, laminar jet flames, simplified analysis, flame lengths for circular –port and slot burners, soot formation and destruction. **(10)**

UNIT III: EVAPORATION AND TURBULENCE
Simple model of droplet evaporation and droplet burning, one dimensional vaporization – controlled combustion, some applications of droplet evaporation and droplet Burning

Introduction to turbulent flows, definition of turbulence, length scales in turbulent flows, analysing turbulent flows, axisymmetric turbulent jet. **(9)**

UNIT IV: TURBULENT FLAMES

Turbulent premixed and non-premixed flames, definition of turbulent flame speed, structure of turbulent premixed flames, wrinkled laminar flame regime, distributed reaction regime, flamelets in eddies regime, flame stabilization, jet flames, applications of turbulent premixed flames. **(8)**

UNIT V: SOLID FUELS AND EMISSIONS

Burning of solids, coal fired boilers, heterogeneous reactions, burning of carbon, coal combustion.

Emission Index, corrected concentrations, control of emissions for premixed and non-premixed flames. **(9)**

Course Outcomes:

1. Calculate the basic parameters of combustion like air-fuel ratio, equivalence ratio, adiabatic flame temperature etc.
2. Describe the concepts related to laminar flames like flame speed, flame length.
3. Explain the phenomena of droplet vaporization and turbulence and their significance to the combustion characteristics and control.
4. Explain the concepts related to turbulent flames like flamelets, flame stabilization, and different flame regimes.
5. Describe various aspects of solid fuel combustion and different mechanisms responsible for generation of harmful emissions from combustion.

Textbooks:

1. Turns, S.R., An Introduction to Combustion -Concepts and Applications, 2nd Edition., McGraw Hill.
2. Jaan Kiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press, 3 edition.

References:

1. Principles of Combustion, Kenneth K. Kuo, John Wiley & Sons
2. Fundamentals Of Combustion, D P Mishra, PHI Learning
3. Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, Warnatz, J., Maas, Ulrich, Dibble, Robert W., Springer

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech III Year II Semester

18HDME104 ERGONOMICS

L	T	P	C
3	0	0	3

Course Prerequisite: (Type course code)

Course Description:

Ergonomics is the process of designing or arranging workplaces, products and systems so that they fit the people who use them. Ergonomics aims to create safe, comfortable and productive workspaces by bringing human abilities and limitations into the design of a workspace, including the individual's body size, strength, skill, speed, sensory abilities (vision, hearing), and even attitudes.

Course Objectives:

The students will study the following:

1. The human life style of communication, factors affecting human work physiology.
2. The human body function in sitting posture, squatting and cross legging postures.
3. The human behaviour in work centres.
4. The human psycho-social behaviour aspects and vvisual performance.
5. The human occupational safety and stress at workplace in view to reduce the potential fatigue, errors, discomforts and unsafe acts.

UNIT I: INTRODUCING ERGONOMICS

Introduction to Ergonomics; Design today- Human aid to lifestyle; Journey, Fitting task to man their contractual structure; Domain, Philosophy and Objective; Mutual task comfort: two way dialogue, communication model; Ergonomics/ human Factors fundamentals; Physiology (work physiology) and stress. **(9)**

UNIT II: HUMAN PHYSICAL DIMENSION CONCERN

Human body- structure and function; anthropometrics; Anthropometry: body growth and somatotypes; Static and dynamic anthropometry, Stand Posture- erect; Anthropometry landmark: Sitting postures; Anthropometry: squatting and cross-legged postures; Anthropometric measuring techniques; Statistical treatment of data and percentile calculations. **(9)**

UNIT III: POSTURE AND MOVEMENT

Human body- structure and function; Posture and job relation; Posture and body supportive devices; Chair characteristics; Vertical work surface; Horizontal work surface; Movement; Work Counter. **(8)**

UNIT IV: BEHAVIOUR AND PERCEPTION, VISUAL ISSUES, ENVIRONMENTS FACTORS

Communication and cognitive issues; Psycho-social behaviour aspects, behaviour and stereotype; Information processing and perception; Cognitive aspects and mental workload; Human error and risk perception; Visual performance; Visual displays; Environmental factors influencing human performance. **(9)**

UNIT V: ERGONOMIC DESIGN PROCESS, PERFORMANCE SUPPORT & DESIGN INTERVENTION

Ergonomics design methodology; Ergonomics criteria while designing; Design process involving ergonomics check; Some checklists for task easiness; Occupational safety and stress at workplace in view to reduce the potential fatigue, errors, discomforts and unsafe acts; Workstation design; Furniture support; Vertical arm reach and design application possibility; Humanising design: Design and human compatibility, comfort and adaptability aspects; Concluding session: Design Ergonomics in India: scope for exploration. **(10)**

Course Outcomes:
At the end of the program, students will be able to:

1. Identify the impact of various personal attributes (anatomical, physiological, anthropometric and psychological) on proper safe working practice.
2. Assess the effect of physical environment factors on comfort and performance
3. Apply principles of good ergonomic design of work areas and equipment to a range of occupational settings.
4. Apply knowledge the ergonomic principles in organisation and culture.
5. Solve ergonomic design process to reduce fatigue discomforts.

Text Books:

1. R S Bridger, Introduction to Ergonomics, 2nd Edition, Taylor &Francis, 2003.
2. J Dul and B Weerdmeester, Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.

References:

1. S Singh, (Edt), Ergonomics Interventions for Health and Productivity, Himanshu Publications, Udaipur, New Delhi, 2007.
2. Green, W.S. and Jordan,P .W, Human Factors in Product Design, Taylor & Francis, 1999.
3. D. Chakrabarti, Indian Anthropometric Dimensions for ergonomic design practice, National Institute of Design, Ahmedabad, 1997.
4. G. Salvendy (edit), Handbook of Human Factors and ergonomics, John Wiley & Sons, Inc., 1998.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech III Year II Semester

18HDME105 GAS DYNAMICS

L	T	P	C
2	1	0	3

Course Prerequisite: Engineering Thermodynamics

Course Description:

The goal of this course is to lay out the fundamental concepts and results for the compressible flow of gases. Topics to be covered include: appropriate conservation laws; propagation of disturbances; isentropic flows; normal shock wave relations, oblique shock waves, weak and strong shocks; compressible flows in ducts with area changes, friction, or heat addition; heat transfer to high speed flows;

Course Objectives:

1. To derive the general expression for the velocity of an infinitesimal pressure disturbance in an arbitrary medium using the governing equations of fluid dynamics.
2. Starting with basic principles of continuity, energy and momentum, derive expressions for property ratios in terms of Mach number and specific heat ratio for fanno flow with a perfect gas. Describe the variations in fluid properties that occur as flow progresses along a Rayleigh line for the case of heating and also for cooling.
3. Sketch a normal shock process on a T-s diagram, indicating as many pertinent features as possible, such as static and total pressures, static and total temperatures and velocities. Indicate each of the properties before and after the shock. Analyze an oblique shock in a perfect gas and develop the relation among shock angle, deflection angle and entering Mach number.
4. Demonstrate the ability to solve typical problems involving moving normal shocks , oblique shocks, Prandtl-Meyer flows by use of the appropriate equations and tables or charts.

UNIT I: FUNDAMENTALS OF COMPRESSIBLE FLOW

Introduction to compressible flow, second law of thermodynamics and entropy equation, acoustic velocity, Mach number and its significance, various flow regimes, Mach cone, Mach angle, Von Karman's rule of supersonic flow, concept of stagnation condition, relation between static an stagnation properties, entropy change in terms of stagnation properties, adiabatic energy equation, Prandtl velocity ellipse, critical speed of sound, stagnation speed of sound, maximum isentropic speed, reference Mach number, Crocco number, Stream thrust and the impulse function, dynamic pressure, flow compressibility factor, pressure coefficient of airfoil, steady one dimensional compressible flow of perfect gas. **(10)**

UNIT II: ONE-DIMENSIONAL ISENTROPIC FLOW

Isentropic process on Mollier diagram, flow expansion and compression, performance curves, effect of area variation, property ratios in terms of Mach number, area ratio in terms of Mach number, impulse function ratio, mass flux in terms of Mach number, mass flux in terms of pressure ratio, flow factor, Mach number and area ratio in terms of pressure ratio, use of gas tables and charts. **(9)**

UNIT III: FANNO FLOW

Governing equations for Fanno flow, Fanno line in Mollier diagram, effect of friction in subsonic and supersonic flows, limiting Mach number, effect of increase in flow resistance, effect of back pressure, Fanno relations for a perfect gas, temperature ratio, pressure ratio, density ratio, velocity ratio, stagnation pressure ratio, impulse function ratio, Change in entropy due to friction, friction coefficient, pressure drop due to friction, effect of friction on flow parameters, tables and charts for Fanno flow, Isothermal flow in Mollier diagram, flow parameter relations in isothermal flow, change in entropy, maximum length of duct, effect of friction in isothermal flow. **(9)**

UNIT IV: RAYLEIGH FLOW

Governing equations for Rayleigh flow, Rayleigh line in Mollier diagram, simple heating process, simple cooling process, Chocking in Rayleigh flow, state of maximum enthalpy, Mach number at maximum entropy and enthalpy, region between maximum enthalpy and entropy, Rayleigh relations for a pefect gas, pressure ratio, stagnation pressure ratio, temperature ratio, stagnation temperature ratio, density ratio, velocity ratio, change in entropy due to heat transfer, working tables and charts, choking due to heat transfer, maximum possible heat addition.

(8)

UNIT V: NORMAL AND OBLIQUE SHOCK WAVES

Types of waves in compressible flow, general characteristics of the normal shock, governing equations, normal shock on Fanno and Rayleigh curves, Prandtl-Meyer equation, Mach number downstream of normal shock, velocity and density ratio across normal shock, pressure ratio across normal shock, temperature ratio across normal shock, stagnation pressure ratio, stagnation to static pressure ratio, change in entropy across normal shock, impossibility of shock from subsonic to supersonic flow, tables and charts, Rankine-Hugoniot relations, weak and strong shocks, moving normal shock wave. Introduction to oblique shock waves, weak compression shock wave and expansion fan, upstream and downstream velocity triangles, governing equations for oblique shock, flow parameters across oblique shock, relation between deflection angle and wave angle, tables and charts for oblique shock, Mach lines, analysis of Prandtl-Meyer flow, Prandtl-Meyer angle. **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. State the basic concepts from which the study of gas dynamics proceeds. Explain the stagnation state concept and the difference between static and stagnation properties. Explain how sound is propagated through any medium. Define sonic velocity and state the differences between shock wave and a sound wave. Discuss the propagation of signal waves from a moving body in a fluid by explaining zone of action, zone of silence, Mach cone and Mach angle.
2. Write equations for the stagnation property in terms of static property, Mach number and ratio of specific heats. Demonstrate skills by developing simple relations in terms of Mach number for a perfect gas. Show graphically how pressure, density, velocity and area vary in steady, one-dimensional, isentropic flow as the Mach number ranges from zero to supersonic values.
3. Simplify the general equations of continuity, energy and momentum to obtain basic relations valid for any fluid in Fanno flow. Sketch a Fanno line in the h-v and the h-s planes. Identify the sonic point and regions of subsonic and supersonic flow.

4. Simplify the general equations of continuity, energy and momentum to obtain basic relations valid for any fluid in Rayleigh flow. Sketch a Raleigh line in the p-v plane together with lines of constant entropy and constant temperature. Sketch a Rayleigh line in the h-s plane. Identify the sonic point and regions of subsonic and supersonic flow.
5. Starting with the basic shock equations for an arbitrary fluid, derive the working equation for a perfect gas relating property ratios on each side of a standing normal shock as a function of Mach number and specific heat ratios. Explain how an oblique shock can be described by the superposition of a normal shock and another flow field. Sketch an oblique shock and define the shock angle and deflection angle.

Text Books:

1. Anderson, J.D., "Modern Compressible flow", McGraw Hill..
2. S.M. Yahya, "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi.

References:

1. Pr. S.L. Somasundaram, "Gas Dynamics and Jet Propulsions", New Age International Publishers.
2. A.H. Shapiro, "Dynamics and Thermodynamics of Compressible fluid Flow", John wiley, New York.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech III Year II Semester

18HDME106 FRACTURE MECHANICS

L	T	P	C
2	1	0	3

Course Prerequisite: Mechanics of Solids and Engineering Mechanics.

Course Description:
The course covers the basic aspects of Engineering Fracture Mechanics. Spectacular failures that triggered the birth of fracture mechanics, Modes of loading, Classification as LEFM and EPFM, Crack growth and fracture mechanisms, Energy release rate, Resistance, Griffith Theory of fracture, Extension of Griffith Theory by Irwin and Orowan, R-Curve, Pop-in phenomena, Crack branching. Necessary and sufficient conditions for fracture, Stress and Displacement fields in the very near and near-tip fields, Various methods for evaluating Stress Intensity Factors, Modeling plastic zone at the crack-tip, fatigue in structural components.

Course Objectives:
1. Classification of fracture
2. Importance of crack tip
3. Experimental setup while performing a standard test
4. About R curve
5. Fatigue crack propagation.

UNIT - I
Introduction: Crack in a structure – Griffith criterion **Mechanism of Fracture and Crack Growth:** cleavage fracture – ductile fracture fatigue cracking – service failure analysis **(9)**

UNIT - II
Elastic Crack Tip Stress Field: Solution to crack problems – effect of finite size stress intensity factor – special cases
Crack Tip Plastic Zone: Irwin plastic zone correction – actual shape of the plastic zone **(9)**

UNIT- III
Energy Principle: Energy release rate – criterion for crack growth – J integral **Plane Strain Fracture Toughness:** Standard test – size requirement – nonlinearity **(9)**

UNIT-IV
Plane Stress and Transitional Behavior: concept of plane stress – R curve concept – thickness effect – plane stress testing **Elastic-Plastic Fracture:** crack tip opening displacement. **(9)**

UNIT - V
Fatigue Crack Propagation: Crack growth and stress intensity factor – factors affecting crack propagation – variable amplitude service loading and its numerical retardation model **(9)**

Course Outcomes:
At the end of the course, student will be able to

1. Analyze the fracture mechanism
2. Gain familiarity with the different modes of failure under the presence of a crack
3. Establish specimen size in accordance with the standard procedures
4. Distinguish between Plane stress fracture toughness and Plane strain fracture toughness
5. Accomplish the relationship between crack propagation and stress intensity factor

Text Book:

1. Prashant Kumar., "Elements of fracture mechanics", Mc Graw Hill Education (India) Private Limited, New Delhi - 2014.

Reference Books:

1. T.L. Anderson, "Fracture Mechanics - Fundamentals and Applications", 3/e, Taylor and Francis Group, 2005.
2. R.N.L.Smith, "Basic Fracture Mechanics", Butterworth Heinemann Publications, 1991.
3. K. Ramesh," e-Book on Engineering Fracture Mechanics", IIT Madras, 2007. URL: http://apm.iitm.ac.in/smlab/kramesh/book_4.htm
4. K. R.Y. Simha, "Fracture Mechanics for Modern Engineering Design", Universities Press (India) Limited, 2001
5. David Broek, "Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, The Hague – 1984.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech IV Year I Semester

18HDME107 POWDER METALLURGY

L	T	P	C
3	0	0	3

Course Prerequisite: Basics of materials science

Course Description: Powder Metallurgy (PM) is a metal working process for forming precision metal components from metal and or ceramic powders. The metal powder is first pressed into product shape at room temperature. This is followed by heating (sintering) that causes the powder particles to fuse together without melting. PM route is exclusively used for manufacturing high end ceramic tools and inserts, self-lubricating bearings, cermets etc.

Course Objectives: Through this course student should be able to

1. To build the necessary fundamentals leading to the development and the importance of powder Metallurgy.
2. To attain necessary knowledge on various particulate production and characterization techniques.
3. Gain working knowledge of compaction and sintering techniques.
4. To attain effective knowledge of applications of powder metallurgy products.

UNIT I: Introduction to Powder Metallurgy (PM) and production processes
Development and importance of PM and their processing; advantages of PM over conventional manufacturing processes, its scope and limitations; applications of PM, Production processes: physical methods, chemical methods, mechanical methods and selection of suitable production method. **(8)**

UNIT II: Particulate characterization and properties
Chemical composition and structure analysis; powder size, shape and surface topography analysis; surface area, apparent & tap density, flow rate, green strength, compressibility, pyrophoricity and toxicity measurements. **(8)**

UNIT III: Compaction of metal particulates
Binders, powder mixing, powder milling, powder pressing, powder shaping and compaction; pressure and pressure less compaction techniques; die compaction: types of presses, tooling and design; behavior of powder during compaction; modern methods of powder compaction: hot and cold isostatic pressing, uniaxial pressing, powder roll compaction, powder extrusion, forging, slip casting injection molding, continuous compaction, explosive compaction, forming of ceramic powders; advantages, limitations and applications of each method. **(10)**

UNIT IV: Sintering
Solid state sintering (SSS), driving forces, stages and mechanism of sintering; sintering zones; liquid phase sintering, activated sintering, spark plasma sintering
Sintering furnaces: Batch type furnaces, continuous furnaces, vacuum furnace.
Sintering atmosphere: Inert gases, vacuum, nitrogen, hydrogen, reformed hydrogen, and disassociated ammonia. **(10)**

UNIT V: Powder Metallurgy Applications:
Porous metals: bearings, self-lubricating bearings; WC and other cemented carbide tool bits, cermets, electrical and magnetic materials, dispersion strengthened materials for high temperature applications and manufacture of diamond based cutting tools, break pads. **(9)**

Course Outcomes:

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

1. Classify and select suitable powder preparation and production techniques.
2. List out various characterization techniques of particulates.
3. Summarize various powder compaction, sintering and processing techniques and describe the theory behind.
4. Describe conventional applications of powder metallurgy.

Text Books:

1. Powder Metallurgy: Science, Technology and Applications, by P. C. Angelo and R. Subramanian, PHI Learning Pvt Ltd.
2. Powder Metallurgy Technology by G. S. Upadhyaya; Cambridge International Science Publishing.

Reference Books:

1. Powder Metallurgy Science by R. M. German, MPIF, NJ, USA.
2. Powder Technology Handbook by H. Masuda, Taylor & Francis.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech IV Year I Semester

18HDME108 ADVANCED FLUID MECHANICS

L	T	P	C
2	1	0	3

Course Prerequisite: 18ME108

Course Description:
This course builds on the fluid mechanics and hydraulic machinery course to introduce more advanced and specialized topics in fluid mechanics like exact solutions of Navier-Stokes equations, boundary layer theory, turbulence, and compressible flows.

Course Objectives:

1. To revisit the governing equations of fluid flow using advanced concepts like strain rate tensors.
2. To explicate various analytical methods for solving Navier Stokes equations for simple yet practical problems in fluid mechanics.
3. To expound on boundary layer theory and its significance in fluid mechanics.
4. To familiarize students with rudimentary concepts in turbulence and compressible flows.

UNIT I: PRELIMINARY CONCEPTS AND GOVERNING EQUATIONS
Historic outlook, practical examples, Eulerian description of fluid flow, acceleration of fluid, strain rate, transport properties of fluids, thermodynamic properties, bulk modulus, coefficient of thermal expansion, boundary conditions for fluid flow problems
Derivation and mass, momentum and energy conservation equations. Stream function, Euler equation, Bernoulli Equation, thermal decoupling for incompressible flows, different coordinate systems, boundary conditions and control volume formulation. **(10)**

UNIT II: EXACT SOLUTIONS TO NAVIER STOKES EQUATIONS
Dimensionless parameters in viscous flow.
Exact solution to Navier-Stokes equation: Flow between parallel plates, axial flow between concentric cylinders, flow between rotating concentric cylinders, Poiseuille flow, Hagen-Poiseuille flow, combined Poiseuille-Couette flow, similarity solutions, Stoke's solution. **(8)**

UNIT III: BOUNDARY LAYER THEORY
Flat plate integral analysis of momentum and energy boundary layers, definition of displacement, momentum and energy thickness.
Laminar boundary layer equations, flow separation, similarity solutions, Blasius solution, Reynolds analogy.
Free shear flows, plane laminar jet, plane laminar wake, approximate integral methods. **(9)**

UNIT IV: TURBULENT FLOWS
Physical description, mathematical description, fluctuations and averaging, Reynolds-averaged NS Equations, turbulent boundary layer equations, turbulent kinetic energy and Reynolds stresses, integral turbulent boundary layer equations, velocity profiles, law of the wall,

turbulent flows in pipes and channels, turbulent flows on flat plates, free turbulence in jets and wakes, introduction to turbulence modeling. **(9)**

UNIT V: COMPRESSIBLE FLOWS

Compressible boundary layer equations, steady isentropic flow of an perfect gas, viscous fluid, role of velocity of sound in compressible flows, Fanno (flow with friction) and Rayleigh Lines (flow with heat addition), Normal Compression Shock, Oblique Shock, Supersonic Wave Drag. Introduction to numerical solutions. **(9)**

Course Outcomes:

1. Derive governing equations of fluid flows using advanced concepts like strain rate tensor.
2. Solve a range of practical problems fluid mechanics using the analytical solutions of Navier-Stokes equation.
3. Calculate forces interactions in fluid flows using concepts from boundary layer theory.
4. Calculate forces interactions in turbulent fluid flows using analytical solutions from differential as well as integral methods.
5. Describe intricacies in the physics of the flows introduced by compressibility effects and estimate their influence on the flows.

Textbooks:

1. Frank M. White, Viscous Fluid Flow, 3rd Edition, McGraw Hill.

References:

1. B K Hodge and Keith Koenig, Compressible Fluid Dynamics, Pearson
2. Cohen and Kundu, Fluid Mechanics, 5th edition, Elsevier.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Honors in Mechanical Engineering

B.Tech IV Year I Semester

18HDME109 MODELING OF SI AND CI ENGINES

L	T	P	C
2	1	0	3

Course Prerequisite: Thermodynamics, IC engines

Course Description:

The purpose of this course is to lay out the fundamental concepts on fundamental computer simulations in SI and CI engines. Topics to be covered comprise of: Chemical reactions, Ideal and actual cycle simulation, Combustion stages in SI engines, Combustion stages in CI engines, Flows in engine manifolds, scavenging in engines, Flame stability in Gas Turbines.

Course Objectives:

The objectives of the course to recognize diverse techniques of computer simulation and analysis of IC engine performance.

UNIT I: SIMULATION PRINCIPLES

First and second laws of thermodynamics – Estimation of properties of gas mixtures – Structure of engine models – Open and closed cycle models – Cycle studies – Chemical reactions – First law application to combustion – Heat of combustion – Adiabatic flame temperature – Hess Law-Le chatelier's principle. Heat transfer in engines – Heat transfer models for engines – Simulation models for IC Engines. (Ideal and actual cycle simulation) – Chemical equilibrium and calculation of equilibrium composition. **(10)**

UNIT II: SIMULATION OF COMBUSTION IN SI ENGINE

Combustion in SI engines – Flame propagation and velocity – Single zone models – Multi zone models Mass – Burning rate – Turbulence models. One dimensional model – Chemical kinetics modeling – Multidimensional models – Flow chart preparation. **(9)**

UNIT III: SIMULATION OF COMBUSTION IN CI ENGINE

A: Combustion in CI engines single zone models – Premixed-Diffusive models – Wiebe model – Whitehouse way model – Two zone models – Multizone models –

B: Meguerdichian and Watson's model – Hiroyasu's model – Lyn's model – Introduction to multidimensional and spray modeling – Flow chart preparation. **(9)**

UNIT IV: SIMULATION OF TWO STROKE ENGINE

Thermodynamics of the gas exchange process – Flows in engine manifolds – One dimensional and multidimensional models. Flow around valves and through ports models for scavenging in two stroke engines – Isothermal and non-isothermal models – Heat transfer and friction. **(9)**

UNIT V: SIMULATION OF GAS TURBINE COMBUSTORS

Gas Turbine Power plants – Flame stability – Combustion models for steady flow simulation– Emission models – Flow chart preparation. **(8)**

Course Outcomes:
The students after completing the course will be able to:

1. Understand the basic simulation principles of gas mixtures, engine models, Ideal and actual cycle simulation of spark ignition and compression ignition engine.
2. Be acquainted with the basic simulation principles of spark ignition engines.
3. Be acquainted with the basic simulation principles of compression ignition engines.
4. To understand the computer simulation of two stroke cycle and gas turbine combustor.
5. To understand the computer simulation of gas turbine combustor.

Text Books:
1. V. Ganesan, "Computer Simulation of Spark Ignition Engine Processes", Universities Press, 2000.
2. V. Ganesan, "Computer Simulation of Compression Ignition Engine Processes", Universities Press, 2000.

References:
1. Cohen H. Rogers GEC. – "Gas Turbine Theory" – Pearson Education India Fifth edition, 2001.
2. Bordon P. Blair, "The Basic Design of two-Stroke engines", SAE Publications, 1990.
3. Horlock and Winterbone, "The Thermodynamics and Gas Dynamics of Internal Combustion Engines", Vol. I & II, Clarendon Press, 1986.
4. J.I.Ramos, "Internal Combustion Engine Modeling", Butterworth – Heinemann ltd, 1999.
5. J.N.Mattavi and C.A. Amann, "Combustion Modeling in Reciprocating Engines", Plenum Press, 1980
6. Ashley S. Campbell, "Thermodynamic Analysis of Combustion Engines", Krieger Publication Co, 1985

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

MINORS in
MECHANICAL ENGINEERING
Stream Name: Electric Vehicles

(Offered to all the Engineering Disciplines except Mechanical Engineering)

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME101 FUNDAMENTALS OF AUTOMOTIVE ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisite: Zeal to Learn

Course Description:
Automotive vehicle: IC engine- layout, components, materials, and production processes, Mechanical unit: transmission, drive train, steering, chassis, suspension, brakes, wheels, and tyres.

Course Objectives:
1. This is an introductory multi-disciplinary course aimed at providing a comprehensive overview of the operating systems of a modern automobile.
2. It also aims at analysing the working features of an automobile vehicle with the technologies, materials and processes associated with it.
3. Understand the fundamentals, principle of operation and performance of various clutches and gear boxes.
4. Understand the principle of operation, performance and gain the knowledge about various steering system, wheels and tyres, suspension and braking system.

UNIT- I: INTRODUCTION TO IC ENGINES AND WHEELS AND TYRES SYSTEM
Introduction to IC engines- Two Stroke and Four Stroke - IC Engine Operation, SI & CI engines, Engine Performance Evaluation, Cylinder block, crankcase, cylinder head, piston, piston rings, piston pin, connecting rod, crankshaft, fly wheel, valves and valve timing.
Wheels and Tyres System – Types of Wheels, Construction, Structure and Function, Wheel Dimensions. Tyres – Tyre functions, Tyre Materials, Types of Tyres, Tyre Construction, Tyre Designations, Tyre Force Generation, Tire Pressure Monitoring System (TPMS), Problems. **(8)**

UNIT- II: TRANSMISSION SYSTEM
Transmissions and Driveline - Introduction, Friction Clutches, Gear Theory – Straight Tooth Spur Gears, Helical Spur Gears, Straight Tooth Bevel Gears, Spiral Bevel Gears, Hypoid Gears.
Manual Transmissions - Transmission Power Flows, Synchronizer Operation
Automatic Transmissions - Fluid Couplings and Torque Converters, Planetary Gears, Planetary Gear-Set Torque Converter, Simpson Drive, Hydraulic Control System.
Continuously Variable Transmissions (CVT) - Van Doorne Continuously Variable Transmission (CVT), Torotrak Continuously Variable Transmission (CVT), Driveshafts - Hooke’s Joints, Shaft Whirl, Differentials, Four-Wheel Drive (FWD) and All-Wheel Drive (AWD). **(10)**

UNIT- III: STEERING SYSTEM

Steering Systems - Introduction, Steering Mechanisms - Worm Systems, Worm and Sector, Worm and Roller, Recirculating Ball, Rack and Pinion Steering, Power Steering.

Steering Dynamics- Low-Speed Turning, High-Speed Turning, Effects of Tractive Forces, Wheel Alignment – Camber, Steering Axis Inclination (SAI), Toe, Caster, Wheel Alignment Steering Geometry Errors, Front-Wheel-Drive Influences, Driveline Torque, Loss of Cornering Stiffness Due to Tractive Forces, Increase in Aligning Torque Due to Tractive Forces, Four-Wheel Steering- Low-Speed Turns, High-Speed Turns, Implementation of Four-Wheel Steering.

Vehicle Rollover - Quasi-Static Model, Quasi-Static Rollover with, Suspension, Roll Model, Problems **(9)**

UNIT- IV SUSPENSION SYSTEM

Suspension System – Introduction - Construction, Operation & Materials; Perception of Ride, Basic Vibrational Analysis, Single-Degree-of-Freedom Model (Quarter Car Model), Two-Degrees-of-Freedom Model (Quarter Car Model), Two-Degrees-of-Freedom Model (Half Car Model).

Suspension System Components – Springs -Leaf Springs, Torsion Bars, Coil Springs, Rubber Springs, Plastic Springs, Pneumatic (Air) Springs, Dampers (Shock Absorbers).

Suspension Types -Solid Axle Suspensions - Hotchkiss Suspensions, Four-Link Suspensions, de Dion Suspensions; Independent Suspensions - Short-Long Arm Suspensions (SLA), MacPherson Struts, Trailing Arm Suspensions, Multi-Link Suspensions, Swing Arm Suspensions.

Roll Center Analysis - Wishbone Suspension Roll Center Calculation, MacPherson Strut Suspension

Roll Center Calculation, Hotchkiss Suspension Roll Center Calculation, Vehicle Motion About the Roll Axis. **Active Suspensions** **(9)**

UNIT- V BRAKING SYSTEM

Braking System – Braking Dynamics – Necessity, Brake Efficiency, Weight Transfer, Stopping Distance and Time, Determination of Braking Torque, Hydraulic Principles.

Brake System Components- Master Cylinder, Power Assistance, Combination Valve-Proportioning Valve, Pressure Differential, Switch, Metering Valve.

Drum Brakes- Analysis of Drum Brakes – Brake Efficiency, Brake Shoe Theory, Types of Master & Wheel Cylinders, Brake Linings, Bleeding of Brakes, Examples.

Disc Brakes- Disc Brake Components, Brake Disc, Brake Pads, Caliper, Disc Brake Analysis, Heat Dissipation from Disc Brakes.

Power Brakes- Vacuum Brakes, Air Brakes and Electric Brakes, Air- Hydraulic Brakes, Electronic Braking System (EBS)- Antilock Brake Systems (ABS) & Traction Control System (TCS), Hill Hold Control, Hill Descent Control, Electronic Brake Force Distribution (EBD), Electronic Stability Program (ESP). **(9)**

Course Outcomes:

After the successful completion of this course:

1. The students will be able to know the functioning of various automobile components as per the global trends and designing of wheels and tyres system.
2. The students will be able to analyse, evaluate and design the Transmission System.
3. The students will be able to analyse, evaluate and design the Steering System.
4. The students will be able to analyse, evaluate and design the Suspension System.
5. The students will be able to analyse, evaluate and design Braking System.

Text Books:

1. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.
2. R. Stone and J. K. Ball, "Automotive Engineering Fundamentals", SAE International, 2004.

Reference Books:

1. T. K. Garrett, K. Newton, and W. Steeds, "The Motor Vehicle", 13th Edition, SAE International, 2001.
2. Kirpal Singh – "Automobile Engineering" Vol. I - Standard Publications, New Delhi.
3. G.B.S Narang – "Automobile Engineering" – Khanna Publications, New Delhi.
4. T.R. Banga & Nathu Singh – "Automobile Engineering" – Khanna Publications, New Delhi.
5. William Crouse and Donald Anglin – "Automotive Mechanics" – Mc Graw Hill.
6. V. Ganesan, Internal Combustion Engines, 3rd Edition, Tata McGraw Hill, 2007.
7. M. Ehsani, Y. Gao and A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition, CRC Press, 2010.
8. D. B. Astow, G. Howard and J. P. Whitehead, "Car Suspension and Handling", 4th Edition, SAE International, 2004.
9. R. Limpert, "Brake Design and Safety", SAE International, 1992.
10. Jack E Rjavee, "Automotive Technology - A system approach", Thomson Asia Pte Ltd, Singapore, 3rd edition, 2004.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME102 FUNDAMENTALS OF ELECTRICAL VEHICLES

L	T	P	C
3	0	0	3

Course Prerequisite: 18EEE101

Course Description:
This course introduces the fundamental concepts, principles and analysis of Battery Management System in Electric Vehicles

Course Objectives:
1. To study the various aspects of batteries and parameters involved in BMS.
2. To learn the selection of BMS topology.
3. To understand the basic functionality of BMS.
4. To study the various design of BMS.
5. To understand the installation of BMS.

UNIT I: INTRODUCTION TO ELECTRIC VEHICLE
Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives **(8)**

UNIT II: INTRODUCTION TO TRACTION MOTORS:
Propulsion Machine Overview - DC Machines, AC Machines, Comparison of Traction Machines, A case study; Machine Specification - Four-Quadrant Operation, Rated Parameters, Rated Torque, Rated and Base Speeds, Rated Power, Peak Operation, Starting Torque; Characteristic Curves of a Machine - Constant-Torque Mode, Constant-Power Mode, Maximum-Speed Mode, Efficiency Maps. **(9)**

UNIT III: HYBRID ELECTRIC VEHICLE
Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance. **(8)**

UNIT IV: FUNDAMENTALS OF EV CONTROLLERS
Introduction to Control, Feedback Controller Design Approach, Modeling the Electromechanical System, The Mechanical System, The PM DC Machine, The DC-DC Power Converter, The PI Controller, Designing Torque Loop Compensation, Determining Compensator Gain Coefficients for Torque Loop, Designing Speed Control Loop Compensation, Determining Compensator Gain Coefficients for Speed Loop, Acceleration of Battery Electric Vehicle (BEV) using PM DC Machine, Acceleration of BEV using WF DC Machine. **(10)**

UNIT V: STORAGE & CHARGING

Different Batteries and Ultracapacitors; Battery characteristics (Discharging &Charging) Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods, Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

(10)

Course Outcomes:

At the end of this course, students will able to

1. Understand the various parameters involved in battery pack .
2. Classify the BMS based on functionality.
3. Understand the application of BMS in Electric Vehicle.
4. Interpret the design of BMS.
5. Execute the installation, testing of BMS.

Text Books:

1. John G. Hayes and A. Goodarzi, "Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles", Wiley Publication, 2018.

References:

1. K Wang Hee Nam: AC Motor Control & Electrical Vehicle Application, CR Press, Taylor & Francis Group, 2019
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME103 PRODUCTION TECHNOLOGY OF AUTOMOTIVE COMPONENTS

L	T	P	C
3	0	0	3

Course Prerequisite: Zeal to learn the subject

Course Description:
The Production Technology of Automobile course provides an understanding, importance and relevance to the manufacturing processes and materials used for producing various automotive components.

MANUFACTURING OF AUTOMOTIVE ENGINE COMPONENTS
Course Objectives:
1. To study and understand the concepts of forming process and know the components produced by forging, extrusion and hydro forming processes.
2. To know about the principle and methods of gear manufacturing process
3. To know about the recent trends for production of automobile components
4. To acquire knowledge in understanding the manufacturing processes and functional requirement of automotive components.

UNIT I: MANUFACTURING OF AUTOMOTIVE ENGINE COMPONENTS
Cylinder block, Cylinder head - Materials, Engine Block Casting -Low pressure die casting, High pressures die casting, expendable pattern casting. Milling, Drilling, Boring, Honing, Reaming, Plasma spray coating.

Camshaft-Materials, Closed die forging, Impression die forging- forging force, and Finishing operations. Heat treatment.

Crankshaft- Materials, Forging, Precision machining, Heat treatment.

Main bearing - Material, Centrifugal casting, Mold material, Surface finishing.

Main bearing cap- Hot chamber die casting, Cold chamber die casting-Precision drilling operation,

Vibration Damper-Material requirement, Vacuum casting

Piston ring & Pin-Extrusion Process.

Valve tappets- Extrusion Process.

Valves-Monometallic, Bimetal, Stellied welded, Chrome plate, Nitrate. Process Cutting, Friction welding (Bimetal Special purpose), Upsetting, Forging, Stellied welding, Heat treatment, Grinding, Plasma spray coating

Automotive springs-Description, Functional requirement- Manufacturing process Hot rolling, oil tempering, cold oiling, stress relieving, coil and grinding, nitriding, slot peering, Strain aging

Inlet Manifold- Injection molding- Types, Injection molds.

Exhaust manifold- Process Welded tubular, Investment casting. engine blocks and valves

UNIT II MANUFACTURING OF GEAR & AXLES

Gear hobbing and gear shaping machines, Gear finishing and shaving, Grinding and lapping of hobs and shaping cutters, gear honing and gear broaching, Shotpeen hardening of gears.
Propeller shaft – Forging Process.
Transmission shaft & Transmission gear blanks: Forging, Extrusion process.
Rear axle drive shaft, axle housing spindles- Extrusion Process. **(7)**

UNIT III MANUFACTURING OF AIR & OIL FILTERS

Air Filters- -Materials Core materials, sealing agents, supporting materials.-Production Process.
Oil Filters-Description of oil filters, Materials, Production Process.
Ceramic Catalytic Convertor-Description of ceramic catalytic convertor- Material Properties-Processing- shaping, sintering, finishing,
Metallic Catalytic Convertor- Material Properties-Need for honey comb structure in metal catalytic convertor-Methods of forming honey comb,
Spark Plug- Processing of ceramic, forming of electrode, bonding.
Foot brake linkage & steering knuckles – Forging Process.
Steering worm blanks, brake anchor pins- Extrusion Process. **(9)**

UNIT IV: MANUFACTURING OF GLASS &RUBBER

Glass -Raw material preparation & melting-Properties of glass -Classification of glass for automotive application-Glass melting furnace- Pot furnace, Day tank, Continuous tank, Electric furnace, Shaping -Spinning, processing, blowing, Rolling, Forming of glass fibre, Centrifugal spraying, Heat treatment -Annealing & Tempering Processing,
Tyre- material selection, manufacturing process-Compound & mixing, Component Preparation, tyre building, curing and inspection. **(8)**

UNIT V: MANUFACTURING OF AUTOMOTIVE BODY

Automotive body materials-Automotive steel grades High strength & ultra-strength-Stamping aluminum sheet, stamping process & die-die operations & tooling -Blank holder-Draw Beads-Blanking & sharing dies-Binding -Deep drawing-Coating & lubrication. Advances in metal forming-Hydro forming & Extrusion, Flexible stamping procedure. TIG welding, Adhesive bonding, Friction Stir welding, Lack welding-Weld bonding, Automotive joining -Joining an automotive frame, Set assembling automotive doors. Mechanical fastening & bolting.
(10)

Course Outcomes:

After the successful completion of this course, Student will be able to:

1. Understand the functional requirement of automotive component for the required manufacturing process like forging, forming processes, casting process, welding process...etc.
2. Apply the various gear manufacturing methods needed for automotive applications.
3. Use the recent trend in manufacturing process for making auto components such as catalytic converters, air filters, etc.
4. Selection of the materials, design considerations and the manufacturing process for the glass and rubber components.
5. Understand the manufacturing processes for constructing the automotive body.

Text Books:

1. Serope Kalpakjian, "Manufactruing Engineeirng and Technology", 6th Edition,Addison-Wesley Publishing Co., Boston, 2010.
2. Mikell P. Groover "Fundamentals of Modern Manufactruing", 4th Edition,John Wiley & Sons.

Reference Books:

1. Mohammed A. Omar, “The Automotive Body Manufacturing System and Processes” 1st Edition, John Wiley & Sons Inc, USA, 2011.
2. Helmi A Youssef, "Manufacturing Technology", CRC Press, 2010.
3. P. N. Rao, “Manufacturing Technology", Vol- I & II, Mc Graw Hill International Editions.
4. R. K. Jain, “Production Technology”, Khanna Publishers, Delhi.
5. Benjamin W Niebel,"Modern Manufacturing Process Engineering", Mc Graw Hill International Editions.
6. Degarmo Paul, Black, Kohser, “Materials and Processes in Manufacturing”, (12e), Wiley, 2017.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME104 BATTERY MANAGEMENT SYSTEMS

L	T	P	C
3	0	0	3

Course Prerequisite: 18EEE101

Course Description:
This course introduces the fundamental concepts, principles and analysis of Battery Management System in Electric Vehicles

Course Objectives:

1. To study the various aspects of batteries and parameters involved in BMS.
2. To learn the selection of BMS topology.
3. To understand the basic functionality of BMS.
4. To study the various design of BMS.
5. To understand the installation of BMS.

UNIT I: INTRODUCTION TO BMS
Cells, Batteries, and Packs, Resistance; Li-Ion Cells - Formats, Chemistry, Safety, Safe Operating Area, Efficiency, Aging, Modeling, Unequal Voltages in Series Strings; Li-Ion BMSs - BMS Definition, Li-Ion BMS Functions, Custom Versus Off-the-Shelf; Li-Ion Batteries - SOC, DOD, and Capacity, Balance and Balancing, SOH; Modeling of battery pack; Modelling approach – Empirical, Physics-based model; **(9)**

UNIT II: BMS CHOICES
Functionality - CCCV Chargers, Regulators, meters, monitors, balancer, protector; Technology – Analog, digital, technical comparison; Topology – centralized, modular, master-slave, distributed, topology comparison. **(9)**

UNIT III: BMS FUNCTIONS
Measurement – Voltage, current, temperature; Management - Protection, Thermal Management, Balancing, Redistribution, Distributed Charging; Evaluation - State of Charge and Depth of Discharge, Capacity, Resistance, State of Health (SOH). **(8)**

UNIT IV: DESIGN OF BMS
Analog BMS design - Analog Regulator, Analog Monitor, Analog Balancer, Analog Protector; Analysis of available Digital BMS design - ATMEL's BMS Processor, Elithion's BMS Chip Set, National Semiconductors' Complete BMS, Peter Perkin's Open Source BMS, Texas Instruments' bq29330/bq20z90, Texas Instruments' bq78PL114/bq76PL; Custom Digital BMS - Voltage and Temperature Measurement, Current Measurement, Evaluation, Communications, Optimization, Switching; Cell Interface; Distributed Charging **(10)**

UNIT V: INSTALLING A BMS

Battery Pack Design, BMS Connections to Pack, BMS Connections to System; Configuring-Cell Configuration, Pack Configuration, System Configuration; Testing; Troubleshooting - Grounding, Shielding, Filtering, Wire Routing, Nuisance Cutouts **(9)**

Course Outcomes:

At the end of this course, students will be able to

1. Understand the various parameters involved in battery pack .
2. Classify the BMS based on functionality.
3. Understand the application of BMS in Electric Vehicle.
4. Interpret the design of BMS.
5. Execute the installation, testing of BMS.

Text Books:

1. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs", Artech House Publishers, 2010.
2. Gregory L Plett , "Battery Management Systems Volume II Equivalent-Circuit Methods", Artech House Publishers, 2016.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME201 ELECTRIC VECHILES LABORATORY

L	T	P	C
0	**0**	**4**	**2**

Course Prerequisite: None

Course Objectives:
The objective of this laboratory is to expose the students practically, a broad knowledge of working, assembly, disassembly, fault rectification of Vehicle – Electrical System, Suspension System, Wheel & Tyre System, Steering System, Transmission System, Braking System, Axles and Differential. It revises student's knowledge of design thinking, material selection and functionality of different parts.

LIST OF EXPERIMENTS

1. Dismantling, Study and Assembling of air brake system, antilock braking system and fault detection.
2. Dismantling, Study and Assembling of Drum and Disc Braking System - Brake bleeding.
3. Dismantling, Study and Assembling of wheel balancing, wheel alignment machine and vehicle lifting machine.
4. Dismantling, Study and Assembling of head light focusing of vehicles underbody inspection of vehicle either by lifting the vehicle or bringing the vehicle over underground inspection pit.
5. Dismantling, Study and Assembling of chassis system, steering systems with different steering gearboxes.
6. Dismantling, Study and Assembling of Transfer case, Sliding mesh gear box, Synchro mesh gear box, Constant mesh gear box and Automatic transmission system.
7. Dismantling, Study and Assembling of Constant Velocity Joint (Front Axles), Rear Axle and Differential.
8. Dismantling, Study and Assembling of suspension system. To obtain the Charging and discharging characteristics of a Battery
9. To design and simulated the bi-direction converter for EV charging
10. To design the speed control of Motor for EV application
11. Calibration of electric sensors utilized in EV
12. Design of driver circuits for the power controllers.

Textbook

1. Lab manual provided by the department

Reference Books

1. Automotive Trouble shooting and Maintenance by Anderson Ashburn.
2. Venk Spicer, Automotive Maintenance and Trouble shooting.
3. Ed May, Automotive Mechanics.
4. Bosch Automotive Handbook.
5. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003.
6. Iqbal Husain, “Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003.
7. Mehrdad Ehsani, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005.
8. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.
9. Lino Guzzella, “Vehicle Propulsion System” Springer Publications,2005.
10. Service manuals of reputed vehicles.

Equipments Required:

1. Chassis.
2. Front axle with Rzeppa joint.
3. Rear axle with differential.
4. Sliding, constant mesh and synchromesh gear box.
5. Steering gear box with linkages.
6. Braking system components like, brake shoe, wheel cylinder, master cylinder, disc braking system.
7. Antilock Braking System.
8. Suspension System.
9. Automotive Batteries and control systems.
10. Bi-Directional convertors, Electric sensors, Driver Circuits and Power Controllers.

Tools and Instruments required:

1. Spanners (Ring and Double and 6mm to 32mm)
2. Players (Cutting and nose)
3. Hammer and mallet
4. Screwdriver
5. Piston Ring Compressor
6. Piston Ring Extractor
7. Allen Key
8. Vernier caliper
9. Cylinder bore gauge
10. Puller
11. Torque wrench

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech IV Year I Semester

18MDME105 VECHILE BODY ENGINEERNG

L	T	P	C
3	0	0	3

Course Prerequisite: Zeal to learn the subject

Course Description:
The Vehicle Body Engineering provides the basic knowledge about constructional details of vehicle bodies and its aerodynamic structure. It provides an understanding, importance and design of Seating and Body. It insights into the vehicle aerodynamics - vehicle drag and types, various types and effects of forces and moments, various body optimization techniques and wind tunnel testing. It provides an understanding, importance and design selection of the body materials, trim, mechanism's, and body repair.

Course Objectives:

1. The students can impart knowledge in construction of car body, design criteria, types of car and safety aspects of car.
2. The students able to know the construction of bus body and dimensions of bus body and safety aspects.
3. The students can impart knowledge in types of commercial vehicles, design of cab and in aerodynamic testing, forces and moments.
4. The student will be well versed in the design and construction of external body of the vehicles and materials used in vehicles.

UNIT I CAR BODY DETAILS
Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car – Visibility- regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design -Car body construction-Various panels in car bodies. Safety aspect of car body. **(9)**

UNIT II BUS BODY DETAILS
Types of bus body: based on capacity, distance travelled and based on construction. Bus body lay out for various types, Types of metal sections used – Regulations – Constructional details: Conventional and integral. driver seat design- Safety aspect of bus body. **(8)**

UNIT III COMMERCIAL VEHICLE DETAILS
Types of commercial vehicle bodies - Light commercial vehicle body. Construction details of commercial vehicle body - Flat platform body, Trailer, Tipper body and Tanker body – Dimensions of driver's seat in relation to controls – Drivers cab design - Regulations. **(8)**

UNIT IV VEHICLE AERODYNAMICS
Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of various forces and moments by using wind tunnel. **(10)**

UNIT V BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR

Types of materials used in body construction-Steel sheet, timber, plastics, GRP, properties of materials. Body trim items-body mechanisms. Hand tools-power tools-panel repair-repairing sheet metal-repairing plastics-body fillers-passenger compartment service- corrosion: Anticorrosion methods, Modern painting process procedure-paint problems **(10)**

Course Outcomes:

After the successful completion of this course:

1. The students will be able to know design of car body and identify the car body parts in a vehicle.
2. The students will be able to evaluate seating design, safety aspects and bus layout design.
3. The students will be able to know about different aspects of commercial vehicle-construction details, design of cabins, seats and body.
4. The students will be able to analyse the Role of various aerodynamic forces and moments, measuring instruments.
5. The students will be able to find the material which can be used in car body, bus body, painting process and tools used for body repairs.

TEXTBOOKS:

1. Powloski, J., Vehicle Body Engineering, Business Books Ltd., 1998.
2. James E Duffy, Body Repair Technology for 4-Wheelers, Cengage Learning,2009.

REFERENCE BOOKS:

1. Wolf-Heinrich Hucho, “Aerodynamics of Road Vehicles”, 4th edition, 2000.
2. Giles, G.J., Body construction and design, Illiffe Books Butterworth & Co., 1991.
3. John Fenton, Vehicle Body layout and analysis, Mechanical Engg. Publication Ltd., London, 1992.
4. Braithwaite, J.B., Vehicle Body building and drawing, Heinemann Educational Books Ltd., London, 1997.
5. Dieler Anselm., The passenger car body, SAE International, 2000
6. Heinz Heisler, “Advanced Vehicle Technology” 2nd edition, Butterworth Heinemann, 2002.
7. Jack E Rjavee, “Automotive Technology- A system approach”, Thomson Asia Pte Ltd, Singapore, 3rd edition, 2004.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

MINORS in
MECHANICAL ENGINEERING –
Stream Name: Digital Manufacturing

(Offered to all the Engineering Disciplines except Mechanical Engineering)

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME106 COMPUTER AIDED MANUFACTURING PROCESS

L	T	P	C
3	0	0	3

Course Prerequisite: Nil

Course Description:
This course is the first course of Mechanical minor degree in digital manufacturing technology. It provides an insight of materials, manufacturing and its requirements of emerging practices. Topics include selection of materials, manufacturing processes and machining processes and various relevant activity. Computer aided manufacturing processes involves various functions involved in the pre and post processes.

Course Objectives:
1. Study the Mechanical properties of materials and their functionality.
2. Selection of materials based on the applications and usability.
3. Study and understand the manufacturing processes and its requirements with modern computer aided environment.
4. Learn various types of activities in manufacturing systems, principles and working processes.
5. Understand and apply the knowledge to select the suitable material, manufacturing and CNC machines.

UNIT I: MATERIALS PROPERTIES
Mechanical properties – fatigue strength – fracture Toughness – Thermal Properties – Magnetic Properties – Fabrication Properties -electrical, optical properties – Environmental Properties, Corrosion properties -shape and size – Material Cost and Availability- failure analysis **(8)**

UNIT II: SELECTION OF MATERIALS
Selection of Materials for Biomedical Applications – Medical Products – Materials in Electronic Packaging – Advanced Materials in Sports Equipment – Materials Selection for Wear Resistance -Advanced Materials in Telecommunications – Using Composites – Manufacture and Assembly with Plastics, fibre and Diamond Films. **(9)**

UNIT III: MANUFACTURING PROCESSES
Interaction of Materials Selection, Design, and Manufacturing Processes – Production Processes and Equipment for Metals – Metal Forming, Shaping, and Casting – Plastic Parts Processing -Composites Fabrication Processes – Advanced Ceramics Processing – surface treatment -Resource -The Price and Availability of Materials. **(9)**

UNIT IV: COMPUTER AIDED MANUFACTURING
CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM, Concepts of Computer Integrated

Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions. Types of manufacturing systems, transfer lines, flexible manufacturing system (FMS), The manufacturing cell, tool management and workpiece handling system, benefits of CIM. **(9)**

UNIT V: NC/CNC MACHINE TOOLS: NC AND CNC TECHNOLOGY
Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re-circulating ball screw, anti-friction slides, step/servo motors. Axis designation, NC/CNC tooling. Fundamentals of part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric sub routines. **(10)**

Course Outcomes:
On successful completion of the course, the student will be able to:
1. Understand the materials properties and their characteristics.
2. Select the suitable material for the specific application.
3. Select and apply the suitable manufacturing process to make a product.
4. Explain the role and functions of Computers in manufacturing processes.
5. Explain the NC/CNC machine tools construction and applications.

Text Books:
1. Ashby, M. F. Materials selection in mechanical design, 4th edition, Elsevier, 2011.
2. Radhakrishna Subramanyan & Raju CAD/CAM/CIM, 4th edition, New Age International (P) Ltd., Publishers, 2008.

References:
3. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
4. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME107 PRODUCT DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

Course Prerequisite: Nil

Course Description:
Product design and development is an important process of all manufacturing industries. This course provides a comprehensive view of idea to product realization. In this course, the students are introduced to various design for manufacture the product based on the development cycle. Industrial design is introduced to the students to simulating the manufacturing process in digital and virtual forms.

Course Objectives:

1. Describe the product development process and account for its conditions and terms and use the most common methods of managing terms and concept development, use basic sketching techniques to communicate ideas, plan, implement and present a design project.
2. Use a CAD-software to design products with moving parts and with the help of top-down methodology,
3. Create advanced solid and surface models, produce realistic images and simple animations of a product,
4. Apply the PDM/PLM-processes to design products.
5. Apply the prototyping model concepts on new product development.

UNIT I: INTRODUCTION
Need for product design & development-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behaviour analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement. **(9)**

UNIT II: CONCEPT GENERATION, SELECTION AND TESTING
Plan and establish product specifications. Task - Structured approaches - clarification - search-externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance - manufacturability – Concept Testing Methodologies. **(9)**

UNIT III: PRODUCT ARCHITECTURE
Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture. **(8)**

UNIT IV: INDUSTRIAL DESIGN

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design. **(10)**

UNIT V: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution. **(9)**

Course Outcomes:

Upon the completion of this course the students will be able to

1. Summarize the concept of Product and Process for organization management.
2. Apply the structured approaches for concept generation, selection and testing of products.
3. Solve system level design issues and creating interface specifications.
4. Explain the importance of CAD/CAM integration in industrial design process.
5. Explain the concept of design for manufacturing and product development.

Text Books:

1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, McGraw – Hill International Edns.1999
2. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education

References:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
3. Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education 2001.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME108 DIGITAL MANUFACTURING PLANNING AND CONTROL

L	T	P	C
3	0	0	3

Course Prerequisite: Nil

Course Description:
This course is essential for working in any capacity of operations in the supply chain because students will gain a thorough understanding of Manufacturing Planning and Control key elements. MPC, is responsible for the planning and control of the flow of materials through the manufacturing process. For efficient, effective and economical operation in a manufacturing unit of an organization, it is essential to integrate the manufacturing planning and control system.

Course Objectives:
The general objectives of the course are to enable the students to

1. able to develop, manage and control all aspects of an effective and efficient manufacturing planning and control system- a key to the success of any product manufacturing company.
2. gain knowledge to develop a demand management system, including activities such as forecasting, determining, and estimating customer demand, converting specific customer orders into promised delivery dates, and balancing demand with supply
3. understand the Planning and forecasting-how to link strategic goals to production by developing an overall business plan which integrates the various functional planning efforts
4. construct and manage an effective operations planning and control for making good use of manufacturing resources
5. understand the Materials Requirement Planning-using e- tool for simulation and performing the detailed analysis.

UNIT I: INTRODUCTION
Overview of manufacturing systems and various issues of interest: Assembly Line, Repetitive batch manufacturing, Cellular manufacturing, FMS, JIT, CIM. **(7)**

UNIT II: MANUFACTURING PLANNING
Preplanning: Forecasting, Economic analysis, Aggregate planning, Capacity planning, Inventory planning.
Decision making in design of manufacturing systems : Group Technology, Line balancing, Plant layout.
Using computer programmes solve forecasting and line balancing problem **(9)**

UNIT III: OPERATIONAL PLANNING
Operations planning : MRP, MRP II, Hierarchical planning systems, JIT systems, FMS
Operation and control: Lot sizing decisions, production scheduling, line of balance, quality planning and control, cost planning and control, productivity planning and control and applications of theory of constraints. **(9)**

UNIT IV: WORLD CLASS MANUFACTURING SYSTEMS
Road map to World Class Manufacturing Systems: Ideal Manufacturing, Intelligent Manufacturing and Agile Manufacturing Systems.
Simulation: Simulation analysis of manufacturing systems. **(9)**

UNIT V: IMPLEMENTATION OF DIGITAL MANUFACTURING
Applications of recent developments in IT including ERP, e-Business, Enterprise Applications Integration (EAI) and Virtual Manufacturing: Concepts, Justification and Status of development and implementation. **(11)**

Course Outcomes:

1. Understand the aspects of an effective and efficient manufacturing planning and control system- a key to the success of any product manufacturing company.
2. Apply the knowledge to plan the management activities such as forecasting, determining and estimating customer demand, converting specific customer orders into promised delivery dates, and balancing demand.
3. Apply control strategies to production by developing an overall business plan which integrates the various functional planning efforts
4. Explain the various functionalities of world class manufacturing system.
5. Explain the digital manufacturing process and issues on the implementation process.

Text Books:

1. R. B. Chase, N. J. Aanilano and F. R. Jacobs (2011), Production and Operations Management- Manufacturing and Services, Tata McGraw Hill, APICS/CPIM Certification Edition.
2. H. Noori and R. Radford (1995), Production and Operations Management, McGraw Hill Inc.

References:

1. Danny Samson, “Manufacturing & Operations Strategy”, Prentice Hall, 1991
2. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers 1990.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME109 BIG DATA ANALYTICS FOR MANUFACTURING

L	T	P	C
3	0	0	3

Course Prerequisite: Nil

Course Description:
This course deals with real world applications of Big data especially in manufacturing engineering. Begin with big data collection in the manufacturing sources and how effectively utilised for further analysis in manufacturing activities. Various practical applications and their case studies illustrates the potential possibility of improvement in the process towards world class manufacturing.

Course Objectives: Specific objectives may be summarized as:
1. Optimize business decisions and create competitive advantage with Big Data analytics
2. Explore the fundamental concepts of big data analytics.
3. Learn to analyze the data acquisition in data collection systems.
4. Understand and apply big data analytics in the various manufacturing applications.
5. Understand the issues and challenges of Big data in design and manufacturing.

UNIT-I BIG DATA
Big Data and its Importance – Four V's of Big Data – Drivers for Big Data – Introduction to Big Data Analytics – Big Data Analytics applications. **(7)**

UNIT-II BIG DATA PROCESSING
Integrating disparate data stores - Mapping data to the programming framework - Connecting and extracting data from storage - Transforming data for processing. **(7)**

UNIT-III DATA ACQUISITION
Data Acquisition, considerations, frameworks, big data collection systems, Messaging queues, custom connectors. Batch analysis-case studies **(7)**

UNIT-IV APPLICATIONS IN MANUFACTURING
Benefits and Impacts of Big Data in Design and Manufacturing Engineering, Applying Big Data Concepts to Improve Flat Steel Production Processes, Big Data in General Electric, General Motors and the Automotive Industry, Big Data in Semiconductor Manufacturing and Integrated Circuits, Big Data at Work for a Missile Plan, Big Data in Cloud-based Design and Manufacturing. **(12)**

UNIT -V CHALLENGES AND ISSUES
Production Process Monitoring, Maintenance, Quality Assurance and Logistics for Manufacturers, Big Data in CAD/CAE/CAM and CAD Educational Assessment, Methods, Technologies and Technology Progress around Big Data, General Challenges of Big Data, Big Data Challenges in Design and Manufacturing Engineering. **(12)**

Course Outcomes:

Upon the completion of this course the students will be able to

1. Understand the business decisions and create competitive advantage with Big Data analytics
2. Apply the fundamental concepts on the big data analytics.
3. Analyze the data acquisition in data collection and processing.
4. Understand and apply big data analytics in the various manufacturing applications.
5. Study and resolve the issues and challenges of Big data in design and manufacturing.

Text Books

1. Arshdeep Bahga & Vijay Madisetti, "Big Data Analytics: A Hands-On Approach, Bahga, 2016.
2. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.

References:

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012.
2. Big data in manufacturing: a systematic mapping study, O'Donovan et al. Journal of Big Data (2015) 2:20, DOI 10.1186/s40537-015-0028-x.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME202 COMUPTER AIDED DESIGN AND MANUFACTURING LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Nil

Course Objectives:

1. To gain practical experience in handling 2D drafting and 3D modelling software systems.
2. To study the features of CNC Machine Tool.
3. To expose students to modern control systems (Fanuc, Siemens etc.,)
4. To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre and CNC EDM.
5. To study the rapid prototyping and build model using 3D printing.

LIST OF EXPERIMENTS

(i) Creation of 3D assembly model of following machine elements using 3D Modelling software, Flange Coupling, Plummer Block, Screw Jack, Lathe Tailstock, Universal Joint , Machine Vice, Safety Valves, Non-return valves, Connecting rod and Piston.

(ii) Manual Part Programming: Part Programming - CNC Machining Centre a) Linear Cutting. b) Circular cutting. c) Cutter Radius Compensation. d) Canned Cycle Operations.

Part Programming: CNC Turning Centre a) Straight, Taper and Radius Turning. b) Thread Cutting. c) Rough and Finish Turning Cycle. d) Drilling and Tapping Cycle.

(iii) Computer Aided Part Programming :CL Data and Post process generation using CAM packages. Application of CAPP in Machining and Turning Centre. 3D printing practice

Course Outcomes:

The students after completing the course will be able to:

1. Draw 3D and Assembly drawing using CAD software.
2. Demonstrate manual part programming with G and M codes using CAM
3. CNC programming with machining practice with CNC Lathe and Milling
4. Develop the prototype using 3 D printer.

Text Books:

Lab manual provided by the department

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech IV Year I Semester

18MDME110 SMART SENSORS AND INDUSTRY 4.0

L	T	P	C
3	0	0	3

Course Prerequisites: Nil

Course Description: Sensors has become an essential device in the process control monitoring and applied in wide range of industries. The areas of applications of sensor technology include meteorology, transport systems (aerospace, automobile, high-speed trains), energy systems, environment, electronics, bio-medical (design of life-support and drug delivery systems), etc. Now days variety of sensors developed for their inherent requirements. Industry 4.0

Course Objectives:

1. Study the working principle of various sensors.
2. Sensors calibrations for acquiring data.
3. Developing the smart manufacturing capabilities on the industrial process.
4. Learn the Industry 4.0 concepts and implement in smart manufacturing.
5. Know the data transmission and cyber security standards.

UNIT I: PHOTONIC AND OPTOELECTRONICS SENSORS

Optical Fiber Sensors: Devices and Techniques, Silicon Mirroring Sensors, Vision-Aided Automated Vibrometer for Remote Audio–Visual Range Sensing, Optical Oxygen Sensors for Micro- and Nanofluidic Devices. Infrared and Thermal Sensors: Thin Film Resistance Temperature Detectors, Adaptive Sensors for Dynamic Temperature Measurements. **(9)**

UNIT II: MAGNETIC AND INDUCTIVE SENSORS

Accurate Scanning of Magnetic Fields, Low & High Frequency Measurements, Technologies for Electric Current Sensors, Sound and Ultrasound Sensors, Piezo resistive, Wireless, and Electrical Sensors, Microwave Sensors for Non-Invasive Monitoring of Industrial Processes, Application of Inertial Sensors in Developing Smart Particles. **(9)**

UNIT III: SMART MANUFACTURING ENABLING TECHNOLOGIES

Design of Anti-Metallic RFID for Applications in Smart Manufacturing, Smart Manufacturing Techniques using Sheet Forming, Software Development Tools to Automate CAD/CAM systems, Interaction between Design Research and Technological Research in Manufacturing Firm. **(9)**

UNIT IV: INDUSTRY 4.0

Defining industry 4.0, Why Industry 4.0 and Why Now?, Four Main Characteristics of Industry 4.0, benefits to business, Industry 4.0 design principles, Building Blocks of Industry 4.0. Conceptual Framework for Industry4.0, Smart Factories: Introducing the Smart Factory, Smart Factories in Action, Why Smart Manufacturing Is Important, Real-World Smart Factories, New Internet services and business models. **(9)**

UNIT V: MANAGING THE DIGITAL TRANSFORMATION

Smart and Connected Product Business Models, Lean Production Systems for Industry4.0, Internet of Things and New Value Proposition, Advances in Robotics in the Era of Industry 4.0, Overview of Cyber Security in the Industry 4.0 Era. **(9)**

Course Outcomes:

1. Understand the working principle of various sensors.
2. Calibrate a sensor for acquiring data.
3. Explain the smart manufacturing capabilities on the industrial process.
4. Understand the Industry 4.0 concepts and implement in smart manufacturing.
5. Apply the data transmission protocols to correlate the cyber security standards.

Textbook:

1. Alp Ustundag Emre Cevikcan Industry 4.0: Managing The Digital Transformation, Springer Series in Advanced Manufacturing, Springer International Publishing Switzerland 2018.
2. Zongwei Luo, Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence, March 2014.

References:

1. Alasdair Gilchrist, Industry 4.0 The Industrial Internet of Things, Springer Science+Business Media New York, 233 Spring Street, 6th Floor, New York, 2016.
2. I. R. Sinclair, Sensors and Transducers, Elsevier, 2001, ISBN: 978-0-7506-4932-2.
3. C.W. de Silava, Sensors and Actuators, 2nd edition, CRC Press, 2016.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

MINORS in
MECHANICAL ENGINEERING
Stream Name: Mechatronics

(Offered to all the Engineering Disciplines except Mechanical Engineering)

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME111 ENGINEERING STATICS AND APPLIED MECHANICS

L	T	P	C
2	1	0	3

Course Prerequisite: Engineering Maths and Physics.

Course Objectives

1. Determine the resultant force and moment for a given system of forces and its application.
2. Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.
3. Determine the centroid and second moment of area
4. Understanding the concept of stress and strain and its application.
5. Understanding of torsion and determine the deformation of a shaft of different shapes.

UNIT-I: INTRODUCTION TO FORCE AND MOMENT
Classification of Engineering Mechanics, laws of Mechanics, characteristics of forces, composition of two force system, resolution of forces, equilibrium of bodies, equilibrium of connected bodies, moment of a force, Varignon's theorem, Couple, resolution of a force into a force and a couple, resultant of non-concurrent force system. **(10)**

UNIT-II: ANALYSIS OF PIN-JOINTED PLANE FRAMES AND FRICTION
Perfect, Deficient and Redundant Frames. Nature of forces in members. Method of analysis. Method of joint. Method of section. Method of tension coefficients. Frictional force. Laws of friction. Angle of friction. Problems of non-concurrent force systems. **(8)**

UNIT-III: CENTROID AND MOMENT OF INERTIA
Properties of Areas and Solids: Centroid, Centre of Gravity; Moment of Inertia, Polar moment of Inertia and Principal Axes, Moment of Inertia of rigid Bodies.
Centre of gravity, center of gravity of composite bodies, Theorem of pappus-Guldinus, Mass-moment of inertia, radius of gyration, parallel axis theorem, moment of inertia of composite bodies. **(9)**

UNIT-IV: PROPERTIES OF MATERIALS
Stress, Strain, Elasticity, Hooke's Law, Elastic Constants, Stress-Strain Diagram, Factor of Safety, Working Stress, Thermal Stress, Strain Energy in Tension, Compression and Shear, Bi-axial Stress, Stresses in Thin –Walled Pressure Vessels. **(9)**

UNIT-V: TORSION
Pure torsion, derivation of torsional equations, polar modulus, power transmission, torsional rigidity, Stepped shafts and composite shafts, Coupling, strain energy in torsion, closed coiled helical spring. Torsion of hollow and thin walled shafts. **(9)**

Text Book:

1. Mechanics of Materials by Gere and Timoshenko, second addition
2. Beer, Ferdinand P., and Elwood Russell Johnston. Vector mechanics for engineers. New York: McGraw-Hill, 2003.

Reference Books

1. Shames, Irving Herman, and G. Krishna Mohana Rao. Engineering mechanics: statics and dynamics. Englewood Cliffs: Prentice-Hall, 1967.
2. Russell, C. Hibbler. Engineering Mechanics: Statics, Value Edition+ Modified Mastering Engineering Revision With... Pearson Etext--Access Card Package. Prentice Hall, 2019.
3. Bhavikatti, S. S. Fundamentals of Engineering Mechanics. New Academic Science, 7th Edition.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME112 FLUID POWER SYSTEMS

L	T	P	C
3	0	0	3

Course Prerequisite: 18MAT108

Course Description:
Fluid power systems are the systems that use pressurized fluids for generation, control and transmission of power. Such systems are extensively used in automobiles, heavy machinery and in control systems. This course is intended to provide the students with necessary background in the fluid power so that they acquire a working knowledge of the typical fluid power systems. The fundamental concepts required for design, analysis, application, operation and maintenance of fluid power systems will be covered.

Course Objectives:

1. To review the fluid mechanics principles that is relevant to fluid power systems
2. To teach basic components of fluid power systems and their working principles
3. To elucidate the working of hydraulic pumps, motors, valves, actuators and their use in hydraulic circuits
4. To elucidate the working of compressors, pneumatic actuators, valves and their use in pneumatic circuits.
5. To describe the implementation logic control using fluid circuits

UNIT I: INTRODUCTION TO HYDRAULIC POWER
Pascal's law and problems on Pascal's Law, Continuity equation, Bernoulli's equation. Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps, Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.
Hydraulic Actuators and Motors: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance. **(10)**

UNIT II: CONTROL COMPONENTS IN HYDRAULIC SYSTEMS
Directional Control Valves – Symbolic representation, Constructional features, pressure control valves –direct and pilot operated types, flow control valves. Shock absorber .Hydraulic Circuit Design and Analysis: Control of single and double acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, and Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits. **(9)**

UNIT IV: PNEUMATIC CONTROL
Characteristics of compressed air. Structure of Pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, and Lubricators. Pneumatic Actuators: Linear cylinders– Types, conventional type

of cylinder working, end position cushioning, seals, mounting arrangements applications. Rotary cylinder types construction and application. Design parameters, selection.
Pneumatic Control valves: Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications. **(9)**

UNIT V: MULTI-CYLINDER APPLICATIONS
Coordinated and sequential motion control. Motion and control diagrams – signal elimination methods. Cascading method. Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications., Distribution of compressed air- Piping layout. **(9)**

UNIT III: ACCESSORIES AND MAINTENANCE OF FLUID POWER SYSTEMS
Conductor sizing for flow rate requirements, Hydraulic oils; Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting. Safety of Fluid Power Systems. **(8)**

Course Outcomes:
At the end of the course, student will be able to
1. Apply the basic fluid mechanics principles used in design and analysis of fluid power systems
2. Distinguish between different types of fluid power systems and know their relative merits and demerits
3. Design and analyze components of hydraulic systems like pumps, hydraulic motors, cylinders, valves and actuators.
4. Design and analyze components of pneumatic systems like compressors, valves and actuators.
5. Describe the working principles of controls for fluid power circuits.

Text Books:

1. Fluid Power with applications, Anthony Esposito, Fifth edition, Pearson education, Inc. 2000.
2. Pneumatics and Hydraulics, Andrew Parr. Jaico Publishing Co. 2000.

References:

1. Pinches, Industrial Fluid Power, Prentice hall
2. D. A. Pease, Basic Fluid Power, Prentice hall
3. J. J. Pipenger, Industrial Hydraulics, McGraw Hill
4. H. L. Stewart, Hydraulics and Pneumatics, Industrial Press

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME113 INDUSTRIAL AUTOMATION

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
This course reviews the introduction to automation, Material Handling, Overview of Material Handling Equipment, Storage Systems, Automated Production Lines and Line balancing method to reduce lead time.

Course Objectives:
The students will study:

1. The principles of automation, importance of automated flow lines and its types.
2. Study the elements in automation, types of automation and levels of automation.
3. Outline of the system configurations used in automated production.
4. Recognize and articulate the foundational assumption of the transfer mechanism, types of transfer mechanism that may be used for work part transfer.
5. Automated assembly systems, and their associated system configurations, list the hardware components used for parts delivery at workstations Outline typical automated assembly.

UNIT I - INTRODCUTION TO AUTOMATION:
Automation and control technologies in production system Basic elements of an automated system, advanced automation functions, levels of automation, continuous and discrete control systems, computer process control, common measuring devices used in automation, desirable features for selection of measuring devices. **(10)**

UNIT II - INTRODUCTION TO MATERIAL HANDLING SYSTEM:
Overview of Material Handling Equipment, Considerations in Material Handling System Design, 10 Principles of Material Handling, Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems. **(10)**

UNIT III - PRODUCTION AND ASSEMBLY SYSTEMS:
Automated production lines- fundamentals, system configurations, work part transfer mechanisms, storage buffers, control of production line, applications Automated assembly systems- fundamentals, system configurations, parts delivery at work stations, applications. **(9)**

UNIT IV - CELLULAR MANUFACTURING
Group technology, part families, parts classification and coding, production flow analysis, Opitz coding system, composite part concept, machine cell design, applications of GT. **(8)**

UNIT V - FLEXIBLE MANUFACTURING SYSTEMS:

Introduction to FMS, types of FMS, FMS components, applications and benefits, planning and implementation issues in FMS, quantitative analysis of FMS. **(8)**

Course Outcomes:

After completion of the program, students will be able to:

1. Explain types of automation, components of automation, strategies and levels of automation and advanced automation functions.
2. Understand automated transfer and storage system, recognize the equipment's used in auto- mated transfer and storage system.
3. Summarize the various automated storage systems and automatic data capture.
4. Apply the transfer lines with and without storage buffers in manual assembly line.
5. Apply line balancing algorithms to various manual assembly lines problems.

Text Books:

1. Mikell P. Grover - Automation, Production Systems, and Computer-Integrated Manufacturing, PHI Publication.

Reference books:

1. CAD CAM: Principles, Practice and Manufacturing Management, Chris Mc Mohan, Jimmie Browne, Pearson edu. (LPE)
2. Automation, Buckinghsm W, Haper & Row Publishers, New York, 1961.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME114 ROBOTICS AND CONTROL

L	T	P	C
3	0	0	3

Course Prerequisite: Knowledge of Engg. Mechanics, Instrumentation & Control and Maths.

1. To make students understand how does a serial robot works
2. To make students learn how to design a serial robot for a given task
3. To make students understand the societal impacts of robotic technology

UNIT I: INTRODUCTION TO INDUSTRIAL ROBOTS
Classification, Robot configurations, Functional line diagram, Degrees of Freedom. Components, common types of arms, joints, grippers. Robot Reference frames, Robot characteristics, Robot Workspace, Robot Applications. **(9)**

UNIT II: KINEMATICS OF ROBOTS
Kinematics of robots- Position analysis: Robot as Mechanism, Conventions, Matrix representation, Homogeneous Transformation, Representation of transformation, Inverse of Transformation, Forward and Inverse Kinematic of Robots, Forward and Inverse kinematics equations: position and orientation, Roll, Pitch ,Yaw Angles, Euler Angles, Articulated Joints, Denavit Hartenberg Representation of forward kinematics, Inverse Kinematic Programming of Robot, Degeneracy and Dexterity. **(10)**

UNIT III: DIFFERENTIAL MOTIONS AND VELOCITIES OF ROBOTICS
Differential motions and velocities: Differential relationship, Differential versus large scale motions, Differential motions of a frame versus a Robot, Differential motion of a frame about Reference axes, General axis, Frame, Interpretation of the differential change, Differential Change between frames **(8)**

UNIT IV: MANIPULATOR DYNAMICS, TRAJECTORY PLANNING AND ROBOT PROGRAMMING
Lagrange – Euler and Newton – Euler formations, Trajectory Planning: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion – straight line motion. Robot programming -Types – features of languages and software packages. **(9)**

UNIT V: CONTROL OF MANIPULATORS
Open and closed loop control, Linear control schemes. Model of manipulator joint, Joint actuator, Partitioned PD control Schemes, PID control schemes, Computed Torque Control, Force control of Robotics Manipulators tasks, Force control strategy, Hybrid Position/ Force control , Impedance force /Torque control. **(9)**

Course Outcomes:
On completion of this course, the students will be able to

1. Understand the fundamentals of robotics.
2. Apply the mechanics of serial manipulator.
3. Plan the trajectory of a serial manipulator.
4. Design the position and force control techniques for a serial manipulator.

Text Books

1. Niku Saeed B., Introduction to Robotics, John Wiley & Sons
2. Mittal R.K. and Nagrath I.J., Robotics and Control, McGraw Hill Education

Reference Books

1. Saha S.K., Introduction to Robotics, McGraw Hill Education
2. Craig John J., Introduction to Robotics: Mechanics and Control, Pearson

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME203 MECHATRONICS LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Basic Electronics and fundamental concepts of Mechatronics

Course Objectives:

1. To synergize the combination of mechanical, electrical, electronics, control, and computer engineering to design and manufacture useful products.
2. To provide a common floor where students could perform experiments regarding fundamental sequence control using various sensors and actuators.
3. To assist the students in the development of 'hands-on' skills on multidisciplinary systems.
4. To design and analyze basic pneumatics system.
5. To write CNC program codes for various machining operations.

List of Experiments:

1. Control of stepper motor/ stepper motor interfacing with (8051) microcontroller
2. Closed loop position control of DC motor
3. Closed loop velocity control of DC motor (to write an assembly language program to control the speed of DC motor using (8051) microcontroller)
4. Closed loop control of pneumatics cylinder
5. Actuation of single acting cylinder by OR gate using PLC
6. Actuation of single acting cylinder by AND gate using PLC
7. Actuation of single acting cylinder with ON delay timer using PLC
8. Stimulate the single acting cylinder with OFF delay timer using PLC
9. Automatic actuation of double acting cylinder using PLC
10. Continuous actuation of double acting cylinder using proximity sensor
11. Range measurement using ultrasonic sensor
12. Modelling and position control of one degree of freedom planar mechanism
13. PLC program development to a pick and place robot
14. Introduction to CNC & NC machines, and part programming (G-codes and M-codes)
15. Developing CNC program codes for threading, milling, drilling, etc. (G-codes and M-codes)
16. Experiments on CNC lathe – Turning, threading operations

Course Outcomes:

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

1. Design a mechatronic system with the help of microcontrollers, PLCs, and other electrical and electronic circuits.
2. Conduct experiments with the actual robot to experience its basic movements/motions.
3. Control the pneumatics cylinder using PLCs.
4. Control the position and speed of DC stepper motor using microcontroller.
5. Write part programs for CNC lathe and milling operations.

Text Books:

Lab manual provided by the department

Reference Books:

1. Bolton W., ‘*Mechatronics*’, 3rd Ed., Pearson, 2004.
2. K. P. Ramachandran, G. K. Vijayaraghavan, M. S. Balasundaram, ‘*Mechatronics*’, Wiley India, 2012.
3. R. K. Rajput, ‘A textbook of Mechatronics’, S Chand, 2008.
4. Devdas Shetty and Richard A. Kolk, ‘Mechatronics system design’, 2nd Edition, Cenage Learning.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech IV Year I Semester

18MDME115 MECHATRONICS

L	T	P	C
3	0	0	3

Course Prerequisites: Basic Electronics Engineering

Course Objectives

1. To have the comprehensive knowledge of the technology related to mechatronics and automation.
2. To understand the structure of electronics and their applications in mechanical devices.
3. To understand the principle of automatic control with the help of drives and actuators.
4. To understand the principles of process control and programmable logic controllers.
5. To develop an ability to use the technique, skills, and modern engineering tools necessary for engineering practice.

UNIT-I: INTRODUCTION

Introduction: Definition of Mechanical Systems; Elements of Mechatronics system; Design process; systems – measurement and control systems; Applications – CNC machines, flexible manufacturing system (FMS), computer integrated manufacturing (CIM), humanoid robot, Advanced vehicle control systems (AVCS) **(9)**

UNIT-II: SENSORS AND TRANSDUCERS

Definition of transducer; classification of transducers; characteristic parameters used in transducers; Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. **(10)**

UNIT-III: DRIVES AND ACTUATORS

Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Electrical actuators: DC motor, AC servo motor, Stepper motor, Induction motor speed control **(9)**

UNIT-IV: CONTROLLERS

Controller principles, Proportional, Integral, Derivative controller, PID controllers, Introduction to PLCs, Basic structure of a PLC, Principles of operation, selection of PLC for the application **(8)**

UNIT-V: DESIGN OF MECHATRONICS SYSTEMS

Mechatronics approach to design; case examples – boat autopilot, high-speed tilting trains, automatic car park system, engine management system, antilock brake system (ABS control; Robotic automation in car automated production lines. **(9)**

Course Outcomes:

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

1. Understand the fundamentals of mechatronics systems and significance of system and design process in mechatronics applications.
2. Illustrate the significance of sensors and transducers in measurement and instrumentation process.
3. Describe the operation of hydraulic and pneumatic, electrical, and mechanical actuator systems.
4. Understand PID, PLC, general functions, its advantages and application.
5. Develop issues encountered and techniques required in developing mechatronics products and automation systems.

Textbook:

1. Bolton W., '*Mechatronics*', 3rd Ed., Pearson, 2004.

Reference books:

1. K. P. Ramachandran, G. K. Vijayaraghavan, M. S. Balasundaram, '*Mechatronics*', Wiley India, 2012.
2. R. K. Rajput, '*A textbook of Mechatronics*', S Chand, 2008.
3. Devdas Shetty and Richard A. Kolk, '*Mechatronics system design*', 2nd Edition, Cenage Learning.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

MINORS in MECHANICAL ENGINEERING
Stream Name: NANOTECHNOLOGY

(Offered to all the Engineering Disciplines except Mechanical Engineering)

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME116 ELEMENTS OF NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description: To enable the students to learn the basics of nanoscience and nanotechnology

Course Objectives:

1. Understand the fundamentals of nanotechnology and to gain Knowledge on different classes of nanomaterials
2. Learn what are the various synthesis methods of nanomaterials
3. Acquire the knowledge on characterization techniques involved in nanotechnology.
4. Understand the various applications in nanotechnology

UNIT I: BASICS AND SCALE OF NANOTECHNOLOGY

Introduction and scientific revolutions, Time and length scale in structures, Definition of a nanosystem, Dimensionality and size dependent phenomena, Surface to volume ratio, Fraction of surface atoms and surface energy, Surface stress and surface defects, Properties at nanoscale – optical & mechanical, Properties at nanoscale – electronic & magnetic. **(9)**

UNIT II: DIFFERENT CLASSES OF NANOMATERIALS

Classification based on dimensionality, Quantum dots, wells and wires, Carbon-based nano materials – fullerences and buckyballs, Carbon nanotubes and grapheme, Metal based nano materials – Nanogold and Nanosilver, Metal oxide based nano materials, Nanocomposites and Nano-polymers, Nanoglasses and nano ceramics, Biological nanomaterials **(9)**

UNIT III: SYNTHESIS OF NANOMATERIALS

Chemical methods: Metal nanocrystals by reduction, **Chemical methods:** Metal nanocrystals by reduction, Solvothermal synthesis and photochemical synthesis, Sonochemical routes and chemical vapor deposition (CVD), Metal oxide chemical vapor deposition (MOCVD)
Physical methods: Ball milling, Electrodeposition techniques, Spray pyrolysis and flame pyrolysis, DC/RF magnetron sputtering, Molecular beam epitaxy (MBE) **(9)**

UNIT IV: FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES

Nanofabrication: Photolithography and its limitation and electron beam lithography (EBL), Nanoimprinting and soft lithography patterning.**Characterization:** Field emission scanning electron microscopy (FESEM) and environmental scanning electronmicroscopy (ESEM), High resolution transmission electron microscope (HRTEM), Scanning tunneling microscope (STM), Surface enhanced raman spectroscopy (SERS), X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), Rutherford backscattering spectroscopy (RBS) **(10)**

UNIT V: APPLICATIONS IN NANOTECHONOLOGY

Solar energy conversion and catalysis, Molecular electronics, nanoelectronics and printed electronics, Polymers with a special architecture, liquid crystalline systems, Linear and nonlinear optical and electro-optical properties, Applications - nanomaterials for data storage, Photonics and plasmonics, Chemical and biosensors, Nanomedicine and nanobiotechnology, Nanotoxicology challenges **(8)**

Course Outcomes:

The successfully complete of this course, Student will be able to:

1. Understand the fundamentals of nanotechnology
2. Give a general introduction to different classes of nanomaterials
3. Improve their knowledge on various synthesis methods of nanomaterials
4. Understand characterization techniques involved in nanotechnology
5. Familiarize themselves with nanotechnology potentialities

Text Books

1. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2008
3. A.Nabok, "Organic and Inorganic Nanostructures", Artech House, 2009

Reference Books/Other Reading Material

1. C.Dupas, P.Houdy, M.Lahmani, "Nanoscience: Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007.
2. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., 2001

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME117 FUNDAMENTALS OF SOLID-STATE ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description: To teach fundamental scientific concepts essential to solid state engineering so that students are capable of taking more advanced courses in the field of materials science.

Course Objectives:

1. Acquire knowledge on physics of crystalline solids and elastic properties, lattice dynamics, transport properties and optical processes in solids
2. Understand quantum mechanical concepts of free electron and theory of solids
3. Gain theoretical knowledge on optical properties.

UNIT I: CRYSTAL BINDING AND ELASTIC CONSTANTS

Introduction to interatomic forces, Van der Waals – London interaction, Equilibrium lattice constants and cohesive energy, Ionic crystals, Madelung energy and Madelung constant, Evaluation of the Madelung constant, Covalent, metallic and hydrogen bonding, Hook's law: elastic strain components, dilation, Stress components, elastic compliance and stiffness constants. **(9)**

UNIT II: CRYSTAL DIFFRACTION, VIBRATIONS AND THERMAL PROPERTIES

Crystal diffraction – Bragg's law, Reciprocal lattice vectors, concept of Brillouin zones, Vibration of crystals with monoatomic basis, First Brillouin zone, Group velocity, quantization of elastic waves (concept of phonon), Phonon heat capacity: Planck's distribution and normal modes, Density of states in one and three dimensions, Debye model for density of states - T^3 law, Einstein model for density of states **(9)**

UNIT III: FREE ELECTRON FERMI GAS: TRANSPORT PHENOMENA

Free electron gas in one dimensions, Fermi- Dirac distribution, Effect of temperature on the Fermi – Dirac distribution function, Free electron gas in three dimensions: Fermi energy, Density of states, Heat capacity of the electron gas, Electrical conductivity and Ohm's law, Electrical resistivity: Matthiessen's rule, Motion in magnetic fields: cyclotron frequency, Hall effect, thermal conductivity of metals – Wiedemann-Franz law **(9)**

UNIT IV: ENERGY BANDS AND SEMICONDUCTOR CRYSTALS

Nearly free electron model: origin of the energy bands Bloch functions and Kronig-Penney model, Wave equation of electron in a periodic potential, Metals and insulators in energy band concept, Semiconductors: direct and indirect band gap, Equations of motions: concept of holes and effective mass, Intrinsic carrier concentration and mobility, Impurity conductivity: donor and acceptor states, semimetals, super lattices and Zener tunneling **(9)**

UNIT V: OPTICAL PROPERTIES OF SOLIDS

Optical reflectance, Kramers-Kronig relations, Electronic interband transitions, Concept of excitons and energy level diagram, Frenkel excitons: Alkali halides and molecular crystals, Mott-Wannier excitons, Raman effect in crystals, Concept of plasmons – derivation of plasma frequency, basic concept of polaritons and polarons (qualitative treatment) **(9)**

Course Outcomes:

The successfully complete of this course, Student will be able to:

1. Familiarize with the physics of crystalline solids and elastic properties
2. Acquire knowledge on lattice dynamics, transport properties and optical processes in solids
3. Understand quantum mechanical concepts of free electron and theory of solids
4. Gain theoretical knowledge on optical properties, electron-phonon interactions in solids and in modern heterostructures
5. Understand the optical properties of solids and basic concept of qualitative treatment.

Text Books

1. C. Kittel, "Introduction to Solid State Physics", 8^{th} edition, Wiley India, 2015
2. M. Ali Omar, "Elementary Solid State Physics-Principles and Applications", Pearson Publication, 2005

Reference Books

1. Herald Ibach, Hans Luth, "Solid State Physics-An Introduction to Principles of Materials Science", Springer Publication, 2009
2. J. Dekker, "Solid State Physics", Macmillan India Ltd, 2004
3. J.M. Ziman, "Principles of Theory of Solids", Cambridge University Press, 1999

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME118 QUANTUM MECHANICS FOR NANOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description: To provide a working knowledge of the foundations, techniques, and key results of quantum mechanics for solving problems in nanotechnology.

Course Objectives:

1. Understand the origin of old and new Quantum Mechanics
2. Explain the bound and scattering state and can solve the numerical
3. Demonstrate comprehensive knowledge on quantum physics behind applications - Nano Dimension and Quantum Phenomena

UNIT I: BASIC FORMULATION & BOUND STATE PROBLEMS

Old quantum mechanics, Heisenberg uncertainty principle, Ehrenfest theorem, Statistical interpretation and normalization of wave function, Hermitian operator, commutation, Schrödinger's time dependent and time independent wave equations, Stationary states, Infinite square well in one and three dimensions, Delta function potential, Finite square well. **(9)**

UNIT II: SCATTERING STATES & QUANTUM TUNNELING

Scattering states, Reflection and transmission of particles, Delta function potential well, Rectangular potential barrier ($E<V_0$), Rectangular potential barrier ($E>V_0$), Alpha-particle emission, Tunneling effect, Double delta function potential barriers, Resonant tunneling. **(8)**

UNIT III: DISCRETE EIGENVALUE PROBLEMS

Energy Eigen functions and Eigen values coordinates precession, Spherical Harmonic oscillator in one dimension, Momentum, Eigen values, Schrödinger equation in spherical coordinates, Angular equation, radial equation, Infinite spherical well, ground state properties of hydrogen atom, Angular momentum (L_x,L_y,L_z), Generalized angular momentum (J_x,J_y,J_z), Eigen values, Spin ½. **(9)**

UNIT IV: APPROXIMATION METHODS

Principle of variational method, Proof of variational method and implementation, Energy Eigen value in case of time independent perturbation theory for non-degenerate energy levels, Eigen function in case of time independent perturbation theory for non-degenerate energy levels, Energy Eigen value in case of time independent perturbation theory for degenerate energy levels, Eigen function in case of time dependent perturbation theory for two-level systems, Sinusoidal perturbations Incoherent perturbation, Transition rate , Adiabatic and Sudden approximations (Elementary concepts) **(10)**

UNIT V: IDENTICAL PARTICLES AND SCATTERING THEORY
Two particle system's Schrödinger equation, Transformation to center of mass frame from laboratory frame Exchange operator symmetrization of wave function Bosons and Fermions Exchange forces, solids, free electron gas Band structure, quantum scattering theory Differential and total cross sections, Green's functions, Born approximation, application to spherically symmetric potentials. **(9)**

Course Outcomes:
The successfully complete of this course, Student will be able to:
1. Explain the origin of old and new Quantum Mechanics
2. Explain the bound and scattering state and can solve the numerical
3. Correlate quantum physics behind applications - Nano Dimension
4. Solve the many body problems using various assumptions
5. Start the core subjects of Nanotechnology based on Quantum Phenomena

Text Books
1. David J. Griffiths, "Introduction to Quantum Mechanics", Second Edition, Pearson, 2009
2. AjoyGhatak and S. Lokanathan, "Quantum Mechanics", Fifth Edition, Macmillan, 2009

Reference Books
1. Bransden B.H., and Joachain C.J., "Quantum Mechanics", Second Edition, Pearson, 2007
2. YoavPeleg, Reuven Pnini, ElyahuZaarur, and Eugene Hecht, "Schaum's Outline of Quantum Mechanics", Second Edition, Tata McGraw Hill, 2010
3. Mathews P.M. and Venkatesan K.,"Quantum Mechanics", Second Edition, Tata McGraw Hill, 2010

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME119 MICRO AND NANOFABRICATION

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description: To deal with the aspects of the technology of processing procedures involved in the fabrication of micro and nanoelectronic devices

Course Objectives:

1. Learn a systematic overview of micro and nano fabrication processes and understanding of lithography, etching and ion implantation methods to fabricate, structure and modify the layer
2. Understand thin film fabrication techniques including PVD and CVD and to apply the knowledge to film formation
3. Apply the knowledge of microfabrication technology to the fields of general microelectronics systems

UNIT I: CRYSTAL GROWTH, EPITAXY AND OXIDATION

Introduction to IC fabrication, Electronic grade silicon – crystal plane and orientation – defects in the lattice, Czochralski crystal growing, Silicon shaping – processing consideration Vapour phase epitaxy – liquid phase epitaxy, Selective epitaxy - molecular beam epitaxy – epitaxial evaluation Growth mechanism and kinetics Thin oxides – oxidation techniques and systems – oxide properties, Redistribution of dopants at interface – oxidation of polysilicon – Oxidation induced effects **(10)**

UNIT II: LITHOGRAPHY, WET AND DRY ETCHING

Optical lithography, Mask Making, Electron lithography, X-ray lithography, Ion lithography – plasma properties, Feature size control and an-isotropic etch mechanism, Lift off techniques, Plasma reactor – Fl2&Cl2 based etching, Relative plasma etching techniques and equipment **(8)**

UNIT III: DEPOSITION, DIFFUSION & ION IMPLANTATION

Deposition process Physical vapour deposition – sputtering Polysilicon - plasma assisted depositionModels of diffusion in solids – Fick's one dimensional, diffusion equation – atomic diffusion mechanismCarrier recovery due to annealing, Implantation equipment – annealing - shallow junction High energy implantation Metallization applications, Metallization choices – patterning – metallization problems **(9)**

UNIT IV: DEVICE AND MOS CIRCUIT FABRICATION

Isolation – p-n junction isolation, Self alignment – local oxidation, Trench techniques – planarizationChemical- mechanical polishing – metallization and gettering, Basic MOS device considerations – MOS transistor Layout and design rules, Metal - gate transistor layout – polysilicon-gate transistor layout -channel length and width biases, CMOS technology - CMOS isolation and latch up Silicon - on –Insulator devices , State-of- the art and advanced, CMOS technologies. **(9)**

UNIT V: TOWARD MOLECULAR NANOTECHNOLOGY
Directed self-assembly: device assembly, Electrostatic self-assembly, Templated self-assembly: colloids and nanoparticle, Templated self-assembly: block copolymers and DNA nanostructures, Scanning probe lithographic techniques: local anodic oxidation Scribing, Atomic manipulation by SPA, Erasable electrostatic lithography, Electronics with nanotubes, nanowires, and carbon-60 **(9)**

Course Outcomes:
The successfully complete of this course, Student will be able to:

1. Provide learners a systematic overview of micro and nano fabrication processes
2. Gain understanding of lithography, etching and ion implantation methods to fabricate, structure and modify the layer
3. Understand thin film fabrication techniques including PVD and CVD and to apply the knowledge to film formation
4. Apply the knowledge of microfabrication technology to the fields of general microelectronics systems
5. Understand the various methods of molecular nanotechnology.

Text Books/
1. Sami Franssila, "Introduction to Microfabrication", Wiley Publications, 2010
2. Sorab. K. Gandhi, "VLSI Fabrication and Principles", McGraw Hill, 2005

Reference Books
1. Richard C.Jaeger, "Introduction to Microelectronic Fabrication", Prentice hall, 2002
2. Bo Cui, "Recent advances in Nanofabrication Techniques and Applications", InTech Publisher, 2011
3. A G Davies and J M T Thompson, "Advances in Nanoengineering Electronics, Materials and Assembly",Imperial College Press, 2007
4. Michael Pycraft Hughes , "Nanoelectromechanics in Engineering and Biology", by CRC Press LLC, 2003

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME204 MICRO AND NANOFABRICATION LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Micro & Nanofabrication

Course Description: To gain knowledge in Micro and Nano fabrication Processes

Course Objectives:

1. Students will gain knowledge and hands on experience in fabrication of Nano-powders using Planetary Ball Mill.
2. Students will gain knowledge and hands on experience in cleaning and processing wafers for thin films.
3. Students will have hands on experience over utilization of various non ambient atmospheric conditions.
4. Students will gain knowledge and experience in fabrication and post processing of thin films.
5. Students will get knowledge in utilization of AFM and SPM using nanolithography.

List of Experiments:

1. To fabricate nano powders using Planetary Ball Mill.
2. To perform wafer cleaning processes followed for VLSI applications
3. To oxidize silicon under O_2 ambient using temperature-controlled furnace
4. To deposit Al thin film on the oxidized silicon surface
5. To perform patterning by photolithography process
6. To perform wet chemical etching of silicon dioxide and metal thin films.
7. To fabricate MOS capacitor and study its I-V characteristics
8. To pattern nanostructures using E-Beam lithography (Virtual Laboratory)
9. To analyze nanostructures defined by E-Beam lithography using AFM (Virtual Laboratory)
10. To do nanolithography by scanning probe microscopy (Virtual Laboratory)

Course Outcomes:

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

1. Gain basic knowledge on micro and nanofabrication processes used electronic devices
2. Develop understanding of fundamental issues, ideas and results involved in microfabrication
3. Acquire experience in micro-fabrication processes
4. Provide basic knowledge in Thin film fabrication

Text Books:

Lab manual provided by the department

Reference Book

1. Micro and Nano Fabrication Laboratory Course Material, 2016
2. Sami Franssila, “Introduction to Microfabrication”, Wiley Publications, 2010
3. Sorab. K. Gandhi, "VLSI Fabrication and Principles", McGraw Hill, 2005
4. Richard C.Jaeger, “Introduction to Microelectronic Fabrication”, Prentice Hall, 2002
5. A G Davies and J M T Thompson, “Advances in Nanoengineering Electronics, Materials and Assembly”, Imperial College Press, 2007

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech IV Year I Semester

18MDME120 INDUSTRIAL NANOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description: To provide knowledge of various industrial applications of nanotechnology

Course Objectives:

1. Elucidate on advantages of nanotechnology based applications in each industry
2. Provide instances of contemporary industrial applications of nanotechnology
3. Provide an overview of future technological advancements and increasing role of nanotechnology in each industry

UNIT I: NANOTECHNOLOGY IN ELECTRICAL AND ELECTRONICS INDUSTRY
Nano electrical and electronic devices: advantageous, Data storage and memory, Micro and nanoelectromechanical systems Lasers, lighting and displays Batteries, Fuel cells, Photovoltaic cells, Electric double layer capacitors, Nanoparticle coatings for electrical products **(9)**

UNIT II: NANOTECHNOLOGY IN BIOMEDICAL AND PHARMACEUTICAL INDUSTRY
Nanoparticles in bone substitutes and dentistry, Tissue engineering/regenerative medicine, Scaffolds for tissue engineering, Nanorobotics in surgery, Drug delivery advantages of nanostructured delivery systems, Activation and targeting of nanotechnology-based drug delivery systems, Cancer diagnostics and therapy: why nanotechnology, Nanotools for early cancer detection, Nanomedicine for cancer treatment. **(9)**

UNIT III: NANOTECHNOLOGY FOR ENVIRONMENT APPLICATIONS
Nanotechno structured catalysts TiO_2 nanoparticles for water, purification: background of TiO2 as a semiconductor photocatalyst, Photocatalytic mechanism, general pathways, and kinetics, Photocatalytic degradation of specific waterborne pollutants, Nanoparticles for treatment of arsenic, Treatment of arsenic using nanoparticles other than TIO2, Nanoscale carbon materials for contaminant separation, Nanostructured metal oxide gas sensors for air-quality monitoring, The gas-sensing mechanism, integrated solid-state sensors. **(10)**

UNIT IV - NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY
Nanotechnology in agriculture, Precision farming, smart delivery system, Insecticides using nanotechnologyPotential of nano-fertilizers, Nanotechnology in food industry, Packaging, Food processing, Food safety and biosecurity, Contaminant detection and smart packaging **(8)**

UNIT V - NANOTECHNOLOGY IN TEXTILES AND COSMETICS
Nanofibre production –electrospinning, controlling morphologies, of nanofibers, Multifunctional polymer nanocomposites, Carbon nanotubes and nanocomposites, Nano-filled polypropylene fibers, Nano-finishing in textiles (UV resistant, antibacterial), hydrophilic,

self-cleaning, flame retardant finishes), Cosmetics – formulation of gels Formulation of shampoos, hair-conditioners (micellar self- assembly and its manipulation) Sun-screen dispersions for UV protection using Titanium oxide – color cosmetics **(9)**

Course Outcomes:

The successfully complete of this course, Student will be able to:

1. Elucidate on advantages of nanotechnology based applications in Electronics and Electrical industry
2. Elucidate on advantages of nanotechnology based applications in Biomedical & Pharma Industry.
3. Elucidate on advantages of nanotechnology based applications in Environmental applications.
4. Elucidate on advantages of nanotechnology based applications in Agriculture & Food Technology.
5. Provide instances of contemporary industrial applications of nanotechnology in Textile Industry.

Text Books

1. Mark A.R., Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Pearson Education, India,2003
2. Bharat Bhushan,"Handbook of Nanotechnology", Springer, Barnes & Noble,2004

Reference Books

1. Eelina H. Malsch, "Biomedical Nanotechnology", CRC Press,2005
2. Kenneth E.G.,Craig R.H., Cato T.L., Lakshmi S.N., "Biomedical Nanostructures", John Wiley & Sons Inc.,2008
3. Maqhong Fan, Huang C.P., Alan E.B., "Environanotechnology",Elsevier,2010
4. Tian C.Z., Rao Y.S., Keith C.K.L., ZhiqiangH.,Tyagi R.D., Irene M.C.L, "Nanotechnologies For WaterEnvironment Applications", ASCE publications, 2009
5. Jennifer Kuzma and Peter VerHage, "Nanotechnology in agriculture and food production", WoodrowWilson International Center,2006
6. Lynn J. Frewer, WillehmNorde, Fischer R. H. and Kampers W. H., "Nanotechnology in the Agri-foodsector",Wiley-VCH Verlag,2011
7. P. J. Brown and K. Stevens, "Nanofibers and Nanotechnology in Textiles", Woodhead Publishing Limited, Cambridge, 2007
8. Mai Y-W., "PolymerNano composites", Woodhead publishing, 2006
9. Chang W.N., "Nanofibres fabrication, performance and applications', Nova Science Publishers Inc, 2009

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

MINORS in
MECHANICAL ENGINEERING
Stream Name: Energy Engineering

(Offered to all the Engineering Disciplines except Mechanical Engineering)

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year I Semester

18MDME121 FLUID MECHANICS AND HYDRAULIC MACHINERY

L	T	P	C
2	1	0	3

Course Prerequisite: Partial Differential Equations

Course Description:
Modelling and predicting the behaviour of fluid flow is an important part of many scientific and technological problems. Flow of fluid is an important aspect of atmospheric and oceanic circulation, combustion in engines, biological processes such as the flow of blood. From the days of Isaac Newton to the present day world, considerable progress has been made in the mathematical modelling of fluid flow. With the advent of enhanced computational ability, computational fluid dynamics has played a major role in solving complex fluid flow problems. In this course, the students are introduced to various fluid properties and to model fluids at rest. Flow of fluids is introduced to the students in two forms, namely, the Lagrangian and the Eulerian form. Eventually, both the integral and differential form of the governing equations of fluid dynamics are derived. Flow of fluids in closed conduits and over various geometries is also introduced. Basic design of hydraulic turbines and pumps are introduced to the students.

Course Objectives:
1. To provide a basic understanding of the properties and behavior of matter (fluids) by means of analytical equations.
2. To develop an understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
3. To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.
4. Determine the force applied by a jet on stationary and moving vanes.
5. To understand the working principle of hydraulic machinery like turbines and pumps.

UNIT I: FLUID PROPERTIES AND KINEMATICS OF FLUID FLOW
The Concept of a Fluid, Classification of fluid flows, System & Control volume, Density, Specific gravity, Thermodynamic Properties of a Fluid, Viscosity, Surface Tension, Capillarity, Vapor pressure and Cavitation. Lagrangian and Eulerian descriptions, material derivative, velocity and acceleration field, streamlines, path lines and streak lines.
Fluid statics: Barometer and atmospheric pressure, Manometry, Buoyancy and stability. **(9)**

UNIT II: GOVERNING EQUATIONS OF FLUID FLOW
Reynold’s transport theorem, Integral form of the conservation of mass for moving or deforming control volumes and steady flow processes, Integral form of Energy equation, Integral form of linear momentum equation, Integral form of angular momentum equation. Derivation of the Bernoulli equation **(9)**

UNIT III: INTERNAL AND EXTERNAL FLOW

Laminar and Turbulent flows, Entrance region, Laminar flow in pipes, Turbulent flow in pipes, Minor and Major losses. Orifice meter and Venturimeter.

Flow over flat plate, Boundary layer equations, Displacement, Momentum and Energy thicknesses, Momentum integral technique for boundary layers, Boundary layers with pressure gradients. **(8)**

UNIT IV: IMPACT OF JET VANES & HYDRAULIC TURBINES

Hydrodynamic force of jet striking stationary and moving vanes, flat and curved vanes, jet impinging centrally and tangentially.

Classification of hydraulic turbines- Impulse and reaction turbines; Basic equation of energy transfer in rotodynamic machines, specific speed; Components of Pelton turbine, Velocity triangles and power for Pelton turbine, Maximum efficiency of Pelton turbine; Types of reaction turbines, Components of Francis turbine, Velocity triangles, power and efficiency of Francis turbine. Kaplan turbine. **(11)**

UNIT V: HYDRAULIC PUMPS

Working principle and main parts of a centrifugal pump; Classification of centrifugal pumps; Static and Manometric head of a centrifugal pump; Efficiencies of centrifugal pump.

Main parts and working of reciprocating pump; Discharge, work done and power required to drive a reciprocating pump; Slip of a reciprocating pump; **(8)**

Course Outcomes:

The students after completing the course will be able to:

1. Interpret the properties of fluids and their applications, determine differential pressure using manometric principles, calculate the buoyant forces and estimate the stability of floating and immersed bodies.
2. Distinguish between a system and control volume approach and will be able to use the governing equations based on integral approach for solving fluid flow problems.
3. Have a clear understanding of internal flow physics and capable of estimating the major and minor losses observed in pipe flows. Similarly, they will be able to assess various flow parameters in external flows with and without pressure gradients.
4. Assess the forces acting on vanes with varied geometries and point of jet impact. Further, they can differentiate different turbines and estimate the performance parameters of various turbine used in hydraulic power plants.
5. Differentiate different pumps and calculate their performance characteristics.

Text Books:

1. Cengel, Y.A, Cimbala, John, M., “Fluid Mechanics, Fundamentals and Applications”, McGraw Hill Education; Third edition (1 July 2017)
2. B.K. Venkanna, “ Fundamentals of Turbomachinery”, PHI Learning Private Limited,2018

References:

1. R. K. Bansal, “A Textbook of Fluid Mechanics and Hydraulic Machines”, Laxmi Publications, Ltd., 2005
2. Robert W. Fox and Alan T. Mc Donald, “Introduction to Fluid Mechanics”, John Wiley & Sons Private Ltd., 2009, 7th Edition.
3. James R. Welty, Charles E. Wicks and Robert E. Wilson, “Fundamentals of Momentum, Heat and Mass transfer”, John Wiley & Sons (Asia) private limited., 2008, 5th Edition.
4. Frank M White, “Fluid Mechanics”, Tata McGraw-Hill, 7th Edition, 2012.
5. Milton Van Dyke, “An Album of Fluid Motion”, Parabolic Press, 12th Edition.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech. II Year I Semester

18MDME122 APPLIED THERMODYNAMICS

L	T	P	C
2	1	0	3

Course Prerequisite: 18MDME121

Course Description:
This course on Applied Thermodynamics focuses on applied aspects of Engineering Thermodynamics which is an essential prerequisite for many courses of mechanical engineering. The principles of thermodynamics are also applicable to a wide range of problems encountered in all branches of engineering. This course is designed to equip the students with a thorough knowledge of basics and applications of thermodynamics and to provide them with necessary skills and techniques to solve problems in thermodynamics through a systematic analysis using fundamental principles. The specific topics to be covered in the course include concepts of system and surroundings, energy, energy transfer by work and heat, properties of substances and property changes, first and second laws of thermodynamics along with applications of these concepts to analysis of steam turbines, nozzles, refrigeration, air conditioning and internal combustion engines.

Course Objectives:
1. To introduce the concepts of system, surroundings, energy interactions, thermodynamics properties of substances and to teach different techniques used for estimating the properties like gas laws and property tables
2. To learn the principles of work and energy.
3. To acquire knowledge about the fundamentals of thermodynamic laws, concepts and principles.
4. To perform thermodynamic analysis of engineering systems like steam turbines, nozzles, refrigeration and air conditioning, and internal combustion engines.

UNIT I: THERMODYNAMIC BASICS
Macroscopic versus Microscopic viewpoint, Thermodynamic system and control volume, Thermodynamic properties, processes and cycles, Homogeneous and heterogeneous systems, Thermodynamic equilibrium, Quasi-static process, Concept of continuum, Zeroth law of thermodynamics, temperature scale, Ideal gas, Work Transfer, Heat transfer, First law of thermodynamics, Specific heat, Enthalpy, Internal Energy, Steady flow energy equation and application, PMM1 and Steady flow energy equation. **(9)**

UNIT II: SECOND LAW OF THERMODYNAMICS
Qualitative difference between heat and work, cyclic heat engine, Kelvin-Planck statement of second law, Clausius' statement of second law, Refrigerator and heat pump, Equivalence of Kelvin-Planck and Clausius statement, Reversibility and Irreversibility, Carnot cycle, Reversed

heat engine, Carnot's Theorem, Corollary of Carnot's theorem, absolute thermodynamic temperature scale and Efficiency of heat engine, Entropy, Inequality of Clausius, Temperature-Entropy plot
Pure Substances: Pure substance, Vapor-Liquid-Solid-Phase equilibrium in a pure substance, Independent properties of a pure substance, Phase boundaries, tables of thermodynamic properties, Thermodynamic Surfaces, p-v and p-T diagram for a pure substance, p-v-T surface, T-s and h-s or Mollier diagram for a pure substance, dryness fraction, Steam Tables, Charts of Thermodynamic properties, Measurement of steam quality.
(9)

UNIT III: STEAM TURBINES & NOZZLES
Steam Turbines : Classification of steam turbines, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of impulse and reaction turbines, losses in steam turbines, Governing of turbines.
Steam and Gas Nozzles: Flow through Convergent and convergent-divergent nozzles, variation of velocity, area and specific volume, choked flow, throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, Super saturated flow. **(9)**

UNIT IV: REFRIGERATION & AIR-CONDITIONING
Refrigerants: **Desirable properties, Common refrigerants used, Nomenclature**
Refrigeration: Comparison of heat engine, heat pump and refrigerating machine, Unit of refrigeration and C.O.P, Simple vapour compression refrigeration cycle, **T-S, P-h and h-s charts**, Effect of Subcooling and Superheating, Air refrigeration Cycle.
Air-Conditioning: Properties of moist air, Dry, wet bulb and Dew point temperature, Psychrometric chart, Psychrometric processes in air conditioning equipment. **(9)**

UNIT V: INTERNAL COMBUSTION ENGINES
I. C. Engines: Classification of IC engines, two stroke & four stroke, and SI & CI engines – comparison, Otto and Diesel cycles, Valve and port timing diagrams, Performance analysis of I.C Engines, Morse test, Heat balance.
Combustion: Combustion analysis, heating values, air requirement, Air/Fuel ratio, standard heat of reaction and effect of temperature on standard heat of reaction, Combustion efficiency, heat of formation, Adiabatic flame temperature, enthalpy of formation, enthalpy and internal energy of combustion, Combustion in SI and CI Engine, Knocking phenomenon and control.
(9)

Course Outcomes:
On successful completion of the course, the student will be able to:

1. Apply the fundamentals of the zeroth and first laws of thermodynamics and analyze a wide range of systems.
2. Apply the second law of thermodynamics for the design of heat engine, heat pump and refrigerators and to Evaluate entropy changes in a wide range of processes.

3. Calculate important parameters like efficiency, power, and torque for steam turbines and nozzles.
4. Perform simple calculations for refrigeration and air conditioning systems like estimating power requirement, COP etc.
5. Explain the basic nomenclature, working, underlying principles, and combustion processes in IC engines and their performance testing.

Text Books:

1. Cengal, Y.A and Boles, M.A, Thermodynamics: An Engineering Approach, 5th ed., McGraw-Hill, 2006.
2. R.K. Rajput, Applied Thermodynamics, 2nd Edition, Laxmi Publications.

References:

1. Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.

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Mode of Evaluation: Assignments, Mid Examinations and End Semester Examination

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME123 HEAT TRANSFER

L	T	P	C
2	1	0	3

Course Prerequisite: 18MDME121 & 18MDME122

Course Description:
Fundamental concepts of heat transfer; steady-state and unsteady-state heat conduction; analytical and empirical relations for forced and free convection heat transfer; condensation and boiling; heat exchanger analysis and design; and Heat transfer by radiation.

Course Objectives:
1. To elucidate the fundamental mechanisms of heat transfer
2. To teach the governing laws of heat transfer by conduction, convection and radiation
3. To train the students in using the analytical and empirical methods for estimating heat transfer under different conditions.
4. To explicate the rudimentary aspects in heat transfer with phase change.
5. To introduce different approaches for solving sizing and rating problems in Heat Exchanger design

UNIT I: INTRODUCTION AND STEADY ONE-DIMENSIONAL CONDUCTION
Underlying physics and basic rate equations for conduction, convection and radiation modes of heat transfer; Relationship to Thermodynamics, Thermal properties of materials, Heat conduction equation in Cartesian, cylindrical and spherical coordinates; Boundary conditions and initial conditions. Simplification of conduction equations for one dimensional steady state conduction; Applications to plane wall, cylindrical shell and spherical shells, composite walls; Electrical analogy and overall heat transfer coefficient; conduction with heat generation.
(9)

UNIT II: EXTENDED SURFACES AND TRANSIENT CONDUCTION
Heat transfer from extended surfaces; governing equation and analytical solutions for different boundary conditions, performance and efficiency of fins. The Lumped heat capacitance model, governing equation, Biot number; One dimensional transient heat flow: applications to semi-infinite solid, plane slab, cylinders and spheres; Heisler charts. **(9)**

UNIT III: CONVECTION HEAT TRANSFER
Thermal and velocity boundary layers, convection heat transfer coefficient, laminar and turbulent boundary layers, boundary layer momentum and energy equations, non-dimensional parameters and their significance, Correlations for forced convection problems involving flat plates, cylinders; spheres and banks of tubes. Internal flows- mean velocity, mean temperature, entry and fully developed regions, correlations for heat transfer in laminar and turbulent pipe flows. Natural convection heat transfer on a vertical plate; governing equations, dimensionless numbers, empirical relations for natural convection on plates, cylinders and spheres. **(9)**

UNIT IV: BOILING, CONDENSATION AND HEAT EXCHANGERS
Non-dimensional numbers in heat transfer with phase change, Boiling heat transfer modes, pool boiling, forced convection boiling, empirical correlations for boiling heat transfer, Condensation heat transfer mechanism, condensation on a vertical plate and vertical cylinders, film condensation inside horizontal tubes; dropwise condensation. Classification of heat exchangers, overall heat transfer coefficient, fouling factor, LMTD and NTU analyses of heat exchangers. **(9)**

UNIT V: RADIATION HEAT TRANSFER
Physical mechanism of Radiation, radiation intensity, black body radiation, Planck's distribution law, Wein's displacement law, Stefan Boltzmann law, Real surfaces, emissivity, absorptivity, reflectivity and transmissivity, Kirchoff's identity, grey surface, view factor between surfaces, reciprocity relation, heat exchange between grey surfaces and black surfaces, electric network analogy, radiation shields. Effect of participating media, Radiation combined with other modes of heat transfer. **(9)**

Course Outcomes:
1. Estimate heat transfer rate due to conduction, convection and radiation under simple conditions using Fourier's Law, Newton's Law, and Stefan-Boltzmann Law.
2. Calculate the temperature distribution and rate of heat transfer in one dimensional heat conduction problems (Cartesian, polar and spherical coordinates) like composite walls, cylinders, and extended surfaces.
3. Calculate temperature evolution in lumped and one-dimensional conduction systems using Newton's law of cooling, analytical methods and chart solutions.
4. Calculate the heat transfer and temperature distribution in external and internal fluid flow problems using the principles of momentum and thermal boundary layer, bulk mean temperature, mean temperature, phase change, Nusselt condensation theory and empirical Nusselt number correlations.
5. Design an appropriate heat exchanger, like condenser, evaporator, radiator etc., for a given heat transfer requirement using LMTD and NTU-ϵ methods.
6. Calculate heat transfer due to radiation under certain conditions using the concepts of black and grey bodies, shape factor and electrical network analogy.

Textbook:
1. F. P. Incropera & D. P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, 2001, 5th edition.

References:
1. Yunus Cengel, Heat and Mass Transfer: Fundamentals and Application, McGraw Hill
2. J.P. Holman, Heat Transfer, McGraw Hill, 2002, 9th Edition.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME124 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
2	1	0	3

Course Prerequisites: Fluid Mechanics, Thermodynamics and Applied Mathe

Course Description: Computational fluid dynamics (CFD) has become an essential tool in analysis and design of thermal and fluid flow systems in wide range of industries. Few prominent areas of applications of CFD include meteorology, transport systems (aerospace, automobile, high-speed trains), energy systems, environment, electronics, bio-medical (design of life-support and drug delivery systems), etc. The correct use of CFD as a design analysis or diagnostic tool requires a thorough understanding of underlying physics, mathematical modelling and numerical techniques. The user must be fully aware of the properties and limitations of the numerical techniques incorporated in CFD software. This course aims to provide precisely these insights of CFD.

Course Objectives:
Specific objectives may be summarized as:

1. To give the students necessary exposure to the CFD techniques such that they can solve basic fluid flow problems using CFD
2. To understand mathematical characteristics of partial differential equations.
3. To learn computational solution techniques for various types of partial differential equations.

UNIT I: GOVERNING EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS

Introduction and Philosophy of Computational Fluid Dynamics, Need for problem solving with CFD, Applications of CFD, Basic structure of a CFD code, Governing equations: Continuity equation, Momentum equation, Energy equation, Mathematical classification of partial differential equations: Parabolic, Elliptic and Hyperbolic equations, Well posed and ill posed problems, Initial and boundary conditions. **(9)**

UNIT II: LINEAR SOLVERS AND FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS

Solution of discretised linear algebraic equations, Iteration method: Jacobi's method, Elimination methods: L-U decomposition technique, Tridiagonal matrix algorithm (Thomas' algorithm), Finite Volume Method for one-dimensional steady state diffusion, two-dimensional diffusion and three-dimensional diffusion problems. **(9)**

UNIT III: FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS

Steady one dimensional convection and diffusion, Central differencing scheme, Properties of discretisation schemes, Assessment of the central differencing scheme for convection-diffusion

problems, Upwind differencing scheme, Hybrid differencing scheme, Quick scheme.
(9)

UNIT IV: SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY COUPLING IN STEADY FLOWS

Introduction, Staggered grid, Momentum equations, The SIMPLE algorithm, Assembly of a complete method, SIMPLER and SIMPLEC methods. **(9)**

UNIT V: TURBULENCE MODELLING AND GRID WITH APPROPRIATE TRANSFORMATION

Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Turbulence models: Mixing length model, The k-ε model, Reynolds stress equation model, Grid with Appropriate Transformation: General transformation of the equations, Metrics and Jacobian, Stretched (Compressed) grids, Boundary fitted coordinate systems, Elliptic grid generation. **(9)**

Course Outcomes:
1. Develop the basic governing equations for fluid and heat flow by examining the physical boundary conditions.
2. Construct the discretized equations according to the nature (i.e. elliptic, parabolic and hyperbolic) of the flow problem.
3. Solve the linear algebraic equations by direct and iterative methods.
4. Analyze and evaluate various finite volume based CFD schemes to solve convection-diffusion problems.
5. Apply the variations of SIMPLE schemes for incompressible flows.
6. Select an appropriate model for turbulence flow and method for grid generation.

Text Books:
1. John D Anderson, “Computational Fluid Dynamics”, Tata-McGraw Hill Publisher, 1st Edition, 1995.
2. K Muralidhar & T Sundararajan, “Computational Fluid Flow and Heat Transfer”, Narosa Book Distributors Pvt Ltd, 2nd Edition, 2009.
3. H K Versteeg& W Malalasekara, “Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Pearson Education (Indian Reprint), 2nd Edition, 2007.

References:
1. S V Patankar, “Numerical Heat Transfer and Fluid Flow”, Taylor & Francis, 1st Edition, 1980.
2. R H Pletcher, J C Tannehill& D A Anderson, “Computational Fluid Mechanics and Heat Transfer”, CRC Press, 3rd Edition, 2012.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech III Year II Semester

18MDME205 THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Thermal Engineering

Course Objectives:

1. To enable the students to do experimentation on heat transfer equipment and gain practical knowledge about heat transfer in thermal systems
2. To give practical exposure to students on working and performance evaluation of fluid machinery.
3. To give hands on training to students on .

LIST OF EXPERIMENTS

1. Overall heat transfer coefficient of composite slab apparatus
2. Heat transfer coefficient in transient heat conduction
3. Efficiency and effectiveness of a pin-fin
4. Emissivity of gray body
5. Experiment on critical heat flux apparatus
6. Performance test on parallel and counter flow heat exchanger
7. Performance test on Pelton wheel.
8. Performance test on Francis turbine.
9. Performance test on Kaplan turbine.
10. Performance Test on a 4 -Stroke Diesel Engines
11. Performance Test on 2-Stroke Petrol engine
12. Evaluation of Engine friction by conducting Morse test on 4-Stroke Multi cylinder Engine
13. Retardation and motoring test on 4- stroke engine
14. Heat Balance of an I.C. Engine.
15. Performance Test on Reciprocating Air – Compressor Unit

Course Outcomes:

The students after completing the course will be able to:

1. Experimentally evaluate important parameters in heat transfer equipment.
2. Conduct performance tests on hydraulic turbines.
3. Conduct different types of performance tests on IC engines.
4. Conduct performance test on compressors.

Text Books:

Lab manual provided by the department

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

Dept. of Mechanical Engineering

Minors in Mechanical Engineering

B. Tech IV Year I Semester

18MDME125 DESIGN OF GAS TURBINE ENGINES

L	T	P	C
2	1	0	3

Course Prerequisite: Basic Thermodynamics, Heat Transfer, Thermal Engineering

Course Description: Gas turbine is the heart of a jet propulsion system and also used to develop shaft power for power generation. It is intended that the student learn the basic working process of gas turbines when being used for thrust generation and also for shaft power generation. Various parts of the gas turbine, namely, the compressor, turbine, combustion chamber etc. are incorporated into the course and a detailed mathematical modelling of these various accessories is part of the course. At the end of this course, the student will be equipped with the tools necessary to analyse the gas turbine using practical and jet propulsion cycles and also evaluate the performance of the compressors and axial turbines.

Course Objectives:

1. Introduce the student with the various types of cycles used for analysing gas turbines.
2. To make the student understand the working process of centrifugal and axial compressors in a gas turbine.
3. To determine the performance of an axial flow turbine in a gas turbine
4. To introduce the combustion chamber, inlet and nozzle systems of a gas turbine.

UNIT I: INTRODUCTION AND BASIC PRINCIPLES

Compressible flow machines, Energy transformation, Stagnation properties, Velocity of sound, Streamline, Streamtube, Mach number, Mach angle and Mach cone, Streamtube area-velocity relation, Normal shock wave, Oblique shock and expansion waves, flow with friction and heat transfer, flow in constant-area duct with friction. Open and closed cycle arrangements, Ideal cycle analysis, Simple gas turbine cycle, Heat exchange cycle, Reheat cycle, Reheat and Heat exchange cycle, Intercooled cycle, Intercooled cycle with heat exchanger, Intercooled and reheat cycle, Intercooled cycle with heat exchange and reheat, Ericsson cycle.

(9)

UNIT II: GAS TURBINE CYCLES

Practical cycles and their analysis, Stagnation properties, Compressor and Turbine efficiency, Pressure or flow losses, Heat exchanger effectiveness, Effect of varying mass flow, Effect of variable specific heat, Mechanical losses, Cycle efficiency, Polytropic efficiency, Performance of actual cycle, Jet propulsion cycles, Ramjet engine, Pulsejet engine, Turboprop engine, Turbojet engine, Thrust equation, Specific thrust of the turbojet engine, Efficiencies related to Jet propulsion cycles, Thrust augmentation. **(9)**

UNIT III: COMPRESSORS

Centrifugal Compressor: Essential parts, principle of operation, Ideal energy transfer, Blade shapes and velocity triangles, Analysis of flow through compressor, Diffuser, Volute casing, Performance parameters, Losses in centrifugal compressors, Compressor characteristics, Surging and Choking.

Axial Flow Compressors: Geometry and working principle, Stage velocity triangles, Work done factor, Enthalpy-Entropy diagram, Compressor stage efficiency, Performance coefficients, Degree of reaction, Flow through blade rows, Flow losses, Stage losses, Pressure rise calculation in a blade ring, Performance characteristics, Comparison of axial flow compressors. **(9)**

UNIT IV: TURBINES

Single impulse stage, Single reaction stage, Multistage machines, Velocity triangles of a single stage machine, Expression for work output, Blade loading and flow coefficients, Blade and Stage efficiencies, Maximum utilization factor for a single impulse stage, Velocity compounding of multistage impulse turbine, Pressure compounding of multistage impulse turbine, Reaction turbine, Multistage reaction turbines, Blade to gas speed ratio, Losses and efficiencies, Performance graphs. **(9)**

UNIT V: COMBUSTION, NOZZLE & INLET SYSTEMS

Combustion theory applied to gas turbine combustor, Factors affecting combustion chamber design, Factors affecting combustion chamber performance, Form of combustion system, Requirements of the combustion chamber, Process of combustion in a gas turbine, Combustion chamber geometry, Mixing and Dilution, Combustion chamber arrangements, Inlets, Subsonic inlets, Diffuser, Supersonic inlets, Exhaust nozzles. **(9)**

Course Outcomes:

The students after completing the course will be able to:

1. Develop a relationship for the energy transfer in a turbomachine and understand the concept of the degree of reaction.
2. Analyse the performance of practical gas turbine and jet propulsion cycles by taking into account the various losses in different components.
3. Analyse the flow through the centrifugal and axial compressor from inlet to outlet and also analyse the effect of impeller blade shape on the performance of centrifugal and axial compressor.
4. Analyse the performance of a multi-stage pressure compounded axial reaction turbine for various degree of reactions and draw the performance charts.
5. Evaluate the factors affecting the design of combustion chamber and also understand the various inlet types and evaluate the nozzle performance

Text Books:

1. V. Ganesan, Gas Turbines, Tata McGraw Hill Co., 3rd edition, 2010.

References:

1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, CRC Press (Taylor & Francis Group)
2. Cohen and Rogers, Gas Turbines Theory, Wesley Longman, 1996.
3. J.F. Lee, Theory and design of stream and gas turbine, McGraw Hill, 1954.
4. R. Yadav, Steam & Gas Turbines and Power Plant Engineering, Central Publishing House, 2004.

Mode of Evaluation: Assignments, Mid Examinations, End Semester Examination.