B.Tech. (Mechanical Engineering) - 2018 Batch

PROGRAMME STRUCTURE

Sl.No.	Course Component	Category	Credits
1	Humanities and Social Sciences including Management courses	HSMC	10
2	Basic Science courses	BSC	27
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.,	ESC	19
4	Professional Core Courses	PCC	53
5	Project work, seminar and internship in industry or appropriate work place / academic and research institutions in India / abroad.	P	15
6	Professional Elective Courses relevant to chosen specialization / branch.	PEC	18
7	Open subjects – Electives from other technical and/or emerging Courses	OEC	18
8	Mandatory Courses [Environmental studies, Induction Program, Indian Constitution, Value Education, etc.] (non-credit)	MC	0
		Total Credits	**160**

COURSE COMPONENTS AND CURRICULUM

Humanities & Social Sciences Including Management Courses (HSMC)

Sl.No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18EN1001	English	2	0	0	2
2	18EN1002	English Language Lab	0	0	2	1
3	18ME2074	Operations Research	3	0	0	3
4	18MS2010	Engineering Economics	3	0	0	3
5	18ME2075	Technical Aptitude	0	0	1	1
		Total Credits				**10**

Basic Science Courses (BSC)

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18PH1001	Engineering Physics - Electromagnetism, Optics and Properties of Matter	3	1	0	4
2	18PH1002	Engineering Physics - Electromagnetism, Optics and Properties of Matter Lab	0	0	3	1.5
3	18CH1003	Engineering Chemistry	3	1	0	4
4	18CH1002	Applied Chemistry Laboratory	0	0	3	1.5
5	18MA1001	Calculus and Linear Algebra	3	1	0	4
6	18MA1008	Ordinary Differential Equations and Complex variables	3	1	0	4

7	18MA2005	Partial Differential Equations, Probability and Statistics	3	1	0	4
8	18MA2014	Numerical Mathematics and Computing	3	1	0	4
					Total Credits	**27**

Engineering Science Courses (ESC)						
Sl.No	**Code No.**	**Name of the Course**	**Hours per week**			**Credits**
			L	**T**	**P**	
1	18ME1001	Engineering Drawing	0	0	4	2
2	18ME1002	Engineering Graphics (AutoCAD)	0	0	2	1
3	18CS1001	Programming for Problem Solving	3	0	0	3
4	18CS1003	Fundamentals of Computer Programming Lab.	0	0	2	1
5	18ME1003	Engineering Mechanics	3	1	0	4
6	18ME1004	Workshop / Manufacturing Practices Laboratory	0	0	2	1
7	18EE1003	Basic Electrical & Electronics Engineering	3	1	0	4
8	18EE1004	Basic Electrical & Electronics Engineering Laboratory	0	0	2	1
9	18ME2073	Engineering Design Laboratory (CAE)	0	0	4	2
					Total Credits	**19**

Professional Core Courses (PCC)

Sl.No	**Code No.**	**Name of the Course**	**Hours per week**			**Credits**
			L	**T**	**P**	
1	18ME2009	Fluid Mechanics Laboratory	0	0	2	1
2	18ME2010	Heat and Mass Transfer	3	0	0	3
3	18ME2011	Heat Transfer Laboratory	0	0	4	2
4	18ME2012	Strength of Materials	3	0	0	3
5	18ME2013	Strength of Materials Laboratory	0	0	2	1
6	18ME2014	Solid Mechanics	3	0	0	3
7	18ME2015	Kinematics and Theory of Machines	3	1	0	4
8	18ME2016	Design of Machine Elements	3	0	0	3
9	18ME2017	Design of Transmission Systems	3	0	0	3
10	18ME2018	Dynamics Laboratory	0	0	2	1
11	18ME2019	Machine Drawing Laboratory	0	0	2	1
12	18ME2020	Manufacturing Processes	3	0	0	3
13	18ME2021	Manufacturing Laboratory-I	0	0	4	2
14	18ME2022	Manufacturing Technology	3	0	0	3
15	18ME2023	Manufacturing Laboratory -II	0	0	2	1
16	18ME2024	Computer Aided Manufacturing Laboratory	0	0	2	1
17	18ME2025	Materials Engineering	3	0	0	3
18	18ME2076	Thermodynamics	3	0	0	3
19	18ME2077	Applied Thermodynamics	3	0	0	3
20	18ME2078	Thermal Engineering Laboratory	0	0	2	1

21	18ME2079	Fluid Mechanics and Fluid Machines	3	1	0	4
22	18EI2009	Instrumentation and Control	3	0	0	3
23	18EI2010	Instrumentation and Control Laboratory	0	0	2	1
Total Credits						**53**

Project (P)

Sl. No.	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	ITP2903/ISP2993	Industrial Training / Internship	15 Days			1
2	ITP2904/ISP2994	Industrial Training / Internship	15 Days			1
3	PP2911	Project Preparation	-	-	-	1
4	18ME 2999	Project	-	-	-	12
		Total				15

SEMESTER-WISE CURRICULUM

Semester- I (First Year)						
Branch / Course : B.Tech. Mechanical Engineering						
S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18PH1001	Engineering Physics - Electromagnetism, Optics and Properties of Matter	3	1	0	4
2	18PH1002	Engineering Physics - Electromagnetism, Optics and Properties of Matter Lab	0	0	3	1.5
3	18ME1001	Engineering Drawing	0	0	4	2
4	18CS1001	Programming for Problem Solving	3	0	0	3
5	18CS1003	Fundamentals of Computer Programming Lab.	0	0	2	1
6	18EN1001	English	2	0	0	2
7	18EN1002	English Language Laboratory	0	0	2	1
8	18MA1001	Calculus and Linear Algebra	3	1	0	4
					Total Credits	**18.5**
Semester-II (First Year)						
Branch / Course : B.Tech. Mechanical Engineering						
Sl. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME1002	Engineering Graphics (AutoCAD)	0	0	2	1
2	18CH1003	Engineering Chemistry	3	1	0	4
3	18CH1004	Applied Chemistry Laboratory	0	0	3	1.5
4	18EE1003	Basic Electrical & Electronics Engineering	3	1	0	4
5	18EE1004	Basic Electrical & Electronics Engineering Laboratory	0	0	2	1

6	18ME1003	Engineering Mechanics	3	1	0	4
7	18ME1004	Workshop / Manufacturing Practices Laboratory	0	0	2	1
8	18MA1008	Ordinary Differential Equations and Complex variables	3	1	0	4
					Total Credits	**20.5**

Semester- III (Second Year)

Branch / Course : B.Tech. Mechanical Engineering

S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18MA2005	Partial Differential Equations, Probability and Statistics	3	1	0	4
2	18ME2076	Thermodynamics	3	0	0	3
3	18ME2079	Fluid Mechanics and Fluid Machines	3	1	0	4
4	18ME2009	Fluid Mechanics Laboratory	0	0	2	1
5	18ME2021	Manufacturing Laboratory - I	0	0	4	2
6	18ME2022	Manufacturing Technology	3	0	0	3
7	18ME2012	Strength of Materials	3	0	0	3
8	18ME2013	Strength of Materials Laboratory	0	0	2	1
					Total Credits	**21**

Semester- IV (Second Year)

Branch / Course : B.Tech. Mechanical Engineering

S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18MA2014	Numerical Mathematics and Computing	3	1	0	4
2	18ME2016	Design of Machine Elements	3	0	0	3
3	18ME2077	Applied Thermodynamics	3	0	0	3
4	18ME2018	Dynamics Laboratory	0	0	2	1
5	18ME2015	Kinematics and Theory of Machines	3	1	0	4
6	18ME2078	Thermal Engineering Laboratory	0	0	2	1
7	18ME2025	Materials Engineering	3	0	0	3
8	18ME2014	Solid Mechanics	3	0	0	3
9	18CH2001	Environmental Studies	3	0	0	0
					Total Credits	**22**

Semester- V (Third Year)

Branch / Course : B. Tech. Mechanical Engineering

S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME2020	Manufacturing Processes	3	0	0	3
2	18ME2011	Heat Transfer Laboratory	0	0	4	2
3	18ME2010	Heat and Mass Transfer	3	0	0	3
4	18ME2019	Machine Drawing Laboratory	0	0	2	1
5	18ME2017	Design of Transmission Systems	3	0	0	3
6	18ME2024	Computer Aided Manufacturing Laboratory	0	0	2	1

7	18ME2074	Operations Research	3	0	0	3
8	18EI2009	Instrumentation and Control	3	0	0	3
9	18EI2010	Instrumentation and Control Laboratory	0	0	2	1
10	ITP2903/ ISP2993	Industrial training / Internship	15 days			1
11	18MS2014	Constitution of India	2	0	0	0
					Total Credits	**21**

Semester- VI (Third Year)

Branch / Course : B.Tech. Mechanical Engineering

S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME2073	Engineering Design Laboratory (CAE)	0	0	4	2
2		Professional Elective-I	3	0	0	3
3		Professional Elective-II	3	0	0	3
4		Professional Elective-III	3	0	0	3
5		Open Elective-I	3	0	0	3
6		Open Elective-II	3	0	0	3
7		Open Elective-III	3	0	0	3
8	18ME2023	Manufacturing Laboratory -II	0	0	2	1
9	18ME2075	Technical Aptitude	0	0	2	1
					Total Credits	**22**

Semester- VII (Fourth Year)

Branch / Course : B.Tech. Mechanical Engineering

S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1		Professional Elective-IV	3	0	0	3
2		Professional Elective-V	3	0	0	3
3		Professional Elective-VI	3	0	0	3
4		Open Elective-IV	3	0	0	3
5		Open Elective-V	3	0	0	3
6		Open Elective-VI	3	0	0	3
7	18MS2010	Engineering Economics	3	0	0	3
8	ITP2903/ ISP2993	Industrial training / Internship	15 days			1
					Total Credits	**22**

Semester- VIII (Fourth Year)

Branch / Course : B.Tech. Mechanical Engineering

S. No	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	PP2911	Project Preparation	-	-	-	1
2	18ME2999	Full Semester Project	-	-	-	12
					Total Credits	**13**

B.TECH. Mechatronics Engineering (2018 BATCH)

PROGRAMME STRUCTURE

Sl.No.	Course Component	Category	Credits
1	Humanities and Social Sciences including Management courses	HSMC	13
2	Basic Science courses	BSC	27
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	ESC	17
4	Professional Core Courses	PCC	52
5	Project work, seminar and internship in industry, or appropriate workplace/academic and research institutions in India/abroad.	P	15
6	Professional Elective Courses relevant to chosen specialization/branch	PEC	18
7	Open subjects- Electives from other technical and /or emerging courses	OEC	18
8	Mandatory Courses [environment studies, induction prgramme, Indian constitution, value education etc]	MC	0
		Total Credits	**160**

Humanities & Social Sciences Including Management Courses (HSMC)

Sl.No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18EN1001	English	2	0	0	2
2	18EN1002	English Language Lab	0	0	2	1
3	18MS2011	Principles of Management Systems & Industrial Psychology	3	0	0	3
4	18ME2074	Operations Research	3	0	0	3
5	18MS2010	Engineering Economics	3	0	0	3
7	18ME2075	Technical Aptitude	0	0	1	1
					Total Credits	**13**

Basic Science Courses (BSC)

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18PH1001	Engineering Physics - Electromagnetism, Optics and Properties of Matter	3	1	0	4
2	18PH1002	Engineering Physics - Electromagnetism, Optics and Properties of Matter Lab	0	0	3	1.5
3	18CH1003	Engineering Chemistry	3	1	0	4
4	18CH1002	Applied Chemistry Laboratory	0	0	3	1.5
5	18MA1001	Calculus and Linear Algebra	3	1	0	4

6	18MA1008	Ordinary Differential Equations and Complex variables	3	1	0	4
7	18MA2005	Partial Differential Equations, Probability and Statistics	3	1	0	4
8	18MA2014	Numerical Mathematics and Computing	3	1	0	4
					Total Credits	**27**

Engineering Science Courses (ESC)

Sl.No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME1001	Engineering Drawing	0	0	4	2
2	18ME1002	Engineering Graphics (AutoCAD)	0	0	2	1
3	18CS1001	Programming for Problem Solving	3	0	0	3
4	18CS1003	Fundamentals of Computer Programming Lab.	0	0	2	1
5	18ME1003	Engineering Mechanics	3	1	0	4
6	18ME1004	Workshop / Manufacturing Practices Laboratory	0	0	2	1
7	18EE1003	Basic Electrical & Electronics Engineering	3	1	0	4
8	18EE1004	Basic Electrical & Electronics Engineering Laboratory	0	0	2	1
9	18ME2073	Engineering Design Laboratory (CAE)	0	0	4	2
					Total Credits	**19**

Professional Core Courses (PCC)

Sl.No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18MR2001	Metrology and Measurement Systems	3	0	0	3
2	18MR2002	Fluid Power Control and Automation Lab	0	0	2	1
3	18MR2003	Design of Mechatronic Systems	3	0	0	3
4	18MR2004	Metallurgy Laboratory	0	0	2	1
5	18MR2005	CAD/CAM Laboratory	0	0	2	1
6	18ME2020	Manufacturing Processes	3	0	0	3
7	18ME2076	Thermodynamics	3	0	0	3
8	18ME2016	Design of Machine Elements	3	0	0	3
9	18ME2025	Materials Engineering	3	0	0	3
10	18ME2079	Fluid Mechanics and Fluid Machines	3	1	0	4
11	18ME2009	Fluid Mechanics Laboratory	0	0	2	1
12	18ME2012	Strength of Materials	3	0	0	3
13	18ME2013	Strength of Materials Laboratory	0	0	2	1
14	18EI2002	Control Systems	3	0	0	3
15	18EI2011	Virtual Instrumentation: Theory and Applications	3	0	0	3

16	18EI2012	Virtual Instrumentation and Data Acquisition Laboratory	0	0	2	1
17	18EI2006	Micro Controller and PLC	3	0	0	3
18	18EI2013	Micro Controller and PLC Lab	0	0	2	1
19	18EC2032	Electron Devices and Circuits	3	0	0	3
20	18EC2033	Electron Devices and Circuits Laboratory	0	0	2	1
21	18EC2035	Sensors and Signal Processing	3	0	0	3
22	18EE2019	Electrical Machines and Drives	3	0	0	3
23	18EE2020	Electrical Machines and Drives Laboratory	0	0	2	1
					Total Credits	**52**

Project (P)

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	ITP2903/ISP2993	Industrial Training /Internship	15 Days			1
2	ITP2904/ISP2904	Industrial Training /Internship	15 Days			1
3	PP2911	Project Preparation	-	-	-	1
4	18MR2999	Full Semester Project	-	-	-	12
					Total Credits	**15**

SEMESTER WISE CURRICULM

Semester- I (First Year)

Branch / Course : Mechatronics Engineering

Sl. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18PH1001	Engineering Physics - Electromagnetism, Optics and Properties of Matter	3	1	0	4
2	18PH1002	Engineering Physics - Electromagnetism, Optics and Properties of Matter Lab.	0	0	3	1.5
3	18EN1001	English	2	0	0	2
4	18EN1002	English Language Lab	0	0	2	1
5	18ME1001	Engineering Drawing Laboratory	0	0	4	2
6	18MA1001	Calculus and Linear Algebra	3	1	0	4
7	18CS1001	Programming for Problem Solving	3	0	0	3
8	18CS1003	Fundamentals of Computer Programming Lab.	0	0	2	1
					Total Credits	**18.5**

Semester-II (First Year)

Branch / Course : Mechatronics Engineering

Sl.No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18MA1008	Ordinary Differential Equations and Complex variables	3	1	0	4

2	18ME1002	Engineering Graphics Laboratory (AutoCAD)	0	0	2	1
3	18CH1003	Engineering Chemistry	3	1	0	4
4	18CH1002	Applied Chemistry Laboratory	0	0	3	1.5
5	18ME1003	Engineering Mechanics	3	1	0	4
6	18ME1004	Workshop / Manufacturing Practices Laboratory	0	0	2	1
7	18EE1003	Basic Electrical & Electronics Engineering	3	1	0	4
8	18EE1004	Basic Electrical & Electronics Engineering Laboratory	0	0	2	1
					Total Credits	**20.5**

Semester- III (Second Year)

Branch / Course : Mechatronics Engineering

Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18MA2005	Partial Differential Equations, Probability and Statistics	3	1	0	4
2	18ME2025	Materials Engineering	3	0	0	3
3	18ME2079	Fluid Mechanics and Fluid Machines	3	1	0	4
4	18ME2009	Fluid Mechanics Laboratory	0	0	2	1
5	18ME2012	Strength of Materials	3	0	0	3
6	18ME2013	Strength of Materials Laboratory	0	0	2	1
7	18EC2032	Electronic Devices and Circuits	3	0	0	3
8	18EC2033	Electronic Devices and Circuits Laboratory	0	0	2	1
9	18MR2002	Fluid Power Control and Automation Lab	0	0	2	1
					Total Credits	**21**

Semester- IV (Second Year)

Branch / Course : Mechatronics Engineering

Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18MA2014	Numerical Mathematics and Computing	3	1	0	4
2	18ME2020	Manufacturing Process	3	0	0	3
3	18MR2001	Metrology and Measurement Systems	3	0	0	3
4	18MR2004	Metallurgy Laboratory	0	0	2	1
5	18ME2076	Thermodynamics	3	0	0	3
6	18EE2019	Electrical Machines and Drives	3	0	0	3
7	18EE2020	Electrical Machines and Drives Laboratory	0	0	2	1
8	18EI2002	Control Systems	3	0	0	3
9	18CH2001	Environmental Studies	3	0	0	0
					Total Credits	**21**

Semester- V (Third Year)

Branch / Course : Mechatronics Engineering

Sl. No.	**Course Code**	**Course Title**	**Hours per Week**	**Credits**

			L	T	P	
1	18MR2003	Design of Mechatronics Systems	3	0	0	3
2	18MR2005	CAD/CAM Laboratory	0	0	2	1
3	18ME2016	Design of Machine Elements	3	0	0	3
4	18ME2074	Operations Research	3	0	0	3
5	18EC2035	Sensors and Signal Processing	3	0	0	3
6	18EI2006	Micro Controller and PLC	3	0	0	3
7	18EI2013	Micro Controller and PLC Lab	0	0	2	1
8	18EI2011	Virtual Instrumentation: Theory and Applications	3	0	0	3
9	18EI2012	Virtual Instrumentation and Data Acquisition Laboratory	0	0	2	1
10	ITP2903/ ISP2993	Industrial Training /Internship	15 days			1
11	18MS2014	Constitution of India	2	0	0	0
					Total Credits	**22**

Semester- VI (Third Year)						
Branch / Course : Mechatronics Engineering						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1		Professional Elective - I	3	0	0	3
2		Professional Elective - II	3	0	0	3
3		Professional Elective - III	3	0	0	3
4		Open Elective – I	3	0	0	3
5		Open Elective – II	3	0	0	3
6		Open Elective – III	3	0	0	3
7	18ME2075	Technical Aptitude	0	0	2	1
8	18MS2011	Principles of Management Systems & Industrial Psychology	3	0	0	3
					Total Credits	**22**

Semester- VII (Fourth Year)						
Branch / Course : Mechatronics Engineering						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1		Professional Elective - IV	3	0	0	3
2		Professional Elective - V	3	0	0	3
3		Professional Elective - VI	3	0	0	3
4		Open Elective – IV	3	0	0	3
5		Open Elective - V	3	0	0	3
6		Open Elective - VI	3	0	0	3
7	18MS2010	Engineering Economics	3	0	0	3

8	ITP2903/ ISP2993	Industrial Training /Internship	15 days			1
					Total Credits	**22**

Semester- VIII (Fourth Year)						
Branch / Course : Mechatronics Engineering						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	PP2911	Project Preparation	-	-	-	1
2	18MR2999	Full Semester Project	-	-	-	12
					Total Credits	**13**

M.TECH. (Thermal Engineering) FOR 2018 BATCH

PROGRAMME STRUCTURE

Sl.No	Course Component	Credits
1	Professional Core Courses	25
2	Professional elective courses	15
3	Open courses- Electives from other technical and/or Emerging courses	3
4	Mini Project/ Industrial Training	2
5	Project Phase I & II	23
6	Audit Courses 1 & 2	(non-credit)
	Total Credits	68

COURSE COMPONENTS AND CURRICULUM

PROFESSIONAL CORE COURSES

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME3001	Thermodynamics and Combustion	3	0	0	3
2	18ME3002	Advanced Fluid Dynamics	3	0	0	3
3	18ME3003	Advanced Heat Transfer	3	0	0	3
4	18ME3004	Design of Thermal Power Equipment	3	0	0	3
5	18ME3005	Refrigeration System Design	3	0	0	3
6	18ME3006	Computer Aided Design Laboratory	0	0	4	2
7	18ME3007	Analysis and Simulation Lab	0	0	4	2
8	18ME3008	Advanced Heat Transfer Laboratory	0	0	4	2
9	18ME3009	Advanced Computational Fluid Dynamics Laboratory	0	0	4	2
10	18MS3104	Research Methodology and IPR	2	0	0	2
			Total Credits			**25**

PROJECT

Sl.no	Code no	Name of the course	Hours Per week			Credits
			L	T	P	
1	MP3951	Mini Project	0	0	4	2
2	18ME3998	Project Phase I	0	0	16	8
3	18ME3999	Project Phase II	0	0	30	15
			Total Credits			25

PROFESSIONAL ELECTIVE COURSES

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME3023	Nuclear Power Engineering	3	0	0	3
2	18ME3024	Energy Conservation and Management.	3	0	0	3
3	18ME3025	Solar Energy Utilization	3	0	0	3
4	18ME3026	Air Conditioning System Design	3	0	0	3
5	18ME3027	Gas Turbines	3	0	0	3
6	18ME3028	Advanced Instrumentation in Thermal Engineering	3	0	0	3
7	18ME3029	Biomass Energy	3	0	0	3
8	18ME3030	Design and Analysis of Heat Exchangers	3	0	0	3
9	18ME3031	Two Phase Flow and Heat Transfer	3	0	0	3
10	18ME3032	Computational Fluid Dynamics	3	0	0	3
11	18ME3033	Advanced IC Engines	3	0	0	3
12	18ME3034	Advanced Turbo machinery	3	0	0	3
13	18ME3035	Design of Solar and Wind System	3	0	0	3
14	18MA3001	Advanced Mathematical Methods in Engineering	3	0	0	3
					Total Credits	**42**

OPEN ELECTIVE COURSE

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME3058	Business Analytics	3	0	0	3
2	18ME3059	Industrial Safety	3	0	0	3
3	18ME3060	Operations Research	3	0	0	3
4	18ME3061	Cost Management of Engineering Projects	3	0	0	3
5	18ME3062	Composite Materials	3	0	0	3
6	18ME3063	Waste to Energy	3	0	0	3
					Total Credits	**18**

AUDIT COURSE

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18EN3001	English for Research Paper Writing	2	0	0	0
2	18EN3002	Personality Development & Value Education	2	0	0	0
3	18CE3085	Disaster Management	2	0	0	0
4	18MS3105	Constitution of India	2	0	0	0
5	18ME3066	Pedagogy Studies	2	0	0	0
					Total Credits	**0**

SEMESTER WISE CURRICULUM

Sl. No.	Course Code	Course Title	Hours per Week			Credits
Semester- I (First Year)						
Branch / Course: M.Tech. Thermal Engineering						
			L	T	P	
1	18ME3001	Thermodynamics and Combustion	3	0	0	3
2	18ME3002	Advanced Fluid Dynamics	3	0	0	3
3	18ME3023	1.Nuclear Power Engineering	3	0	0	3
	18ME3024	2. Energy Conservation and Management.	3	0	0	
	18ME3025	3.Solar Energy Utilization	3	0	0	
4	18ME3026	1. Air Conditioning System Design	3	0	0	3
	18ME3027	2. Gas Turbines	3	0	0	
	18ME3028	3.Advanced Instrumentation in Thermal Engineering	3	0	0	
5	18ME3006	Computer Aided Design Laboratory	0	0	4	2
6	18ME3007	Analysis and Simulation Lab	0	0	4	2
7	18MS3104	Research Methodology and IPR	2	0	0	2
8		Audit Course – I	2	0	0	0
					Total Credits	**18**

Sl. No.	Course Code	Course Title	Hours per Week			Credits
Semester-II (First Year)						
Branch / Course : M.Tech. Thermal Engineering						
			L	T	P	
1	18ME3003	Advanced Heat Transfer	3	0	0	3
2	18ME3004	Design of Thermal Power Equipment	3	0	0	3
3	18ME3029	1.Biomass Energy	3	0	0	3
	18ME3030	2.Design and Analysis of Heat Exchangers	3	0	0	
	18ME3031	3.Two Phase Flow and Heat Transfer	3	0	0	
4	18ME3032	1.Computational Fluid Dynamics	3	0	0	3
	18ME3033	2.Advanced IC Engines	3	0	0	
	18ME3034	3.Advanced Turbo machinery	3	0	0	
5	18ME3008	Advanced Heat Transfer Laboratory	0	0	4	2
6	18ME3009	Advanced Computational Fluid Dynamics Laboratory	0	0	4	2
7		Audit Course - II	2	0	0	0
8	MP3951	Mini-Project	0	0	4	2
					Total Credits	**18**

Semester- III (Second Year)						
Branch / Course : M.Tech. Thermal Engineering						
Sl. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18ME3005	Refrigeration System Design	3	0	0	3
2	18ME3035	1. Design of Solar and Wind System	3	0	0	3
	18MA3001	2. Advanced Mathematical Methods in Engineering	3	0	0	
3		Open Elective	3	0	0	3
4	18ME3998	Project Phase – I	0	0	16	8
					Total Credits	17

Semester- IV (Second Year)						
Branch / Course: M.Tech. Thermal Engineering						
Sl. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18ME3999	Project Phase - II	0	0	30	15
					Total Credits	15

M.TECH. (Engineering Design) FOR 2018 BATCH

PROGRAMME STRUCTURE

Sl.No	Course Component	Credits
1	Professional Core Courses	25
2	Professional elective courses	15
3	Open courses- Electives from other technical and/or Emerging courses	3
4	Mini Project/ Industrial Training	2
5	~~Part & Full semester Projects~~ (Project Phase I & Phase II)	23
6	Audit Courses 1 & 2	(non-credit)
	Total Credits	68

COURSE COMPONENTS AND CURRICULUM

PROFESSIONAL CORE COURSES

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	C
1	18ME3017	Advanced Stress Analysis	3	0	0	3
2	18ME3018	Finite Element Methods in Engineering	3	0	0	3
3	18ME3019	Advanced Vibrations and Acoustics	3	0	0	3
4	18ME3020	Computer Aided Design	3	0	0	3
5	18ME3013	Engineering Materials and Applications	3	0	0	3
6	18ME3006	Computer Aided Design Laboratory	0	0	4	2
7	18ME3007	Analysis and Simulation Lab	0	0	4	2

8	18ME3021	Vibration Laboratory	0	0	4	2
9	18ME3022	Multibody Dynamics Lab (ADAMS)	0	0	4	2
10	18MS3104	Research Methodology and IPR	2	0	0	2
					Total Credits	**25**

PROJECT

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	ME3951	Mini-Project	0	0	4	2
2	18ME3998	Project- Phase I	0	0	16	8
3	18ME3999	Project- Phase II	0	0	30	15
					Total Credits	**25**

PROFESSIONAL ELECTIVE COURSES

Sl. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	C
1	18ME3048	Advanced Machine Design	3	0	0	3
2	18ME3012	Design for Manufacturing and Assembly	3	0	0	3
3	18ME3049	Advanced Strength of Materials	3	0	0	3
4	18ME3045	Engineering Product Design and Development Strategies	3	0	0	3
5	18ME3050	Engineering Fracture Mechanics	3	0	0	3
6	18ME3051	Advanced Mechanism Design	3	0	0	3
7	18ME3052	Tribology in Design	3	0	0	3
8	18ME3047	Industrial Robotics	3	0	0	3
9	18ME3053	Rotor Dynamics	3	0	0	3
10	18ME3054	Optimization Techniques	3	0	0	3
11	18ME3055	Condition Based Monitoring	3	0	0	3
12	18ME3036	Quality Concepts in Design	3	0	0	3
13	18ME3013	Engineering Materials and Applications	3	0	0	3
14	18ME3056	Multi-body Dynamics	3	0	0	3
					Total Credits	**42**

OPEN ELECTIVE COURSES

Sl. No.	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME3058	Business Analytics	3	0	0	3
2	18ME3059	Industrial Safety	3	0	0	3
3	18ME3060	Operations Research	3	0	0	3
4	18ME3061	Cost Management of Engineering Projects	3	0	0	3

5	18ME3062	Composite Materials	3	0	0	3
6	18ME3063	Waste to Energy	3	0	0	3
					Total Credits	**18**

AUDIT COURSE

Sl. No.	**Code No.**	**Name of the Course**	**Hours per week**			**Credits**
			L	**T**	**P**	
1	18EN3001	English for Research Paper Writing	2	0	0	0
2	18EN3002	Personality Development & Value Education	2	0	0	0
3	18CE3085	Disaster Management	2	0	0	0
4	18MS3105	Constitution of India	2	0	0	0
5	18ME3066	Pedagogy Studies	2	0	0	0
					Total Credits	**0**

SEMESTER WISE CURRICULUM

Semester- I (First Year)						
Branch / Course : M.Tech. Engineering Design						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME3017	Advanced Stress Analysis	3	0	0	3
2	18ME3018	Finite Element Methods in Engineering	3	0	0	3
3	18ME3048	1. Advanced Machine Design	3	0	0	3
	18ME3012	2. Design for Manufacturing and Assembly	3	0	0	
	18ME3049	3.Advanced Strength of Materials	3	0	0	
4	18ME3036	3.Quality Concepts in Design	3	0	0	3
	18ME3050	2. Engineering Fracture Mechanics	3	0	0	
	18ME3051	3. Advanced Mechanism Design	3	0	0	
5	18ME3006	Computer Aided Design Laboratory	0	0	4	2
6	18ME3007	Analysis and Simulation Lab	0	0	4	2
7	18MS3104	Research Methodology and IPR	2	0	0	2
8		Audit Course - I	2	0	0	0
					Total Credits	**18**

Semester-II (First Year)						
Branch / Course: M.Tech. Engineering Design						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME3019	Advanced Vibrations and Acoustics	3	0	0	3
2	18ME3020	Computer Aided Design	3	0	0	3
3	18ME3052	1.Tribology in Design	3	0	0	3

	18ME3047	2.Industrial Robotics	3	0	0	
	18ME3053	3.Rotor Dynamics	3	0	0	
4	18ME3054	1.Optimization Techniques	3	0	0	3
	18ME3055	2.Condition Based Monitoring	3	0	0	
	18ME3045	1. Engineering Product Design and Development Strategies	3	0	0	
5	18ME3021	Vibration Laboratory	0	0	4	2
6	18ME3022	Multibody Dynamics Laboratory (ADAMS)	0	0	4	2
7		Audit Course - II	2	0		0
8	MP3951	Mini-Project	0	0	4	2
					Total Credits	**18**

Semester- III (Second Year)

Branch / Course : M.Tech. Engineering Design

Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME3013	Engineering Materials and Applications	3	0	0	3
2	18ME3056	1.Multi-body Dynamics	3	0	0	3
	18MA3001	2.Advanced Mathematical Methods in Engineering	3	0	0	
3		Open Elective	3	0	0	3
4	18ME3998	Project Phase – I	0	0	16	8
					Total Credits	**17**

Semester- IV (Second Year)

Branch / Course : M.Tech. Design Engineering

Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME3999	Project Phase - II	0	0	30	15
					Total Credits	**15**

M.TECH. (Advanced Manufacturing Technology) FOR 2018 BATCH

PROGRAMME STRUCTURE

Sl.No	Course Component	Credits
1	Professional Core Courses	25
2	Professional elective courses	15
3	Open courses- Electives from other technical and/or Emerging courses	3
4	Mini Project/ Industrial Training	2
5	~~Part & Full semester Projects~~ (Project Phase I & Phase II)	23
6	Audit Courses 1 & 2	(non-credit)
	Total Credits	68

COURSE COMPONENTS AND CURRICULUM

PROFESSIONAL CORE COURSES

Sl. No.	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	C
1	18ME3010	Advanced Manufacturing Processes	3	0	0	3
2	18ME3011	Advanced Metal Cutting Theory	3	0	0	3
3	18ME3012	Design for Manufacturing and Assembly	3	0	0	3
4	18ME3013	Engineering Materials and Applications	3	0	0	3
5	18ME3014	Advanced Metrology and Measurement Systems	3	0	0	3
6	18ME3006	Computer Aided Design Laboratory	0	0	4	2
7	18ME3007	Analysis and Simulation Lab	0	0	4	2
8	18ME3015	Advanced Computer Aided Manufacturing Lab	0	0	4	2
9	18ME3016	Mechatronics and Robotics Laboratory	0	0	4	2
10	18MS3014	Research Methodology and IPR	2	0	0	2
		Total Credits				**25**

PROJECT

Sl.No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	ME3951	Mini-Project	0	0	4	2
2	18ME3998	Project- Phase I	0	0	16	8
3	18ME3999	Project- Phase II	0	0	30	15
					Total Credits	**25**

PROFESSIONAL ELECTIVE COURSES

Sl. No.	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME3018	Finite Element Methods in Engineering	3	0	0	3
2	18ME3036	Quality Concepts in Design	3	0	0	3
3	18ME3037	Manufacturing System and Simulation	3	0	0	3
4	18ME3038	Flexible Manufacturing System	3	0	0	3
5	18ME3039	Computer Integrated Manufacturing systems	3	0	0	3
6	18ME3040	Computer Applications in Design	3	0	0	3
7	18ME3041	Design of Fluid Power Systems	3	0	0	3
8	18ME3042	Total Quality Management	3	0	0	3
9	18ME3043	Industrial Automation and Mechatronics	3	0	0	3
10	18ME3044	Control of CNC Machine tools	3	0	0	3
11	18ME3045	Engineering Product Design and Development Strategies	3	0	0	3
12	18ME3046	Advanced Tool Design	3	0	0	3
13	18ME3047	Industrial Robotics	3	0	0	3
14	18MA3001	Advanced Mathematical Methods in Engineering	3	0	0	3
					Total Credits	**42**

OPEN ELECTIVE COURSE

Sl. No.	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME3058	Business Analytics	3	0	0	3
2	18ME3059	Industrial Safety	3	0	0	3
3	18ME3060	Operations Research	3	0	0	3
4	18ME3061	Cost Management of Engineering Projects	3	0	0	3
5	18ME3062	Composite Materials	3	0	0	3
6	18ME3063	Waste to Energy	3	0	0	3
					Total Credits	**18**

AUDIT COURSE

Sl. No.	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18EN3001	English for Research Paper Writing	2	0	0	0
2	18EN3002	Personality Development & Value Education	2	0	0	0
3	18CE3085	Disaster Management	2	0	0	0
4	18MS3105	Constitution of India	2	0	0	0
5	18ME3066	Pedagogy Studies	2	0	0	0
					Total Credits	**0**

SEMESTER WISE CURRICULUM

Semester- I (First Year)						
Branch / Course: M.Tech. Advanced Manufacturing Technology (AMT)						
Sl. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18ME3010	Advanced Manufacturing Processes	3	0	0	3
2	18ME3011	Advanced Metal Cutting Theory	3	0	0	3
3	18ME3018	1.Finite Element Methods in Engineering	3	0	0	3
	18ME3036	2.Quality Concepts in Design	3	0	0	
	18ME3037	3.Manufacturing System and Simulation	3	0	0	
4	18ME3038	1.Flexible Manufacturing System	3	0	0	3
	18ME3039	2.Computer Integrated Manufacturing systems	3	0	0	
	18ME3040	3.Computer Applications in Design	3	0	0	
5	18ME3006	Computer Aided Design Laboratory	0	0	4	2
6	18ME3007	Analysis and Simulation Lab	0	0	4	2
7	18MS3104	Research Methodology and IPR	2	0	0	2
8		Audit Course – I	2	0	0	0
					Total Credits	**18**

Semester-II (First Year)						
Branch / Course: M.Tech. Advanced Manufacturing Technology (AMT)						
Sl. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18ME3012	Design for Manufacturing and Assembly	3	0	0	3
2	18ME3014	Advanced Metrology and Measurement Systems	3	0	0	3
3	18ME3041	1.Design of Fluid Power Systems	3	0	0	3
	18ME3042	2.Total Quality Management	3	0	0	
	18ME3043	3.Industrial Automation and Mechatronics	3	0	0	
4	18ME3044	1.Control of CNC Machine tools	3	0	0	3
	18ME3045	2.Engineering Product Design and Development Strategies	3	0	0	
	18ME3046	3.Advanced Tool Design	3	0	0	
5	18ME3015	Advanced Computer Aided Manufacturing Lab	0	0	4	2
6	18ME3016	Mechatronics and Robotics Laboratory	0	0	4	2
7		Audit Course - II	2	0	0	0
8	MP3951	Mini-Project	0	0	4	2
					Total Credits	**18**

Semester- III (Second Year)						
Branch / Course: M.Tech. Advanced Manufacturing Technology (AMT)						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME3013	Engineering Materials and Applications	3	0	0	3
2	18ME3047	1.Industrial Robotics	3	0	0	3
	18MA3001	2. Advanced Mathematical Methods in Engineering	3	0	0	
3		Open Elective	3	0	0	3
4	18ME3998	Project Phase – I	0	0	16	8
					Total Credits	**17**

Semester- IV (Second Year)						
Branch / Course: M.Tech. Advanced Manufacturing Technology (AMT)						
Sl. No.	**Course Code**	**Course Title**	**Hours per Week**			**Credits**
			L	**T**	**P**	
1	18ME3999	Project Phase - II	0	0	30	15
					Total Credits	**15**

LIST OF COURSES

Sl. No	Course Code	Course Title	Credits
1	17ME4001	Applied Thermal Engineering and Experimental Methods	3:1:0
2	18ME2001	Thermodynamics, Refrigeration and Air Conditioning	3:0:0
3	18ME2002	Refrigeration and Air Conditioning Lab	0:0:1
4	18ME2003	Theory of Machines	2:1:0
5	18ME2004	Machine Design	3:0:0
6	18ME2005	Machine Drawing Lab for Agriculture	0:0:1
7	18ME2006	Heat and Mass Transfer in Food Processing	2:0:0
8	18ME2007	Heat Transfer Lab for Agriculture	0:0:1
9	18ME2008	CAD Applications Lab	0:0:2

Sl. No	Code No.	Course Title	Hours per week			Credits
			L	T	P	
1	18ME1001	Engineering Drawing	0	0	4	2
2	18ME1002	Engineering Graphics (AutoCAD)	0	0	2	1
3	18ME1003	Engineering Mechanics	3	1	0	4
4	18ME1004	Workshop / Manufacturing Practices Laboratory	0	0	2	1
5	18ME1005	Basic Mechanical Engineering	3	0	0	3
6	18ME1006	Workshop Practice	0	0	2	1
7	18ME1007	Computer Aided Engineering Drawing	0	0	4	2
8	18ME2009	Fluid Mechanics Laboratory	0	0	2	1
9	18ME2010	Heat and Mass Transfer	3	0	0	3
10	18ME2011	Heat Transfer Laboratory	0	0	4	2
11	18ME2012	Strength of Materials	3	0	0	3
12	18ME2013	Strength of Materials Laboratory	0	0	2	1
13	18ME2014	Solid Mechanics	3	0	0	3
14	18ME2015	Kinematics and Theory of Machines	3	1	0	4
15	18ME2016	Design of Machine Elements	3	0	0	3
16	18ME2017	Design of Transmission Systems	3	0	0	3
17	18ME2018	Dynamics Laboratory	0	0	2	1
18	18ME2019	Machine Drawing Laboratory	0	0	2	1
19	18ME2020	Manufacturing Processes	3	0	0	3
20	18ME2021	Manufacturing Laboratory-I	0	0	4	2
21	18ME2022	Manufacturing Technology	3	0	0	3
22	18ME2023	Manufacturing Laboratory -II	0	0	2	1
23	18ME2024	Computer Aided Manufacturing Laboratory	0	0	2	1
24	18ME2025	Materials Engineering	3	0	0	3

25	18ME2026	Basic Automobile Engineering	3	0	0	3
26	18ME2027	Fundamentals of Thermal Sciences and Fluid Mechanics	3	0	0	3
27	18ME2028	Hydraulics and Pneumatics	3	0	0	3
28	18ME2029	Hydraulics and Pneumatics Laboratory	0	0	2	1
29	18ME2030	Mechanics and Engineering Design Lab	0	0	2	1
30	18ME2031	Kinematics and Dynamics of Machinery	3	0	0	3
31	18ME2032	Mechanics of Solids	3	0	0	3
32	18ME2073	Engineering Design Laboratory (CAE)	0	0	4	2
33	18ME2074	Operations Research	3	0	0	3
34	18ME2075	Technical Aptitude	0	0	1	1
35	18ME2076	Thermodynamics	3	0	0	3
36	18ME2077	Applied Thermodynamics	3	0	0	3
37	18ME2078	Thermal Engineering Laboratory	0	0	2	1
38	18ME2079	Fluid Mechanics and Fluid Machines	3	1	0	4
39	18MR2001	Metrology and Measurement Systems	3	0	0	3
40	18MR2002	Fluid Power Control and Automation Lab	0	0	2	1
41	18MR2003	Design of Mechatronic System	3	0	0	3
42	18MR2004	Metallurgy Laboratory	0	0	2	1
43	18MR2005	CAD/CAM Laboratory	0	0	2	1
44	18ME3001	Thermodynamics and Combustion	3	0	0	3
45	18ME3002	Advanced Fluid Dynamics	3	0	0	3
46	18ME3003	Advanced Heat Transfer	3	0	0	3
47	18ME3004	Design of Thermal Power Equipment	3	0	0	3
48	18ME3005	Refrigeration System Design	3	0	0	3
49	18ME3006	Computer Aided Design Laboratory	0	0	4	2
50	18ME3007	Analysis and Simulation Lab	0	0	4	2
51	18ME3008	Advanced Heat Transfer Laboratory	0	0	4	2
52	18ME 3009	Advanced Computational Fluid Dynamics Laboratory	0	0	4	2
53	18ME3010	Advanced Manufacturing Processes	3	0	0	3
54	18ME3011	Advanced Metal Cutting Theory	3	0	0	3
55	18ME3012	Design for Manufacturing and Assembly	3	0	0	3
56	18ME3013	Engineering Materials and Applications	3	0	0	3
57	18ME3014	Advanced Metrology and Measurement Systems	3	0	0	3
58	18ME3015	Advanced Computer Aided Manufacturing Lab	0	0	4	2
59	18ME3016	Mechatronics and Robotics Laboratory	0	0	4	2
60	18ME3017	Advanced Stress Analysis	3	0	0	3
61	18ME3018	Finite Element Methods in Engineering	3	0	0	3
62	18ME3019	Advanced Vibrations and Acoustics	3	0	0	3
63	18ME3020	Computer Aided Design	3	0	0	3
64	18ME3021	Vibration Laboratory	0	0	4	2
65	18ME3022	Multi body Dynamics Lab (ADAMS)	0	0	4	2

66	18ME3023	Nuclear Power Engineering	3	0	0	3
67	18ME3024	Energy Conservation and Management.	3	0	0	3
68	18ME3025	Solar Energy Utilization	3	0	0	3
69	18ME3026	Air Conditioning System Design	3	0	0	3
70	18ME 3027	Gas Turbines	3	0	0	3
71	18ME 3028	Advanced Instrumentation in Thermal Engineering	3	0	0	3
72	18ME 3029	Biomass Energy	3	0	0	3
73	18ME 3030	Design and Analysis of Heat Exchangers	3	0	0	3
74	18ME 3031	Two Phase Flow and Heat Transfer	3	0	0	3
75	18ME 3032	Computational Fluid Dynamics	3	0	0	3
76	18ME 3033	Advanced IC Engines	3	0	0	3
77	18ME 3034	Advanced Turbo machinery	3	0	0	3
78	18ME 3035	Design of Solar and Wind System	3	0	0	3
79	18ME3036	Quality Concepts in Design	3	0	0	3
80	18ME3037	Manufacturing System and Simulation	3	0	0	3
81	18ME3038	Flexible Manufacturing System	3	0	0	3
82	18ME3039	Computer Integrated Manufacturing systems	3	0	0	3
83	18ME3040	Computer Applications in Design	3	0	0	3
84	18ME3041	Design of Fluid Power Systems	3	0	0	3
85	18ME3042	Total Quality Management	3	0	0	3
86	18ME3043	Industrial Automation and Mechatronics	3	0	0	3
87	18ME3044	Control of CNC Machine tools	3	0	0	3
88	18ME3045	Engineering Product Design and Development Strategies	3	0	0	3
89	18ME3046	Advanced Tool Design	3	0	0	3
90	18ME3047	Industrial Robotics	3	0	0	3
91	18ME3048	Advanced Machine Design	3	0	0	3
92	18ME3049	Advanced Strength of Materials	3	0	0	3
93	18ME3050	Engineering Fracture Mechanics	3	0	0	3
94	18ME3051	Advanced Mechanism Design	3	0	0	3
95	18ME3052	Tribology in Design	3	0	0	3
96	18ME3053	Rotor Dynamics	3	0	0	3
97	18ME3054	Optimization Techniques	3	0	0	3
98	18ME3055	Condition Based Monitoring	3	0	0	3
99	18ME3056	Multi-body Dynamics	3	0	0	3
100	18ME3057	Research Methodology and IPR	2	0	0	2
101	18ME3058	Business Analytics	3	0	0	3
102	18ME3059	Industrial Safety	3	0	0	3
103	18ME3060	Operations Research	3	0	0	3
104	18ME3061	Cost Management of Engineering Projects	3	0	0	3
105	18ME3062	Composite Materials	3	0	0	3
106	18ME3063	Waste to Energy	3	0	0	3
107	18ME3064	Disaster Management	2	0	0	0

108	18ME3065	Constitution of India	2	0	0	0
109	18ME3066	Pedagogy Studies	2	0	0	0

17ME4001 APPLIED THERMAL ENGINEERING AND EXPERIMENTAL METHODS

Credits: 3:1:0

Course Objectives:

To impart Knowledge on

- Fundamentals of heat transfer, exergy analysis and optimization techniques for various energy systems.
- Measurement of thermo physical properties of fluids.
- Design and modelling of experiments.

Course Outcomes:

Ability to:

- Design various experimental systems based on the conservation laws of physics.
- Relate the knowledge in analyzing the heat transfer systems to the fundamental heat transfer laws.
- Identify high performance heat transfer fluids for thermal systems.
- Apply the knowledge of measurement techniques in the modern energy systems.
- Conduct the experiments and record data for further analysis.
- Demonstrate knowledge of various modelling techniques for optimization of experimental results.

UNIT I THERMAL SYSTEM DESIGN. First law and Second law analysis – principle of increase of entropy – Exergy analysis of thermal systems – heat pipes, heat exchanger, thermoelectric cooler.

UNIT II FLUID FLOW AND HEAT TRANSFER. Forced convection – Mass, Momentum and Energy equations – thermal boundary layer – Laminar and Turbulent flow through mini & micro channels.

UNIT III ADVANCED HEAT TRANSFER FLUIDS. Nanofluid preparation and characterization – Micro level mechanisms in nanofluid flow. Measurement of Thermo physical properties.

UNIT IV EXPERIMENTAL METHODS. Pressure, temperature and flow measurements – Velocity. Methods of development of correlations – Uncertainty analysis in experiments. Data acquisition and processing. Regression analysis and curve fitting

UNIT V DESIGN OF EXPERIMENTS. Modeling of thermal equipment - system simulation (successive substitution - Newton - Raphson method) - optimization - linear programming, geometric programming- Examples applied to heat transfer problems and energy systems.

Text books:

1. Frank P Incropera & David P De witt, "Fundamentals of Heat & Mass Transfer", 5^{th} Edition, John Wiley& Sons, 2007.
2. Holman, J.P, "Experimental methods for engineers", 7^{th} Edition, McGraw Hill Education, 2017.

Reference Books:

1. K V Wong, Thermodynamics for Engineers, First Indian Edition, 2010, CRC Press.

2. Kalyanamoy Deb. “Optimization for Engineering Design algorithms and Examples”, Prentice Hall of India Pvt. Ltd. 2013.
3. Sarit K Das, SUS Choi, Nanofluid: Science and Technology, Wiley-Inderscience, 2008.

18ME2001 THERMODYNAMICS, REFRIGERATION AND AIR CONDITIONING

(Use of standard thermodynamic charts and tables are permitted)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The laws of thermodynamics and their applications on thermal systems.
- The working principle and applications of refrigeration and air conditioning systems.
- Psychrometric processes and cycles of air conditioning systems.

Course Outcomes:

Ability to

- Apply the basic concepts of thermodynamics to different thermal systems.
- Perform energy balance and exergy analysis for thermal systems.
- Evaluate the performance of refrigeration cycles
- Analyse psychrometric processes and cycles of air conditioning systems.
- Estimate the energy requirements of cooling and heating equipment for simple air conditioning applications.
- Analyse the performance of air conditioning systems.

Course Description:

Basics of thermodynamics: Thermodynamic System and Control Volume, Thermodynamic Properties, Processes and Cycles, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics, work transfer, heat transfer, specific heat and latent heat, first law of thermodynamics, First Law for a Closed System Undergoing a Cycle, Different Forms of Stored Energy, enthalpy, Steady Flow Process, Otto, diesel and dual cycles. **Entropy and properties of steam:** Second law of thermodynamics, cyclic heat engine, refrigerator and heat pump, reversibility and irreversibility, Carnot cycle, Carnot theorem, entropy principle, The Inequality of Clausius, first and second law combined, third law of thermodynamics, available energy, properties of steam. **Refrigeration cycles:** Refrigerants, refrigeration equipments, vapour compression refrigeration cycle, absorption refrigeration cycle, heat pump system, air refrigeration cycle, Liquefaction of Gases, production of solid ice. **Psychrometric and air conditioning systems:** Properties of atmospheric air, Psychrometric Chart, Psychrometric Processes, air conditioning equipments, comfort air conditioning, summer and winter air conditioning, cooling load estimation, air distribution and ducts. **Applications of refrigeration and air conditioning:** Domestic refrigerator and freezer, water coolers, ice manufacture, refrigerated trucks, cooling of milk, cold storages, room air conditioner, application of air conditioning in industry.

Text Books:

1. P K Nag, “Engineering thermodynamics”, Tata McGraw-Hill, 2013.
2. Arora C P, “Refrigeration and Air conditioning”, Tata McGraw-Hill, New Delhi, 2013.

Reference Books:

1. R S Khurmi and J K Gupta, “A text book of Refrigeration and air conditioning”, S Chand and company Ltd, 2013.

2. R K Rajput, “A text book of engineering thermodynamics”, Laxmi publications, 2016.
3. Yunus A Cengel, Michael A Boles, “Thermodynamics, An engineering approach”, fifth edition, Tata McGraw-Hill, 2014.
4. Manohar Prasad, “Refrigeration and Air conditioning”, Wiley Eastern Ltd, 2011.

18ME2002 REFRIGERATION AND AIR CONDITIONING LAB

Credits: 0:0:1

Course Objectives:

To impart knowledge on

- Refrigeration and air conditioning cycles.
- Refrigeration and air conditioning equipment.
- Working principle of heat pump.

Course Outcomes:

Ability to

- List the components and functions of a household domestic refrigerator.
- Describe the working principle of a water cooler.
- Compare the construction and working principle of window and split air conditioners.
- Analyse the performance of a refrigerator.
- Evaluate the performance of a heat pump.
- Determine the performance of an air conditioner.

List of Experiments

1. Performance test on Refrigeration cycle.
2. Performance test on Heat pump.
3. Performance test on Air Conditioning Cycle.
4. Determination of bypass and capacity factors in air conditioning test rig.
5. Experiments on psychrometric properties of air
6. On-site study of chilling or ice making and cold storage plants.

Reference Books:

1. Arora C P, “Refrigeration and Air conditioning”, Tata McGraw-Hill, New Delhi, 2013.
2. R S Khurmi and J K Gupta, “A text book of Refrigeration and air conditioning”, S Chand and company Ltd, 2013.
3. Manohar Prasad, “Refrigeration and Air conditioning”, Wiley Eastern Ltd., 2011.

18ME2003 THEORY OF MACHINES

Credits: 2:1:0

Course Objectives:

To impart knowledge on

- Fundamentals of mechanisms and principles involved in velocity and acceleration at any point in a link of a mechanism.
- Concepts of toothed gearing and kinematics of gear trains.
- The effects of friction in motion transmission and in machine components and balancing of rotating masses

Course Outcomes:

Ability to

- Illustrate fundamentals of different mechanisms.
- Analyse position, velocity and acceleration of links in mechanisms.
- Understand gear nomenclature and analysis of gear trains
- Design transmission elements considering frictional aspects
- Determine governing speed of various governors
- Balance rotating masses on same and different planes.

Course Description:

Fundamentals of mechanisms and kinematics of simple mechanisms: Elements, links, pairs, kinematics chain and mechanisms. Classification of parts and mechanisms. Lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration graphical (relative velocity and acceleration) method. **Gear and Gear Trains:** Types of Gears. Law of toothed gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear, nomenclature. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted and Epicyclic trains. Determining velocity ratio by tabular method. **Flywheel, Belt and Chain Drives, Bearings:** Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, belt materials, length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Chain drives. Types of friction, laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti-friction bearings. **Governors:** Types of governors. Constructional details and analysis of Watt, Porter and Proell governors. Effect of friction. Sensitiveness, stability, hunting, isochronism. **Balancing:** Static and dynamic balancing. Balancing of rotating masses in one and different planes.

Text Books:

1. Rattan.S.S, "Theory of Machines" , Tata McGraw Hill, 2012

Reference Books:

1. Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
2. Shigley , Pennock,G, Uicker J.J. "Theory of Machines and Mechanisms", Oxford University Press, 2015.
3. Thomas Bevan, "Theory of Machines", CBS Pub., 2001.
4. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", affiliated East-West Press Pvt. Ltd., New Delhi, 3rd Edition, Paper back, 2011.
5. R.S. Khurmi. "Theory of Machines" Khanna Publishers, Delhi, 2006.

18ME2004 MACHINE DESIGN

(Use of approved Data books are permitted)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Stress analysis, theories of failure and material science in the design of machine components .
- Design of common machine elements such as shafts, fasteners, springs, belts and bearings.
- Solving simple, open-ended design problems involving cost, drawings and structural analysis.

Course Outcomes:

Ability to

- Apply basic stress and strain analysis techniques.

- Describe the design process, material selection and calculation of stresses and stress concentrations.
- Make use of standard theories of failure and analyse fatigue to develop safety factors for machine elements.
- Develop solid, hollow shafts and couplings.
- Examine cotter and knuckle joints and design helical and leaf springs.
- Design belt drives, screws and bearings.

Course Description:

Introduction: The design process - Machine Design, Phase/steps in Machine design process - Engineering Materials and their Mechanical properties - Types of loads and stresses - Direct, Bending and torsional stress equations - Impact and shock loading - Factor of safety - theories of failure. **Stress concentration and fatigue**: Stress concentration: Definition, Reason for occurrence, Methods to reduce Stress concentration factor - Design for Variable Loading: Types of variable/Cyclic loads, Fatigue Failure, Endurance Limit and Strength, S-N Diagram (Simple problems). **Shafts and couplings**: Design of solid and hollow shaft under torsion and combined bending and torsion - Design of Keys and keyways - Design of muff, sleeve and rigid flange couplings. **Joints and springs**: Design of cotter and knuckle joints - Design of welded joints subjected to static loads - Design of helical and leaf springs under constant loads and varying loads. **Belts, screws and bearings**: Belt drives - Ratio of tensions - Design of flat and V-belts. Design of screw motion mechanisms like screw jack, lead screw. Design of sliding contact and rolling contact type bearings.

Text Books:

1. T. V. Sundararajamoorthy, "Machine Design", 9th Edition, Anuradha Publications, 2013.
2. S. Md. Jalaludeen, “Machine Design”, Anuradha Publications, Chennai 2011.

Reference Books:

1. T.J.Prabhu, "Fundamentals of Machine Design", Paperback, 2015.
2. V. B. Bhandari , “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill, 2016.
3. Jain R K, “ Machine Design”, Khanna Publishers, New Delhi, 2013.
4. Joseph Shigley, Charles, Richard Budynas and Keith Nisbett, “Mechanical Engineering Design”, 8th Edition, Tata McGraw–Hill, 2015.
5. Bernard Hamrock, “Fundamentals of Machine Elements”, McGrawHill, 2014.

Hand book:

Design data book for engineers, PSG College of Technology, Coimbatore, Kalaikathir Achagam, 2012.

18ME2005 MACHINE DRAWING LAB FOR AGRICULTURE

Credits: 0:0:1

Course objectives:

To impart knowledge on

- The basic concepts of design of agricultural machineries.
- Detailed design and drawing of various components of agricultural machineries.
- Part drawing and assembly drawing.

Course Outcomes:

Ability to

- Identify the angles of projection and dimensioning methods.
- Select suitable standards for fasteners.

- Categorize different forms of screw threads.
- Distinguish between the square, hexagonal nuts and bolts.
- Compare various couplings and joints.
- Construct part drawing from assembled drawing.

List of experiments

1. First and third angle projection, different methods of dimensioning and Sectional drawing of simple machine parts.
2. Forms of screw threads and drawing of BSW, Square and Metric threads.
3. Drawing of square headed and hexagonal headed nuts and bolts & drawing of different types of keys.
4. Drawing of coupling (Sleeve / Flange).
5. Drawing of joints (Cotter / Knuckle).
6. Assembly drawing of simple agricultural equipment.

Reference Books:

1. Narayana K L and Kannaiah P., “Machine Drawing”, SciTech Publications (India) Pvt. Ltd., Chennai, 2010.
2. Anilkumar.K.N.,“Engineering Graphics”, Adhyuthnarayan Publishers, Kottayam, 2005.
3. Bhatt. N. D and Panchal.V. M.,“Machine Drawing”, Charotar Publishing House Pvt. Ltd., Anand, 2013.

18ME2006 HEAT AND MASS TRANSFER IN FOOD PROCESSING

Credits: 2:0:0

Course Objectives:

To impart knowledge on

- Fundamentals and principles of heat and mass transfer.
- Design of heat exchangers.
- Determination of heat transfer coefficient of different modes of heat transfer.

Course Outcomes:

Ability to

- Solve heat transfer problems by applying the principles of conduction, convection, radiation and mass diffusion.
- Design heat transfer systems with extended surfaces.
- Analyse heat exchanger performance.
- Develop empirical correlations to determine the heat transfer coefficient.
- Predict flow patterns in boiling and condensation processes.
- Estimate the diffusion and mass transfer coefficient for gasses and liquids.

Course Description:

Basic heat transfer processes. Theory of heat conduction, Fourier’s law, concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation. Extended surfaces. Effectiveness and efficiency of the fins; unsteady state heat conduction. **Convection:** Forced and free convection, dimensional analysis in convective heat transfer; Dimensionless numbers. **Radiation**

emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; **Condensation and boiling**: Film- and drop-wise condensation. **Heat Exchangers:** fouling factors, jacketed kettles, LMTD, classification of heat exchangers, heat exchanger design and application of different types of heat exchangers in dairy and food industry. **Mass transfer:** Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Text Books:

1. R. C. Sachdeva, "Heat and Mass Transfer", Wiley Eastern, 2017.
2. J.P. Holman, "Heat Transfer", SI Metric 10th Edition, McGraw Hill, ISE, 2011.

Reference Books:

1. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
2. P.S. Ghoshdastidar, "Heat Transfer", Oxford, 2012.
3. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010.
4. C.P. Kothandaraman, "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.
5. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 2011.

18ME2007 HEAT TRANSFER LAB FOR AGRICULTURE

Credit: 0:0:1

Course Objectives:

To impart knowledge on

- Heat transfer characteristics of various heat transfer apparatus.
- Design calculations of different modes of heat transfer.
- Heat transfer coefficients in thermal systems.

Course Outcomes:
Ability to

- Calculate and compare the thermal conductivity of different materials.
- Predict the convective heat transfer coefficient by free convection.
- Determine forced convective heat transfer coefficient using pin–fin.
- Analyze the performance parameters of parallel flow heat exchanger.
- Evaluate the performance parameters of counter flow heat exchanger.
- Estimate the emissivity of grey and black surfaces by radiation.

List of Experiments

1. Determination of thermal conductivity of lagged pipe.
2. Determination of thermal conductivity of composite wall.
3. Determination of free convection using a vertical cylindrical rod.
4. Determination of heat transfer coefficient using a fin–pin by forced convection.
5. Determination of heat transfer coefficient using a parallel and counter flow heat exchangers.
6. Determination of emissivity of the given test surface.

Reference Books:

1. R. C. Sachdeva, "Heat and Mass Transfer", Wiley Eastern, 2017.
2. J.P. Holman, "Heat Transfer", SI Metric 10th Edition, McGraw Hill, ISE, 2011.

3. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
4. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010.
5. C.P. Kothandaraman, "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.

18ME2008 CAD APPLICATIONS LAB

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- Simple modelling software.
- Drawing commands using AutoCAD.
- Sectional views, 2D and 3D drawings using AutoCAD.

Course Outcomes:

Ability to

- Make use of basic drawing aids and modifying tools in AutoCAD.
- Construct and dimension lines and arcs using different methods.
- Create 2D drawings using various tool bars.
- Prepare sectional drawings for machine parts.
- Develop isometric drawing of primitive solids.
- Produce 3D drawings using various tool bars.

List of Experiments

1. Drawing Aids: Snap, Grid, Limits, Osnap tool bars.
2. Modifying Commands: Trim, Extend, Offset, mirror, copy, chamfer, fillet, array, rotate.
3. Application of Line, Arc and Circle commands.
4. Dimensioning, hatching and Layers.
5. 2-D drawing of machine parts- Foot step bearing.
6. 2-D Sectional drawing of machine parts- Knuckle joint and stuffing box.
7. Isometric Drawings of primitive solids and combination of primitive solids.
8. Drawing of hexagonal nut, bolt and other machine parts.
9. Practice on 3-D Commands: Extrusion and loft.
10. Practice on 3-D Commands: Sweep and press pull.
11. Practice on 3-D Commands: revolving and joining.
12. Demonstration on CNC Machine.

Reference Books:

1. Sham Tickoo, "AutoCAD 2017 for Engineers & Designers", 23rd edition, Dreamtech Press, 2016.
2. Zeid Ibrahim, “Mastering CAD/ CAM with Engineering”, McGraw- Hill Education Pvt. Ltd., New Delhi, 2011.

18ME1001	ENGINEERING DRAWING	L T P C 0 0 4 2

Course Objectives: To impart knowledge on

1. Modern engineering tools necessary for engineering drawing
2. Drafting, analysis and to understand the operational functions.
3. Interpretation of technical graphics assemblies of machine components.

Course Outcome: After completing the course the student will be able to

1. Understand the engineering design and solid modelling.
2. Visualize the engineering components.
3. Perform basic geometrical constructions and multiple views of objects.
4. Develop orthographic projection of lines and plane surfaces.
5. Prepare projections and sections of simple solids.
6. Prepare isometric and perspective projection of simple solids

LIST OF EXPERIMENTS

CONCEPTS AND CONVENTIONS (Not for Examination)
Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.
PLANE CURVES: Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.
SCALES : Scales: Construction of Diagonal and Vernier scales.
ORTHOGRAPHIC PROJECTIONS: Orthographic projections – principles, Principal planes-First angle projection-projection of points.
FREE HAND SKETCHING: Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects.
PROJECTION OF POINTS; Projections of points located in four different quadrants
PROJECTION OF LINES; Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces
PROJECTION OF PLANE SURFACES: Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method
PROJECTION OF SOLIDS; Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.
SECTION OF SOLIDS: Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.
DEVELOPMENT OF SURFACES; Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.
ISOMETRIC PROJECTIONS: Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions and miscellaneous problems.
PERSPECTIVE PROJECTIONS; Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method

Text Book:

1. Leo Dev Wins. K, Engineering Drawing, 3rd Edition Pearson Publications, 2017.

2. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

Reference Book:

1. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
3. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
4. Rathnam K., "A First Course in Engineering Drawing", Springer Singapore, 2018.
5. George Sydenham Clarke, "Practical Geometry and Engineering Drawing", Nabu Press 2012.

18ME1002	ENGINEERING GRAPHICS (AUTOCAD)	L	T	P	C
		0	0	2	1

Co requisite: Engineering Drawing

Course Objectives: To impart knowledge on

1. To learn engineering design and its place in society
2. To get exposure to the visual aspects of engineering design and graphics standards
3. To apply graphics standards to create working drawings and communicate across industries.

Course Outcome:

After completing the course the student will be able to

1. Design a system, component, or process to meet desired needs within realistic constraints and sustainability.
2. Communicate effectively with various stake holders of engineering design industry
3. Apply techniques, skills, and modern engineering tools necessary for engineering practice
4. Extract mass, moment of inertia and center of gravity from 2D and 3D model data
5. Optimize material required in fabrication of parts.
6. Visualize assembly of system with fewer parts.

MODULE I – USER INTERFACE (5 Lecture hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command window, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

MODULE II – CUSTOMIZATION, DRAWING AIDS, PAGE SETUP AND PRINTING (5 Lecture hours)

Setting up of units, drawing limits, drawing paper size, scale settings and use of drawing template. Draw to PDF files the printer, Snap to objects manually and automatically using object snap settings; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Printing and saving drawings.

MODULE III – DRAWING AND MODIFYING (5 Lecture hours)

Drawing polylines, ellipses, polygons and use of spline curves. Adding and altering objects, moving and dublicating objects, modifying and maneuvering, hatching and sketching. Polar and rectangular arrays. Application of arcs to draw simple parts. Use of text fonts, formatting text and setting title box for drawing template.

MODULE IV – DIMENSIONING ANNOTATIONS, LAYERING & OTHER FUNCTIONS (5 Lecture hours)

ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths and weight through modifying existing lines (extend/lengthen).

MODULE V – ISOMETRIC, ORTHOGRAPHIC AND 2D TO 3D (5 Lecture hours)
Orthographic projection techniques; drawing isometric drawing from orthographic drawing and vice versa. Creating regions, converting polylines to single entity and 2D to 3D of simple objects. Modeling of simple parts and assemblies. Modifying solids using Boolean operations. Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface. Application of isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Solid, surface, and wireframe models.
MODULE VI – DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT (5 Lecture hours)
Use of Block commands to model repetitive objects in civil, mechanical, electrical and electronics and computer science industries and apply in a design project. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling.

Text Book:

1. G.Ganesan, "Basic Computer Aided Design and Drafting using AutoCAD 2015", McGraw Hill, 2018.
2. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press.

Reference Books:

1. Elliot Gidis, "Up and Running with AutoCAD 2015, 2D and 3D Drawing and Modeling" Academic Press, 2014.
2. Gary R. Bertoline and Eric n. Wiebe, " Fundamentals of Graphics Communication", McGrawHill, 2002.
3. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers," Dream Tech Press, 2014.
4. Terry T. Wohlers, Applying AutoCAD (2013) McGrawHill.
5. Antonio Ramirez., Jana Schmidt., Douglas Smith, "Technical Drawing 101 with AutoCAD 2016 5th Edition, 2016.

18ME1003	ENGINEERING MECHANICS	L T P C 3 1 0 4

Course Objectives: To impart knowledge on

1. Statics with an emphasis on force equilibrium and free body diagrams.
2. Significance of centroid, centre of gravity and moment of inertia.
3. Principles to study the motion of a body and concept of relative velocity and acceleration.

Course Outcome: After completing the course the student will be able to

1. Determine the resultant force and moment for a given system of forces.
2. Determine the centroid and second moment of area of simple solids.
3. Apply fundamental concepts of kinematics and kinetics to the analysis of simple / practical problems.
4. Understand basic kinematics concepts – displacement, velocity and acceleration.
5. Understand basic dynamic concepts – force, momentum, work and energy.
6. Determine friction and its effects as per the laws of friction.

MODULE I – STATICS OF PARTICLE (8 Lecture Hours)
Introduction – Units and Dimensions - Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution and components of forces – Resultant of concurrent forces, Equilibrium of a two force and three force body – Forces in space – Equilibrium of a particle in space – Equilibrium of rigid bodies: Free body diagram. Support Reactions – Beams – Types of loads, Analysis of roof trusses by method of joints and method of sections. Moment of a force about a point – Varignon's theorem – Moment of a couple – Resolution of a given force in to force and couple system.
MODULE II – STATICS OF RIGID BODIES (8 Lecture Hours)

Centre of gravity and Centroid of composite plane figure – Moment of inertia – Parallel axis and Perpendicular axis theorem – Moment of inertia of composite planes – Mass moment of inertia of simple solid and composite bodies.

MODULE III – KINEMATICS OF PARTICLES (8 Lecture Hours)

Rectilinear motion – Displacements, Velocity and acceleration, their relationship – Relative motion, Curvilinear motion – Tangential and Normal components, velocity and acceleration of a particle – Projectile of body. Newton's second law of motion – D-Alembert's principle – Motion of a lift – Motion on an inclined surface – Motion on connected bodies.

MODULE IV – KINETICS OF PARTICLES (7 Lecture Hours)

Work Energy method – Applications of principle of work and energy – Impulse and momentum method - Motion of connected bodies. Impact of elastic bodies.

MODULE V – DYNAMICS OF RIGID BODIES (7 Lecture Hours)

Translation and Rotation about a fixed axis – Equations defining the rotation of a rigid body about a fixed axis – General plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

MODULE VI – FRICTION (7 Lecture Hours)

Frictional force – Laws of sliding friction - Limiting friction – Coefficient of friction and angle of friction – Impending friction – Basic concepts – Problems on body on a rough inclined plane, Ladder friction, Wedge friction.

Text Books:

1. N.H Dubey, "Engineering Mechanics – Statics and Dynamics", McGraw-Hill Education (India) Private Limited, 2016.
2. Rajasekaran S, Sankarasubramanian G., "Fundamentals of Engineering Mechanics 3rd Edition", Vikas Publishing House Pvt. Ltd., 2017

Reference Books

1. Ferdinand P. Beer and E. Russell Johnston Jr. "Vectors Mechanics of Engineers: Statics and Dynamics", McGraw-Hill International Edition, 2014.
2. Palanichamy M.S., Nagan S., "Engineering Mechanics – Statics and Dynamics 3rd Edition", Tata McGraw-Hill, 2004
3. Hibbeler R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2014
4. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics 4th Edition", Pearson Education Asia Pvt. Ltd., 2005.
5. N. Kottiswaran, "Engineering Mechanics", Sri Balaji Publications Edition – 2010

18ME1004	WORKSHOP/ MANUFACTURING PRACTICE LABORATORY	L T P C 0 0 2 1

Co requisite: Manufacturing Technology

Course Objectives: To impart knowledge on
1. Fitting joints, carpentry joints and plumbing practices.
2. Process planning and procedures to develop models in foundry and smithy laboratories.
3. Sequence of operations adopted in welding and sheet metal laboratories to fabricate various Joints and models.

Course Outcome: After completing the course the student will be able to
1. Apply carpentry and fitting joints, to fabricate useful products.
2. Prepare green sand moulds for different patterns.
3. Make machine elements using forging technique.
4. Use welding equipment's to join the structures.
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for typical engineering components.

LIST OF EXPERIMENTS

1. Making of middle lap joint in carpentry.
2. Making of V joint in Fitting.
3. Assembly of pipes, valves and other fittings in Plumbing.
4. Preparation of green sand mould for stepped cone pulley with core preparation.
5. Making of butt joint by arc welding process.
6. Preparation of J bends from square rod by smithy forging operation.
7. Making of Rectangular tray by sheet metal fabrication.

18ME1005	BASIC MECHANICAL ENGINEERING	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. IC Engines, External Combustion Engines, Boilers.
2. Power plants, metal forming, metal joining, machining process
3. The application of CAD, CAM, MEMS and CIM.

Course Outcome: After completing the course the student will be able to
1. Describe the working principle of Engines and Turbines.
2. Classify Boilers and identify different types of engines.
3. Distinguish conventional and non- conventional power plants.
4. Examine various types of engineering materials.
5. Select different types of metal forming and joining processes.
6. Analyze metal machining processes.

MODULE I – ENGINES, BOILERS AND REFRIGERATION (8 Lecture Hours)
Working of Petrol and Diesel Engine – Difference between two stroke and four stroke engines. Principles of fire tube and water tube boilers – Cochran boiler – Babcock & Wilcox boiler, Working principle of Impulse turbine reaction turbine, Refrigeration and air conditioning- working principle of refrigeration and air conditioning.

MODULE II – POWER PLANTS (8 Lecture Hours)
Conventional power plants: Hydro, Thermal, Nuclear power plants – Diesel and Gas Turbine power plants. Non-conventional power plants: Solar, wind and tidal power plants – Geothermal power plant – Ocean Thermal Energy conversion power plant.

MODULE III – ENGINEERING MATERIALS (8 Lecture Hours)
Engineering materials: classification of materials –properties of metals – Alloy steels – Nonferrous metals and alloys. Introduction to plastics and composites.
MODULE IV – INTRODUCTION TO MANUFACTURING PROCESSES (7 Lecture Hours)
Introduction: Metal casting process: patterns –molding processes – melting of cast iron. Metal forming process: Introduction – Forging – Rolling – Extrusion – Drawing operations. Metal joining Process: Introduction - welding – arc welding - gas welding.
MODULE V – INTRODUCTION TO MACHINE TOOLS (7 Lecture Hours)
Lathe – Drilling machine – Milling machine – Shaping Machine – Grinding Machine - Introduction to NC and CNC machines.
MODULE VI – INTRODUCTION TO CAD/CAM, MEMS AND CIM (7 Lecture Hours)
Introduction - Computer Aided Design – Computer Aided Manufacturing – Computer Integrated Manufacturing – Micro Electro Mechanical Systems (MEMS).

Text Books:

1. Praveen Kumar, R Raja, " Basic Mechanical Engineering", Pearson Education 2018.
2. G. Shunmagam, S. Ravindran, "Basic Mechanical Engineering", Tata McGraw Hill, 2011.

Reference Books:

1. I.E. Paul Degarmo, J.T. Black, Ronald A. Kosher, "Material and Processes in Manufacturing", 8th Edition, John Wiley and Sons. 2003.
2. S.R.J. Shantha Kumar, "Basic Mechanical Engineering", HiTech Publications, 2001.
3. Williams D. Callister "Material Science and Engineering", John Wiley and Sons. 2013.
4. C.M. Agrawal, Basant Agrawal, "Basic Mechanical Engineering", Wiley, 2008.
5. Gaurav Shukla, "Handbook Series of Machanical Engineering", Arihant, 2013.

18ME1006	WORKSHOP PRACTICE	L T P C 0 0 2 1

Course Objectives: To impart knowledge on
1. Fitting joints, carpentry joints and plumbing practices.
2. Process planning and procedures to develop models in foundry and smithy laboratories.
3. Sequence of operations adopted in welding and sheet metal laboratories to fabricate various Joints and models.

Course Outcome: After completing the course the student will be able to
1. Apply carpentry and fitting joints, to fabricate useful products.
2. Prepare green sand moulds for different patterns.
3. Make machine elements using forging technique.
4. Use welding equipment's to join the structures.
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for typical engineering components.

LIST OF EXPERIMENTS
1. Making of middle lap joint in carpentry.
2. Assembly of pipes, valves and other fittings in Plumbing.
3. Preparation of green sand mould for stepped cone pulley with core preparation.
4. Making of butt joint by arc welding process.
5. Making of circular and rectangular rings for RCC using bar bending.
6. Making of Rectangular tray by sheet metal fabrication.

Text Books:

1. Bava, R Raja, "Workshop Practice", Tata McGraw 2018.

18ME1007	COMPUTER AIDED ENGINEERING DRAWING	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. To learn engineering design and its place in society
2. To get exposure to the visual aspects of engineering design and graphics standards
3. To apply graphics standards to create working drawings and communicate across industries.

Course Outcome: After completing the course the student will be able to

1. Understand the engineering design and solid modelling.
2. Visualize the engineering components.
3. Design a system, component, or process to meet desired needs within realistic constraints and sustainability.
4. Communicate effectively with various stake holders of engineering design industry
5. Apply techniques, skills, and modern engineering tools necessary for engineering practice
6. Visualize assembly of system with fewer parts.

USER INTERFACE AND CUSTOMIZATION (5 Lecture hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command window, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

Setting up of units, drawing limits, drawing paper size, scale settings and use of drawing template. Draw to PDF files the printer, Snap to objects manually and automatically using object snap settings;

DRAWING AIDS, PAGE SETUP AND PRINTING (5 Lecture hours)

Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Printing and saving drawings.

DRAWING AND MODIFYING (5 Lecture hours)

Drawing polylines, ellipses, polygons and use of spline curves. Adding and altering objects, moving and dublicating objects, modifying and maneuvering, hatching and sketching. Polar and rectangular arrays. Application of arcs to draw simple parts. Use of text fonts, formatting text and setting title box for drawing template.

DIMENSIONING ANNOTATIONS, LAYERING & OTHER FUNCTIONS 5 Lecture hours)

ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths and line weight through modifying existing lines (extend / lengthen).

ORTHOGRAPHIC PROJECTIONS: (5 Lecture hours)

Orthographic projections – principles, Principal planes - First angle projection, Conversion of isometric view into orthographic views.

PROJECTION OF POINTS: (5 Lecture hours)

Projections of points located in four different quadrants.

PROJECTION OF LINES: (5 Lecture hours)

Projection of straight lines (only First angle projections) parallel to both planes, inclined to one plane and parallel to the other, inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces.

PROJECTION OF PLANE SURFACES: (5 Lecture hours)

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

PROJECTION OF SOLIDS: (5 Lecture hours)

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

SECTION OF SOLIDS: (5 Lecture hours)

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

DEVELOPMENT OF SURFACES: (5 Lecture hours)

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs.

ISOMETRIC PROJECTIONS: (5 Lecture hours)

Principles of isometric projection – isometric scale –Isometric views of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions and miscellaneous problems.

Text Book:

1. Leo Dev Wins. K, Engineering Drawing, 3rd Edition, Pearson Publications, 2017.
2. G.Ganesan, "Basic Computer Aided Design and Drafting using AutoCAD 2015", McGraw Hill, 2018.
3. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

Reference Book:

1. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
2. C M Agrawal, Basant Agrawal, Engineering Graphics, C M Agrawal, Basant Agrawal, McGraw Hill Education, 2017.
3. Rathnam K., "A First Course in Engineering Drawing", Springer Singapore, 2018.
4. George Sydenham Clarke, "Practical Geometry and Engineering Drawing", Nabu Press 2012.
5. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2014.

18ME2009	FLUID MECHANICS LABORATORY	L T P C 0 0 2 1

Co requisite: Fluid Mechanics and Machines

Course Objectives: To impart knowledge on

1. The calibration of flow measurement devices and calculation of losses due to friction and pipe fittings.
2. The working principles of Pumps.
3. The working of different types of hydraulic turbines.

Course Outcomes: After completing the course the student will be able to

1. Determine friction factor.
2. Calibrate venture meter.
3. Calibrate orifice meter.
4. Conduct flow measurements in pipes.
5. Determine minor losses in pipes.
6. Conduct load test on pelton wheels.

LIST OF EXPERIMENTS

1. Determination of Darcy's friction factor.
2. Calibration of venturi meter.
3. Calibration of orifice meter.
4. Determination of minor losses in pipes.
5. Performance of single stage centrifugal pump.
6. Load test on Pelton wheel.
7. Performance of Turbine- Kaplan, Francis, pumps-gear/centrifugal/reciprocating pumps

18ME2010	HEAT AND MASS TRANSFER	L T P C 3 0 0 3

Pre requisite: Thermodynamics

Course Objectives: To impart knowledge on
1. To build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
2. To understand governing equations and solution procedures for the three modes, along with solution of practical problems using empirical correlations.
3. To provide knowledge on boiling and condensation heat transfer, analysis, design of heat exchangers and mass transfer.

Course Outcome: After completing the course the student will be able to
1. Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.
2. Obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.
3. Evaluate radiation heat transfer between black, gray surfaces and the surroundings.
4. Design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.
5. Apply boiling and condensation correlations to two phase flow processes.
6. Apply mass transfer correlations to process–based problems.

MODULE I –CONDUCTION (8 Lecture Hours)
Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

MODULE II –CONVECTION (8 Lecture Hours)
Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

MODULE III –RADIATION (8 Lecture Hours)
Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann'slaw, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

MODULE IV – HEAT EXCHANGER (7 Lecture Hours)
Types of heat exchangers, overall heat transfer coefficient, fouling, Analysis and design of heat exchangers using both LMTD and ε- NTU methods.

MODULE V – BOILING AND CONDENSATION (7 Lecture Hours)
Boiling and condensation heat transfer, pool boiling curve, types of condensation, correlations and simple problems.

MODULE VI – MASS TRANSFER (7 Lecture Hours)
Introduction mass transfer, Fick's law of diffusion, equimolar counter diffusion, Convective mass transfer coefficient, non-dimensional number in mass transfer, evaporation process in the atmosphere. Similarity between heat and mass transfer

Text Books:
1. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 2011
2. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2010

Reference Books:
1. A. Bejan, Heat Transfer John Wiley, 1993
2. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley,Sixth Edition, 2007
3. Massoud Kaviany, Principles of Heat Transfer, John Wiley, 2002
4. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
5. R. C. Sachdeva, 'Heat and Mass Transfer', Wiley Eastern, 2017.

18ME2011	HEAT TRANSFER LABORATORY	L T P C 0 0 4 2

Co requisite: Heat and Mass Transfer

Course Objectives: To impart knowledge on
1. The heat transfer characteristics of various heat transfer apparatus
2. The design calculations of different modes of heat transfer
3. Conducting the heat transfer experiments and practically learn how to find heat transfer coefficients

Course Outcome: After completing the course the student will be able to
1. Calculate and compare the thermal conductivity of different materials.
2. Predict the convective heat transfer coefficient by free convection.
3. Analyze the performance of forced convective heat transfer coefficient through pin –fin.
4. Evaluate the performance of radiation through black and gray bodies.
5. Analyze the performance parameters of parallel flow heat exchanger.
6. Analyze the performance parameters of counter flow heat exchanger.

LIST OF EXPERIMENTS

1. Measurement of thermal conductivity through a composite wall.
2. Measurement of thermal conductivity in a lagged pipe.
3. Determination of thermal conductivity in a guarded plate.
4. Measurement of heat transfer coefficient in a vertical cylindrical rod by free convection.
5. Measurement of heat transfer coefficient in a flat plate by natural convection.
6. Determination of heat transfer coefficient in a fin–pin by free convection.
7. Determination of heat transfer coefficient in a fin–pin by forced convection.
8. Measurement of heat transfer coefficient in a forced convection apparatus.
9. Determination of emissivity of the given test surface.
10. Determination of Stefan–Boltzmann constant in radiation heat transfer.
11. Determination of heat transfer coefficient in a parallel flow heat exchangers.
12. Determination of heat transfer coefficient in a counter flow heat exchangers.

18ME2012	STRENGTH OF MATERIALS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Nature of stresses developed in simple geometries
2. Elastic deformation occurring in various simple geometries for different types of loading.
3. Stresses action on shafts, springs and cylinders

Course Outcome: After completing the course the student will be able to
1. Recognize various types loads applied on machine components
2. Understand the nature of internal stresses that will develop within the components
3. Analyse the stresses acting simple geometry of structures.
4. Evaluate the strains and deformation due to the elastic stresses developed.

5. Compute inertia, slopes and deflection in beams
6. Determine the torsional stresses of shaft and hoop stresses in cylinders

MODULE I – SIMPLE STRESSES **(8 Lecture Hours)**
Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

MODULE II – BEAMS **(8 Lecture Hours)**
Beams and types of transverse loading on beams - shear force and bending moment diagrams.
Types of beam supports - cantilevers, simply supported, and over-hanging beams.

MODULE III – LOAD ON BEAMS **(8 Lecture Hours)**
Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Module IV – MOMENT OF INERTIA **(7 Lecture Hours)**
Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Module V – TORSION **(7 Lecture Hours)**
Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Module VI – STRESSES IN CYLINDER **(7 Lecture Hours)**
Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids 2nd Edition, Prentice Hall of India, New Delhi, 2009.
2. R. Subramanian, Strength of Materials 2nd Edition, Oxford University Press, 2010.

Reference Books:

1. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials 7th Edition, Tata Mc GrawHill Publishing Co. Ltd., New Delhi 2014.
2. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2009.
3. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
4. L. S. Srinath, "Advanced Mechanics of Solids", 3rd Edition, TMH Publishing Co. Ltd., New Delhi, 2009.
5. William Nash, "Schaum's Outline of Strength of Materials, 6th Edition", McGraw-Hill Education, 2013.

18ME2013	STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	2	1

Co requisite: Strength of Materials

Course Objectives: To impart knowledge on
1. The evaluation of tensile properties steel
2. Evaluation of bending strength of wood
3. Evaluation of hardness, impact and shear strength of steel

Course Outcome: After completing the course the student will be able to
1. Evaluate ductility and tensile strength of mild steel.
2. Determine resilience of springs.
3. Evaluate bending strength of wood.
4. Evaluate strength of beams.
5. Evaluate impact strength.

6. Evaluate shear strength and hardness of steel.

LIST OF EXPERIMENTS

1. Tension test on mild steel
2. Test on springs (open coiled springs)
3. Static bending test on wood
4. Deflection tests on cantilever beams
5. Charpy Impact tests
6. Double shear and Rockwell Hardness tests on mild steel.

Reference books

Lab manual

18ME2014	SOLIDS MECHANICS	L T P C 3 0 0 3

Pre requisite: Strength of Materials

Course Objectives: To impart knowledge on

1. Relationship between the loads applied to a non-rigid body and the internal stresses and deformations induced in the body.
2. Different approaches to calculate slope and deflection for various types of beams.
3. Mohr's circle method to find magnitude and direction of the principal stresses.

Course Outcome: After completing the course the student will be able to

1. Understand stress and strain relations in simple solids.
2. Estimate stress and strain values in simple solids subjected thermal loads.
3. Analyze the different types of loading and the consequent deflection.
4. Determine maximum stress and angular deflection of solid and hollow shafts.
5. Evaluate stress and strain using Mohr's circle.
6. Apply concepts of failure theories to determine safe design.

MODULE I –STRESSES AND STRAINS (8 Lecture Hours)

Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress strain diagram- Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalized Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses.

MODULE II – SIMPLE BENDING AND TYPES OF BEAMS (7 Lecture Hours)

Cantilever, simply supported, overhanging: Shear Force and Bending Moment Diagrams Theory of simple bending.

MODULE III – DEFLECTION OF BEAMS (8 Lecture Hours)

Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

MODULE IV – TORSION OF SHAFTS (8 Lecture Hours)

Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends – Stresses in helical springs. Bending stress and shear stress in beams.

MODULE V – BI-AXIAL STRESS SYSTEM (7 Lecture Hours)

Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress. Thin cylinders and shells – deformation of thin cylinders and shells.

Module VI – THEORY OF COLUMNS (8 Lecture Hours)

Theory of columns – Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column

Text Books:

1. Ferdinand P.Beer, (2014) , Mechanics of Materials, McGraw Hill.

2. S. Ramamrutham and R. Narayanan, (2014), Strength of Materials 18th Edition.

References Books:

1. Rowland Richards, (2000), Principles of Solid Mechanics, CRC Press.
2. Timoshenko, S.P. and Young, D.H., (2000), Strength of Materials, East West Press Ltd.
3. R.K. Bansal, (2000), Strength of Materials, Laxmi Publications.
4. S.M.A. Kazimi, "Solids Mechanics 2nd Edition", McGraw Hill Education, 2017.
5. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials 7th Edition, Tata Mc GrawHill Publishing Co. Ltd., New Delhi 2014.

18ME2015	KINEMATICS AND THEORY OF MACHINES	L T P C 3 1 0 4

Course Objectives: To impart knowledge on

1. Displacement, velocity and acceleration at any point in a rigid link of a mechanism
2. Cam profiles to give required follower motion and gear combinations to meet the transmission requirements.
3. Turning moment diagram of flywheels and control of machines by governors and gyroscopes.

Course Outcome: After completing the course the student will be able to

1. Determine mobility, position, velocity and acceleration of links in mechanism.
2. Design cam profiles to meet the motion requirements in mechanisms.
3. Determination of forces on parts of slider-crank mechanism and design of flywheel.
4. Predict balancing mass requirement in rotary and reciprocating unbalanced systems.
5. Determine frequency of translational and longitudinal vibration.
6. Apply the use of governors to control speed and gyroscopes to navigate.

MODULE I – KINEMATICS OF SIMPLE MECHANISM (12 Lecture Hours)

Basics of Mechanisms - Basic kinematic concepts and definitions - Description of some common mechanisms - Design of quick return crank-rocker mechanisms Kinematics of Linkage Mechanisms - Displacement, velocity and acceleration analysis of simple mechanisms - Coincident points - Coriolis component of Acceleration.

MODULE II – KINEMATICS OF CAM (10 Lecture Hours)

Kinematics of Cam Mechanisms - Layout of plate cam profiles - Specified contour cams - Pressure angle and undercutting - sizing of cams. Gears and Gear Trains- Law of toothed gearing - tooth profiles - Non-standard gear teeth -Gear trains - Epicyclic Gear Trains - Differentials - Automobile gear box.

MODULE III – STATIC FORCE ANALYSIS AND FLYWHEEL (10 Lecture Hours)

Force analysis - Static force analysis of simple mechanisms - D'Alambert's principle. .Dynamic force analysis - Dynamic Analysis in reciprocating engines. Flywheel - Turning moment diagrams of reciprocating engines - fluctuation of energy - coefficient of fluctuation of energy and speed.

MODULE IV – DYNAMIC ANALYSIS AND BALANCING (10 Lecture Hours)

Dynamic analysis of Slider–crank mechanism. Balancing - Static and dynamic balancing - partial balancing of reciprocating masses of in-line, V and radial engines.

MODULE V – MECHANICAL VIBRATIONS (10 Lecture Hours)

Free vibration – Undamped free vibration of single degree freedom systems. Damped Vibration - Types of Damping - Damped free vibration. Forced vibration of single degree freedom systems - Vibrating isolation and Transmissibility. Transverse vibration - Dunkerley's method - Whirling of shafts - Critical speed. Torsional vibration - Two rotor systems.

MODULE VI – GOVERNORS AND GYROSCOPE (8 Lecture Hours)

Mechanism for Control: Governors - Types - Characteristics - Effect of friction - Other Governor mechanisms. Gyroscopes - Gyroscopic effects in Automobiles, ships and airplanes.

Text books:

1. Singiresu S. Rao, "Mechanical Vibrations", Addison Wesley Longman, 2016.
2. Ambekar A.G., "Mechanical Vibrations and Noise Engineering", Prentice Hall of India, New Delhi, 2006.

Reference books:

1. Benson H Tongue, "Principles of vibration 2^{nd} Edition, Oxford University Press, 2002.
2. Thomson W.T., "Theory of Vibration with Applications", CBS Publishers and Distributers, New Delhi, 2014
3. Kelly, "Fundamentals of Mechanical Vibrations", McGraw Hill Publications, 2000.
4. Rao V. Dukkipati, J. Srinivas, "Vibrations Problem Solving Companion", Narosa Publishers, 2007.
5. KewalPujara. "Vibrations and Noise for Engineers", DhanpatRai& Co, 4th Edition, 2007.

18ME2016	DESIGN OF MACHINE ELEMENTS	L T P C 3 0 0 3

Pre requisite: Kinematics and Theory of Machines

Course Objectives: To impart knowledge on

1. Design principles and basic design procedures.
2. Using design data for the design of mechanical elements.
3. Applying topics learned in Engineering Mechanics and Mechanics of Solids to actual machine elements.

Course Outcome: After completing the course the student will be able to

1. Understand the standard design procedure for Design of machine elements.
2. Analyse stresses acting on components and determine the size based on theories of failure.
3. Design machine components for a given load condition using design data hand books.
4. Decide specifications as per standards given in design data and select standard components to improve interchangeability.
5. Design and develop nonstandard machine components.
6. Prepare a detail design layout and drawing of machine.

MODULE I – STRESSES IN MACHINE MEMBERS (8 Lecture Hours)

Introduction to the design process, Design considerations- limits, fits and standardization, Factors influencing machine design, selection of materials based on physical and mechanical properties. Direct, bending, torsional and combined stress equations, Impact and shock loading. Failure theories.

MODULE II – VARIABLE AND CYCLIC LOADS AND BEARINGS (8 Lecture Hours)

Variable and cyclic loads – fatigue strength and fatigue limit – S-N curve, combined cyclic stress, Soderberg and Goodman equations – Design of sliding and rolling contact bearing.

MODULE III – SHAFTS AND COUPLINGS (7 Lecture Hours)

Design of solid and hollow shaft based on strength, rigidity and critical speed. Design of keys, keyways, Bolts and Nut. Design of Rigid and Flexible couplings.

Module IV – JOINTS AND SPRINGS (7 Lecture Hours)

Design of bolted, riveted and welded joints, Threaded fasteners, Cotter joints, Knuckle joints and pipe joints. Design of helical, leaf, disc and torsional springs under constant loads and varying loads. Design of Power Screws.

Module V – DESIGN OF ENGINE COMPONENTS (8 Lecture Hours)

Design of piston, connecting rod, crankshaft, and flywheel.

Module VI – BRAKES AND CLUTCHES (7 Lecture Hours)

Design of brakes, clutches – Single plate, Multiplate & Cone.

Text Books:

1. S.Md. Jalaludeen, "Machine Design", Anuradha Publications, Chennai 2011.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, "Mechanical Engineering Design", 8 th Edition, Tata McGraw–Hill, 2015.

Reference Books:

1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw–Hill Book Co., 2016.
2. Sundarrajamoorthy T.V. and Shanmugam, 'Machine Design', Khanna Publishers, 2003.

3. Bernard Hamrock, “Fundamentals of Machine Elements”, McGrawHill, 2014.
4. Hall and Allen, “Machine Design”, Schaum Series, 2001.
5. Design Data – Data Book for Engineers, PSG College of Technology, Coimbatore, KalaikathirAchchagam 2012 & Approved Data Sheets.

18ME2017	DESIGN OF TRANSMISSION SYSTEMS	L T P C 3 0 0 3

Pre requisite: Kinematics and Theory of Machines, Design of Machine Elements

Course Objectives: To impart knowledge on
1. The concepts, procedures and the data, to design and analyze machine elements in power transmission systems.
2. Competency to specify, select and design the mechanical components for transmission systems.
3. Development of outline drawing of transmission elements.

Course Outcome: After completing the course the student will be able to
1. Identify the working principles of mechanical components employed in mechanical transmission systems.
2. Apply suitable theories and basic engineering principles and procedures to design the transmission elements.
3. Select appropriate engineering design data from standard data books for mechanical transmission components.
4. Design transmission systems based on the requirements.
5. Design and Draw speed reducer, multispeed gear box.
6. Evaluate the torque, power and other functional requirements of power transmission Elements.

MODULE I – BEARINGS (7 Lecture Hours)
Bearings – Introduction ,types and applications , Selection of bearings based on loads , Sliding contact bearing-terminology, design of Journal bearings, design of Rolling contact bearing.
MODULE II – BELTS, ROPE AND CHAIN DRIVES (7 Lecture Hours)
Belt, types and applications, constructional details of belts, design of Flat belt drives, design of V- belt drives .Chain – Types, selection of Chains, Design of Chains**.** Ropes –design and selection of ropes.
MODULE III – SPUR, HELICAL AND BEVEL GEARS (8 Lecture Hours)
Gears –types and applications. Design of spur gear, Design of Helical gear, Design of herring bone gear, Design of bevel gears.
MODULE IV – WORM AND SKEW GEARS (7 Lecture Hours)
Worm gear –applications, advantages, efficiency of worm gear, design of worm gear, design of Skew gears. Design of a Ratchet & pawl mechanism.
MODULE V – GEAR BOX (8 Lecture Hours)
Speed reducer- types and applications, design of speed reducer. Multispeed Gearbox – types, applications, layout of gear box, speed & kinematic diagrams, design of gearbox.
MODULE VI – GENEVA MECHANISM, CAM DRIVES AND POWER SCREWS (8 Lecture Hours)
Geneva mechanism – applications. Design of Geneva mechanism. Cam drives –applications, design of cams-calculation of geometrical dimensions, Contact stress and Torque calculation. Design of Power screws.

Text Books:

1. S.Md .Jalaludeen , Machine Design, Anuradha Agencies Publications, 2009.
2. Prabhu.T.J., Design of Transmission Elements,2002.

Reference Books:

1. V. Dobrovolsky, ‘Machine Elements’, MIR, 1999.
2. Hall A.S. Holowenko A.R. and Laughlin H.G., ‘Theory and Problems in Machine Design’, Schaum’s Series, 2000.

3. Hall and Allen, 'Machine Design', S.Schaum's Series, 2001.
4. 4. Joseph Edward Shighley, 'Mechanical Engineering', McGraw Hill, 2002.
5. Sundarajamoorthy T.V. and Shanmugam, 'Machine Design', Anuradha Agencies Publications, 2000.

18ME2018	DYNAMICS LABORATORY	L T P C 0 0 2 1

Co requisite: Kinematics and Theory of Machines, Design of Machine Elements

Course Objectives: To impart knowledge on

1. The fundamental principles of dynamics.
2. Mechanical systems using a free body diagram.
3. Equations of motion for translational and rotational mechanical systems.

Course Outcome: After completing the course the student will be able to

1. Compute the moment of inertia of rigid bodies.
2. Demonstrate the working principles of gyroscope.
3. Determine balancing mass in the rotating systems.
4. Demonstrate the principles of kinematics and dynamics of machinery.
5. Use the measuring devices for dynamic testing.
6. Study the effect of dynamics on vibrations in single and multi–degree of freedom system.

LIST OF EXPERIMENTS

1. a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
   b) Kinematics of single and double universal joints.
3. a) Determination of Mass moment of inertia of Fly wheel and Axle system.
   b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
   c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
   b) Multi degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies.
   b) Vibration Absorber – Tuned vibration absorber.
9. Vibration of Equivalent Spring mass system – undamped and damped vibration.
10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
11. a) Balancing of rotating masses. (b) Balancing of reciprocating masses.
12. a) Transverse vibration of Free-Free beam – with and without concentrated masses.
    b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
    c) Determination of transmissibility.

18ME2019	MACHINE DRAWING LABORATORY	L T P C 0 0 2 1

Co requisite: Engineering Drawing, Design of Machine Elements

Course Objectives: To impart knowledge on

1. Conventional representation of mechanical parts by symbol, limits, fits and Geometrical tolerances. Representation of surface finish and welding parameters.
2. Sectional views of joints, connecting rod, plummer block, couplings, screw jack, vice and I.C engine parts.
3. Surface modelling and study parts drawings of an assembly.

Course Outcome: After completing the course the student will be able to

1. Investigate proper representation of mechanical parts by symbols and dimension with limits, fits.
2. Apply geometrical tolerances and represent surface finish and welding parameters
3. Draw sectional views and sectional views of Cotter Joints & Knuckle joints, flange couplings
4. Produce sectional and auxiliary views of Cylinder head, Piston, Connecting rod, camshaft and Crankshaft.
5. Interpret parts drawing of machine parts and do assembly of vice, lathe tailstock, Safety valves
6. Apply surface modeling to body of hair drier, car and washing machine etc.

MODULE I – DRAWING STANDARDS AND CONVENTIONS (8 Lecture Hours)

Conventional representation of threaded parts, springs, gear. Abbreviations and symbols for use in technical drawings. Conventions for sectioning and dimensioning.

MODULE II – LIMITS, FITS AND TOLERANCES (8 Lecture Hours)

Limits, fits, tolerances - selection. Maximum material principle. Surface finish - Selection, methods of indicating. Welding symbols, preparation of Joints for welding.

MODULE III – COMPUTER AIDED DRAFTING OF JOINTS AND VALVES (12 Lecture Hours)

Drawings of Cotter Joints & Knuckle joints, flange couplings and. steam relief valves.

MODULE IV – COMPUTER AIDED DRAFTING OF I.C. ENGINE PARTS (12 Lecture Hours)

Cylinder head, Piston, Connecting rod, camshaft and Crankshaft

MODULE V – COMPUTER AIDED ASSEMBLY DRAWINGS (12 Lecture Hours)

Preparation of Assembly drawing and detailed drawing of mechanical devices- plummer block, vice, lathe tailstock and Screw jack .

MODULE VI – COMPUTER AIDED SURFACE MODELING (8 Lecture Hours)

Surface modelling of automobile body and Appliances (electrical and domestic)

Text book:

1. Goplalakrishna, " Machine Drawing", Subash publishers, 2016.
2. Dhawan RK, "A Textbook of Machine Drawing", S Chand, 2008.

Reference books:

1. Bhatt.N.D, Machine drawing", charotar publishing house, Anand, 2003.
2. Siddheshwar , N.P.Kannaiah& V.V.S. Satry " Machine Drawing" , Tata Mcgraw Hill, 1980.
3. Revised IS Codes 10711, 10713, 10714, 9609, 1165, 10712, 10712, 10715, 10716, 10717, 11663, 11668, 10968, 11669, 8043, 8000.
4. Pro/E Wildfire 5 manuals.
5. David Allan Low, "An Introduction to Machine Drawing and Design", Bastian Books. 2008.

18ME2020	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Principle, methods and applications of casting.
2. Working principle and applications of bulk forming and sheet metal.
3. Joining, unconventional machining and powder metallurgy processes.

Course Outcome: After completing the course the student will be able to

1. Select the appropriate casting process to produce complex parts.
2. Develop products with superior mechanical properties using bulk forming processes.
3. Perform various sheet metal operations on metal sheets.

4. Create permanent joints in working assemblies using welding techniques.
5. Suggest appropriate unconventional manufacturing process for the machining of difficult-to-machine materials.
6. Enhance the properties of components using powder metallurgy.

MODULE I – CASTING AND MOULDING (7 Lecture Hours)
Metal casting processes and equipment, casting allowances, special casting techniques, casting defects and remedial measures.

MODULE II – BULK FORMING (7 Lecture Hours)
Plastic deformation and yield criteria; Fundamentals of hot and cold working processes; load estimation for bulk forming and defects (forging, rolling, extrusion, drawing).

MODULE III – SHEET METAL FORMING (8 Lecture Hours)
Sheet metal characteristics; shearing, bending and drawing operations; Formability of sheet metal; Introduction to high energy rate forming (HERF).

MODULE IV – JOINING/FASTENING PROCESSES (7 Lecture Hours)
Physics of welding design considerations in welding, Solid and liquid state joining processes; Special welding techniques; brazing and soldering; defects in welding.

MODULE V – UNCONVENTIONAL MACHINING PROCESSES (8 Lecture Hours)
Abrasive jet machining; Ultrasonic machining; Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire- EDM; Laser Beam Machining, Plasma Arc Machining; Electron Beam Machining.

MODULE VI – POWDER METALLURGY AND MICRO SYSTEMS FABRICATION (8 Lecture Hours)
Powder metallurgy: production of metal powder; particle size, distribution and size; blending; iso-static pressing and other compacting and shaping processes; sintering; Secondary and finishing processes; impregnation; infiltration; applications. Photolithography, Ion Implantation and Diffusion; Oxidation, CVD,PVD, Etching; Overview of Micro Machining; Bulk Micro Machining; Surface Micro Machining; LIGA Process

Text Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, andSystems, 2008.

Reference Books:

1. Degarmo, Black &Kohser, Materials and Processes in Manufacturing, 2006.
2. R.K. Rajput, "A Textbook of Manufacturing Technology", Laxmi Publications, 2016
3. J. Beddoes, M. Bibby, "Principles of Metal Manufacturing Processes", Butterworth-Heinemann, 2000.
4. John Schey, "Introduction to Manufacturing Processes 3rd Edition", McGraw Hill Education, 2012
5. Kaushik Kumar, Divya Zindani, J. Paulo Davim, "Advanced Machining and Manufacturing Processes (Materials Forming, Machining and Tribology)" Springer, 2018

18ME2021	MANUFACTURING LABORATORY` I (METALLURGY, METROLOGY & MECHATRONICS)	L	T	P	C
		0	0	4	2

Co requisite: Manufacturing Processes

Course Objectives: To impart knowledge on
1. Microstructure and performance of materials.
2. The principles of linear and angular measurement.
3. Fundamental systems of fluid power controls.

Course Outcome: After completing the course the student will be able to

1. Prepare samples for metallurgical studies following appropriate metallographic procedure and extract metallographic images.
2. Analyze various phases of Iron Carbon alloy.
3. Demonstrate measurements using linear and angular measuring instruments.
4. Calibrate linear and angular measuring instruments.
5. Assess the optimal components of pneumatic system.
6. Build a logic circuit for industrial problems.

LIST OF EXPERIMENTS

1. Use of Tool Maker's Microscope.
2. Comparator and sine bar.
3. Surface finish measurement equipment.
4. Bore diameter measurement using micrometer and telescopic gauge.
5. Use of Autocollimator.
6. Determination of strength and permeability of foundry sand.
7. Identification of Cast Iron specimen (a) Grey Cast Iron(b) Spheroidal Graphite Iron (c) Malleable Cast Iron.
8. Sieve Analysis.
9. Identification of Heat Treated steels: (a) Annealed (b) Normalized (c) Hardened (d) Tempered steels and Case Hardened Steel.
10. Identification of brasses and bronzes and aluminum.
11. Basic pneumatic logic gate circuits.
12. Pneumatic material handling circuit.

18ME2022	MANUFACTURING TECHNOLOGY	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on

1. The principles and applications of metal cutting.
2. Construction and working principles of lathe, milling, reciprocating machine tools, hole making andgear cutting operations.
3. Non-conventional machining and additive processes in industry & research.

Course Outcome: After completing the course the student will be able to

1. Select the machining processes suitable for machining a component.
2. Generate the process sequences for machining in machine tools to reduce the lead time.
3. Analyze and choose the optimized machining parameters.
4. Select cutting tools for the identified machining sequences.
5. Appraise the abrasive machining process based on the surface finish requirements.
6. Implement the non-conventional machining processes for machining hard materials.

MODULE I – THEORY OF METAL CUTTING (8 Lecture Hours)

Mechanics of chip formation, Types of chip – chip curl and chip-breaker- orthogonal Vs. Oblique cutting – Merchant circle – shear plane angle according to Merchant – Temperature in metal cutting – Tool life and tool wear – cutting tool materials – cutting fluids.

MODULE II – TURNING AND RECIPROCATING MACHINE TOOLS (8 Lecture Hours)

Centre Lathe – Constructional features –specifications – work holding devices – Turning parameters – cutting tools – geometry. Turning operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation capstan and turret lathes. Shaper, planer, slotter.

MODULE III – MILLING, HOLE MAKING AND GEAR CUTTING (9 Lecture Hours)

Milling – types of milling machine, milling cutters, milling operations, Dividing head-simple, compound and angular indexing, Drilling, reaming, boring, tapping, machining time calculations Broaching machines: broach construction – push, pull, surface and continuous broaching machines. Gear cutting: forming, generations, shaping, planning and hobbing.

MODULE IV – ABRASIVE PROCESSES (9 Lecture Hours)

Grinding wheel – designation and selection, types of grinding machines –Cylindrical grinding, surface grinding, centerless grinding, honing, lapping, super finishing, polishing and buffing.

MODULE V – NON-CONVENTIONAL MACHINING PROCESSES (9Lecture Hours)

Need for Unconventional processes – Electrical discharge machining (EDM) – Dielectric fluid – electrode – wire EDM –Electrochemical Machining (ECM) –Electrochemical Grinding (ECG), Ultrasonic Machining (USM) – Abrasive Jet Machining (AJM) – Laser Beam Machining (LBM) – Plasma Arc Machining (PAM).

MODULE VI – ADDITIVE MANUFACTURING (7 Lecture Hours)

3D printing, Rapid prototyping and rapid tooling.

Text Books:

1. P.N Rao "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi,2013.
2. S. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2014.

Reference Books:

1. Roy A. Lindberg, "Process and Materials of Manufacture", PHI / Pearson Education, 4th Edition, 2006.
2. HMT – "Production Technology", Tata McGraw Hill, 2001.
3. S.K. Hajra Choudhray, S.K. Bose, 'Elements of Workshop Technology, Vol. II, Machine Tools', Media Promoters & Publishers (P) Ltd, 2008.
4. Andrew Y. C. Nee, "Handbook of Manufacturing Engineering and Technology" Springer, 2014.
5. Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed, "Manufacturing Technology: Materials, Processes, and Equipment", CRC Press, 2017.

18ME2023	MANUFACTURING LABORATORY II (SPECIAL MACHINES LAB, LATHE SHOP)	L T P C 0 0 2 1

Co requisite: Manufacturing Technology

Course Objectives: To impart knowledge on

1. Types of machine tools.
2. Metal cutting operations.
3. Selection of tools for machining operations.

Course Outcome: After completing the course the student will be able to

1. Demonstrate skills to machine cylindrical components using Lathe.
2. Demonstrate skills to machine V-block, rectangular block and key way using shaping/milling/slotting machine.
3. Demonstrate skills to cut spur gear using gear hobbing machine.
4. Demonstrate skills to do grinding operation in cylindrical grinding machine.
5. Interpret component drawings and select appropriate cutting tools.
6. Compare the dimensions of the components using measuring instruments.

LIST OF EXPERIMENTS

1. Step turning operation using Lathe.
2. Taper turning operation using Lathe.
3. Knurling and countersinking operation using Lathe.
4. Drilling and boring operation using Lathe.
5. External thread cutting operation using Lathe.
6. Tapping operation using Lathe.
7. Machining rectangular block using shaper.

8. Machining V- block using shaper.
9. Machining rectangular block using milling machine.
10. Key way cutting using slotting machine.
11. Cylindrical grinding using cylindrical grinding machine.
12. Spur gear cutting using gear hobbing machine.

Text/Reference Books:

1. Kalpakjian, S., &Schmid, S. R. Manufacturing processes for engineering materials: Pearson Education, 6^{th} Edition 2017.
2. Manufacturing Technology, Vol. 2, PN Rao, TMH. 3^{rd} Edition 2017.

18ME2024	COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
		0	0	2	1

Co requisite: Manufacturing Technology

Course Objectives: To impart knowledge on

1. NC programming for CNC turning and milling operation and execution.
2. Selection of tools for a machining operation.
3. Simulation and verification of machining processes.

Course Outcome: After completing the course the student will be able to

1. Know features and applications of CNC turning and machining centers.
2. Understand the CNC control in modern manufacturing system.
3. Prepare CNC Programming for different mechanical parts using G codes and M codes.
4. Implement the communication procedure for transmitting the CNC part program from an external computer to the control of the CNC machine tool.
5. Generate automated tool paths for a given engineering component.
6. Operate a modern industrial CNC machine tool for actual machining of simple and complex mechanical.

LIST OF EXPERIMENTS

1. Step turning and Taper turning in CNC.
2. Thread cutting in a CNC Turning Centre.
3. Face milling and step milling in Machining Centre.
4. Profile cut using linear and circular interpolation.
5. Pocketing and slotting in CNC.
6. Mirror using Subprogram and drilling using drilling cycles.
7. Spiral cutting in a CNC 4–axis Trainer Mill.

Reference Books:

Lab manual

18ME2025	MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. The properties and applications of various engineering materials.
2. Testing methods and procedures to find the mechanical properties of engineering materials.
3. Construction of phase diagrams and also the importance of iron-iron carbide phase diagram and different heat treatment.

Course Outcome: After completing the course the student will be able to

1. Identify crystal structures of common engineering materials.
2. Understand the principle of various microscopes.
3. Identify the various behaviors of materials and defects.
4. Analyze failures and predict service behavior of materials for various applications.
5. Interpret and determine the right compositions of metals.

6. Select the heat treatment process based on the metals.

MODULE I – CRYSTAL STRUCTURE (7 Lecture Hours)
Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.
MODULE II – MECHANICAL PROPERTY MEASUREMENT (7 Lecture Hours)
Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's Law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.
MODULE III – STATIC FAILURE THEORIES (9 Lecture Hours)
Ductile and brittle failure mechanisms, Tresca, Von-miss, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, S-N curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT).
MODULE IV – PHASE DIAGRAMS (6 Lecture Hours)
Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binaryphase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotecticreactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.
MODULE V – HEAT TREATMENT (7 Lecture Hours)
Annealing, tempering, normalizing and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.
MODULE VI – STEEL, COPPER ALLOYS & OTHERS (9 Lecture Hours)
Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons;grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze andcupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titaniumalloys.

Text Books:
1. V. Raghavan., "Material Science and Engineering", Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
2. Williams D. Callister "Material Science and Engineering" John Wiley and sons inc. 2014.

Reference Books:
1. Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill, "Physical Metallurgy Principles", Cengage Learning, 2013.
2. Raymond A Higgins "Engineering Materials (Applied Physical Metallurgy) English Language book, society, 2003.
3. Khanna O.P., "A text book of Materials Science and Metallurgy" DhanpatRai and Sons Delhi, 2014.
4. Sydney H. Avner, "Introduction to Physical Metallurgy", 2nd edition McGraw Hill Book Company, 2008.
5. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials: Properties and Selection", Pearson Education India, 2016.

18ME2026	BASIC AUTOMOBILE ENGINEERING	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on
1. To impart knowledge on the basic principles of engines used for automobiles and different systems.
2. To impart knowledge on the various transmission and drive line units of automobiles.
3. To broaden the importance of sensors and fuel injection systems.

Course Outcome: After completing the course the student will be able to
1. Identify the importance and functions of vehicle frame.
2. Describe the thermodynamic principles behind the working of petrol and Diesel.
3. Recognize the construction and working principles of SI and CI engines.
4. Express the functions and components of fuel injection and ignition systems.
5. Summarize the functions and components of engine cooling, lubrication and ignition systems.
6. Outline the functions and components of electric and hybrid vehicles.

MODULE I - INTRODUCTION (8 Lecture Hours)
Classification of vehicles, body and load - Layout of an automobile chassis, Function of major components of a vehicle and introduction to their different systems such as Frame, transmission systems - clutch and gear box, differential, braking system, steering and suspension systems.
MODULE II - THERMODYNAMICS (7 Lecture Hours)
Zeroth, First, second and third law of thermodynamics (concept only), Otto cycle, diesel cycle, fuel used properties of fuels, air requirement for complete combustion of fuel.
MODULE III - IC ENGINES (8 Lecture Hours)
Concept of two stroke and four stroke petrol and diesel engines and their applications to automobiles. Various terms, Valves and Actuating mechanisms – Inlet and Exhaust manifolds. Specification of automobile engines.
MODULE IV - ENGINE LUBRICATION AND COOLING SYSTEMS (7 Lecture Hours)
Lubrication of engine components, Lubrication system – wet sump and dry sump, crankcase ventilation, Types of cooling systems – liquid and air cooled, comparison of liquid and air cooled systems.
MODULE V - AUTOMOTIVE FUEL INJECTION & IGNITION SYSTEM (8 Lecture Hours)
Automobile fuel system: Fuel tank, filters, spark plug, ignition systems (Battery and magneto ignition system), Current trends in multi-point fuel injection system (MPFI), Gasoline Direct Injection (GDI), Common Rail Direct Injection (CRDI).
MODULE VI - AUTO INDUSTRY AND FUELS FOR HYBRID VEHICLES (7 Lecture Hours)
History, leading manufacturers, development in automobile industry, trends, new products. Electric and Hybrid vehicles: types, applications. Pollution and environmental aspects – norms.

Text Books:
1. Kirpal Singh," Automobile Engineering" vol1 and vol2. Standard Publishers, 20011.
2. Ganesan. V., "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2012

Reference Books:
1. S.S. Thipse, "IC Engines", Jaico Publications, 2014.
2. Robert Bosch, "Automotive Hand Book", SAE 9th Edition, 2014.
3. Ramalingam K.K., 'Automobile Engineering' SciTech Publications Pvt. Ltd., 2005.
4. Bechhold, "Understanding Automotive Electronics", SAE, 1998.
5. Newton. K, Steeds.W, Garret.T.K. and Butterworth. 'Motor Vehicle', IE, 1989.

18ME2027	FUNDAMENTALS OF THERMAL SCIENCES AND FLUID MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Work and heat interactions, balance of energy between system and its surroundings
2. Application of I law and II law of thermodynamics to various energy conversion devices
3. Application of mass and momentum conservation laws for fluid flows, measurement of velocity and pressure variations in various types of simple flows.

Course Outcome: After completing the course the student will be able to
1. Apply energy balance to systems and control volumes, in situations involving heat and work interactions
2. Evaluate the performance of energy conversion devices
3. Apply gas laws to solve problems related to gas mixtures
4. Determine fluid properties & analyze forces acting on immersed bodies.

5. Mathematically analyze simple flow situations
6. Determine rate of flow and calculate flow losses through pipes.

MODULE I – FUNDAMENTALS OF THERMODYNAMICS (8 Lecture Hours)
System & Control volume; Property, State, Path, Process, thermodynamic cycle, thermodynamic equilibrium, quasi static process, concept of continuum, Temperature, Definition of thermal equilibrium and Zeroth law, Thermodynamic definition of work and heat - Displacement work; Path dependence of work and heat, illustrations for simple processes.

MODULE II – FIRST LAW OF THERMODYNAMICS (7 Lecture Hours)
First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy, First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices;

MODULE III – SECOND LAW OF THERMODYNAMICS (8 Lecture Hours)
Heat engines, Refrigerator and heat pump, Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale ideal gases and ideal gas mixtures.

MODULE IV – FLUID PROPERTIES AND FLUID STATICS (7 Lecture Hours)
Units and dimensions- Definition of fluid, Properties of fluids, mass density, specific volume, specific gravity, viscosity, Newton's law of viscosity, compressibility, Capillarity and surface tension, Fluid Statics: Pascal's law –Measurement of pressure – Manometers.

MODULE V – EQUATIONS OF FLUID FLOW (8 Lecture Hours) Types of flow, Velocity and acceleration, Control volume- application of continuity equation and momentum equation, Incompressible flow, Euler's equation – Bernoulli's equation and its applications.

MODULE VI – FLOW THROUGH CIRCULAR CONDUITS (7 Lecture Hours)
concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Pipes connected in series and parallel, Need for dimensional analysis – methods of dimension analysis. Turbines, air compressors, R & AC, simple numerical only

Text Books:

1. V. L. Streeter, E.B.Wylie and K.W. Bedford., "Fluid Mechanics", Tata McGraw-Hill, 9th edition, 2010.
2. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013

Reference Books:

1. R. K. Bansal., "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, Revised Ninth Edition, 2017.
2. Frank M White., "Fluid Mechanics", Tata McGraw Hill, Eighth Edition, 2016.
3. Yunus A Cengel and John M Cimbala., "Fluid Mechanics: Fundamentals and applications", Tata McGraw-Hill, Third Edition 2014.
4. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics", John Wiley and Sons, 1999.
5. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014.

18ME2028	HYDRAULICS AND PNEUMATICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Basic principles of hydraulic and pneumatic systems.
2. Actuation modes and control systems.
3. Programming skills in PLC.

Course Outcome: After completing the course the student will be able to
1. Understand the salient features and constructional details of both hydraulic and Pneumatic systems

2. Understand the various types of actuation modes and control system design procedures for design of circuits and to control them.
3. Understand the concepts of servo and proportional valves.
4. Analyze various application circuits
5. Apply the above outcomes to design pneumatic and hydraulic circuits.
6. Build a PLC programme for a particular application.

MODULE I – INTRODUCTION (5 Lecture Hours)

Introduction to fluid power, properties - hydraulic fluids, air. Selection of hydraulic fluids, comparison between hydraulics and pneumatics.

MODULE II – ELEMENTS OF HYDRAULIC SYSTEMS (7 Lecture Hours)

Pumps - types, characteristics. Valves for control of direction, flow and pressure - types, typical construction details, Cartridge valves – basic concepts. Actuators – types and constructional details.

MODULE III – HYDRAULIC SYSTEM DESIGN AND APPLICATIONS (9 Lecture Hours)

Power pack–elements, design. Pipes- material, pipe fittings. seals and packing. Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes. Heat generation in hydraulic system Deceleration circuit, regenerative circuits, feed circuits, sequencing circuits, synchronizing circuits, fail-safe circuits. (6)

MODULE IV – PNEUMATIC CONTROL (4 Lecture Hours)

Components, constructional details, filter, lubricator, regulator, constructional features, types of actuators, control valves for direction, pressure and flow, air motors, air hydraulic equipments.

MODULE V – PNEUMATIC CONTROL SYSTEM DESIGN (8 Lecture Hours)

General approach to control system design, symbols and drawings, schematic layout, travel step diagram, circuit, control modes, program control, sequence control, cascade method, Karnaugh-Veitch mapping.

MODULE VI – ADVANCED TOPICS IN HYDRAULICS AND PNEUMATICS (9 Lecture Hours)

Electro pneumatics, ladder diagram. Servo and Proportional valves - types, operation, application. Hydro-Mechanical servo systems. PLC programming for specific hydraulic and pneumatic applications.

Text Books:

1. Anthony Esposito, “Fluid Power with Application”, Pearson Education (Singapore) Pvt. Ltd, Delhi, India, 2003.
2. Srinivasan R, “Hydraulic and Pneumatic Controls”, McGraw –Hill education (India) Pvt. Ltd, 2010.

Reference Books:

1. Andrew Parr, “Hydraulics and Pneumatics: A Technician's and Engineer's Guide 3rd Edition”, Butterworth-Heinemann, 2011.
2. Majumdar S R, “Oil Hydraulic Systems: Principles and Maintenance”, Tata McGraw- Hill., New Delhi, 2003.
2. Majumda S R, “Pneumatic Systems: Principles and Maintenance”, Tata McGraw- Hill., New Delhi, 1996.
3. Werner Deppert and Kurt Stoll, “Pneumatic Controls: An Introduction to Principles“, Vogel-Druck Wurzburg, Germany, 1975.
4. Peter Rohner, “Fluid Power Logic Circuit Design – Analysis, Design, Method and Worked Examples”, The Macmillan Press Ltd., UK, 1979.

18ME2029	HYDRAULICS AND PNEUMATICS LABORATORY	L T P C 0 0 2 1

Course Objectives:
To impart knowledge on
1. Basic principles of hydraulic and pneumatic systems.
2. Actuation modes and control systems.
3. Simulation software for design of hydraulic and pneumatic circuits.

Course Outcome:
After completing the course the student will be able to
1. Understand constructional details of both hydraulic and Pneumatic systems.
2. Design and Simulation of Pneumatic and Hydraulic circuits using Fluid SIM software
3. Testing of simple pneumatic and hydraulic circuits using single and multiple actuators
4. Testing of electro pneumatic multiple actuator circuits
5. Testing of hydraulic regenerative circuit
6. Testing of electro hydraulic multiple actuator circuits

LIST OF EXPERIMENTS
1. Design of simple pneumatic and hydraulic circuits using basic components.
2. Construction and testing of multiple pneumatic actuator circuit using Cascade method.
3. Co-ordinated motion of actuators using electro – pneumatic elements.
4. Construction and testing of a hydraulic actuator regenerative circuit.
5. Co-ordinated motion of actuators using electro – hydraulic elements
6. Design and Simulation of hydraulic and pneumatic circuits using Fluid SIM

18ME2030	MECHANICS AND ENGINEERING DESIGN LAB	L T P C 0 0 2 1

Course Objectives: To impart knowledge on
1. The fundamental principles of dynamics.
2. Equations of motion for translational and rotational mechanical systems.
3. Design and assembly of engineering components using modelling software.

Course Outcome: After completing the course the student will be able to
1. Compute the moment of inertia of rigid bodies.
2. Demonstrate the working principles of gyroscope.
3. Determine balancing mass in the rotating systems.
4. Demonstrate the principles of kinematics and dynamics of machinery.
5. Design components to meet desired needs within realistic constraints and sustainability.
6. Extract production drawing from solid model and assembly of components.

LIST OF EXPERIMENTS
1. Study of the effect of link length parameters on the output of a Four Bar Mechanism and Slider Crank Mechanism.
2. Determination of moment of inertia of connecting rod.
3. Static and dynamic balancing using rotating unbalanced test rig.
4. Preparation of cam displacement curve and determination of jump speed of the cam.
5. Study on epicyclic gear train and worm wheel reducers.
6. Modeling of engineering components using modeling software.
7. Extraction of Production drawing from solid model.
8. Assembly of engineering components using modeling software.

18ME2031	KINEMATICS AND DYNAMICS OF MACHINERY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Displacement, velocity and acceleration at any point in a rigid link of a mechanism
2. Cam profiles to give required follower motion and gear combinations to meet the transmission requirements.
3. Different types of gears and gear trains

Course Outcome: After completing the course the student will be able to

1. Understand the fundamental concepts of kinematic links, kinematic pairs and kinematic chains
2. Apply Gashoff's law for four bar, slider crank and common mechanisms
3. Calculate displacement, velocity and acceleration in simple mechanisms.
4. Analysis of planar mechanisms, force , moment and balancing of kinematic pairs
5. Design and calculate the velocity and motion of cams
6. Understand the fundamental concepts of various transmission devices

MODULE I – BASICS OF MECHANISMS (8 Lecture Hours)

Definitions: Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degree of freedom – Mobility – Kutzbach criterian - Grashoff's law - Kinematic inversions: Four bar and slider crank mechanism - Mechanical advantage - Transmission angle - Description of common mechanisms, applications of mechanisms.

MODULE II – KINEMATIC ANALYSIS (7 Lecture Hours)

Displacement, velocity and acceleration analysis in simple mechanisms using graphical and analytical methods.

MODULE III – DESIGN/SYNTHESIS OF PLANAR MECHANISMS (8 Lecture Hours)

Number and dimensional synthesis – two and three positions (relative motion) synthesis of slider crank and four bar mechanisms. Design of simple planar linkages, Computer aided synthesis and analyses of simple planar mechanisms.

MODULE IV – FORCE ANALYSIS OF LINKAGES (7 Lecture Hours)

Free body diagrams, Inertia forces and moments, constraint forces, effect of friction and gravity. Static and dynamic force analyses of simple planar mechanisms. Balancing of planar linkages: static and dynamic balancing of planar mechanisms.

MODULE V – CAMS (8 Lecture Hours)

Introduction to Cams- Classifications, law of cam design, cam function / follower motion schemes: uniform velocity, parabolic, simple harmonic motion, cycloid motion paths and introduction to high speed cams. Layout of plate cam profiles for different types of followers - knife-edged and roller.

MODULE VI – GEARS (7 Lecture Hours)

Spur gear terminology and definitions. Fundamental law of toothed gearing and tooth forms. Helical, bevel, worm, and rack and pinion gears (basics only). Gear trains, epicyclic gear trains, differentials, automotive transmission gear trains, Harmonic and special gear drives.

Text books:

1. Rattan S S, "Theory of Machines", Tata McGraw -Hill Publishers, New Delhi, 2009.
2. Norton L, "Kinematics and Dynamics of Machinery", 5th Edition, TMH, 2012.

Reference Books

1. Shigley J E and Uicker J J, "Theory of Machines and Mechanisms", McGraw -Hill Inc., New Delhi, 2003. 3. Bevan.T, "Theory of Machines", CBS Publishers and Distributors, New Delhi, 2002.
2. Myszka, DH,"Machines and Mechanisms: Applied kinematic analysis", 4th Edition, 2012.
3. Ghosh and Mallick.A K, "Theory of Machines and Mechanisms", Affiliated East West Private Limited New Delhi, 1988.
4. R S Khurmi, "Theory Of Machines", S Chand, 2005.
5. Wilson, "Kinematics and Dynamics of Machinery 3rd Edition", Pearson, 2008.

18ME2032	MECHANICS OF SOLIDS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Nature of stresses developed in simple geometries
2. Elastic deformation occurring in various simple geometries for different types of loading.
3. Stresses action on shafts, springs and cylinders

Course Outcome: After completing the course the student will be able to

1. Describe the concepts of stress-strain relationships for homogenous, isotropic materials.
2. Calculate stresses and strains in members subjected to axial structural loads and thermal loads.
3. Determine the volumetric strain of the components and also derive the relationship between the elastic constants.
4. Explain the fundamentals of beams and also calculate the shear force and bending moment of beams.
5. Calculate the stresses and strains in members subject to flexural and torsional loadings.
6. Determine and illustrate principal stresses, maximum shearing stress, and the stresses acting on a structural member.

MODULE I – STRESSES AND STRAINS (8 Lecture Hours)

Stress and strain due to axial force, elastic limit, Hooke's law-factor of safety - stepped bars, uniformly varying sections, stresses in composite bar due to axial force and temperature.

MODULE II – CHANGES IN DIMENSIONS AND VOLUME (7 Lecture Hours)

Lateral strain - Poisson's ratio, volumetric strain, changes in dimensions and volume, shear stress, shear strain, relationship between elastic constants.

MODULE III – BENDING MOMENT AND SHEAR FORCE (8 Lecture Hours)

Relationship between load, shear force and bending moment - shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads, concentrated moments, maximum bending moment and point of contra flexure.

MODULE IV – FLEXURE IN BEAMS (7 Lecture Hours)

Theory of simple bending and assumptions - derivation of equation, section modulus, normal stresses due to flexure.

MODULE V – TORSION (8 Lecture Hours)

Theory of torsion and assumptions-derivation of the equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft, close coiled helical spring with axial load.

MODULE VI – PRINCIPAL STRESSES AND STRAINS (Two dimensional only) (7 Lecture Hours)

State of stress at a point - normal and tangential stresses on a given plane, principal stresses and their planes, plane of maximum shear stress, analytical method, Mohr's circle method, application to simple problems.

Text books:

1. Punmia B C., Ashok Kumar Jain and Arun Kumar Jain, "Mechanics of materials", Laxmi Publications, New Delhi, 2005.
2. Egor P Popov, “Engineering Mechanics of Solids”, Prentice Hall of India Learning Ltd., New Delhi, 2010.

Reference books:

1. Hibbeler RC., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007.
2. Ramamrutham S and Narayan R., "Strength of Materials", Dhanpat Rai and Sons, New Delhi, 2008.
3. Crandall, S. H., Dahl, N. C. and Lardner, T. J, An Introduction of the Mechanics of Solids, 3rd ed., Tata McGraw Hill, 2012.
4. Shames, I. H, Engineering Mechanics: Statics and Dynamics, 4th ed., Prentice Hall of India, 2004.
5. Meriam, J. L. and Kraige, L. G, Engineering Mechanics Statics, 5h ed., John Wiley and Sons, 2004.

18ME2073	ENGINEERING DESIGN LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on

1. Preparing drawings for various mechanical components using a commercially available 3D modeling software package
2. Using Finite Element Analysis software to solve various field problems in mechanical engineering
3. Optimizing and verifying the design of various machine elements

Course Outcomes: After completing the course the student will be able to

1. get familiarized with the computer applications in design
2. prepare drawings for various mechanical components.
3. model and analyze various physical problems
4. select appropriate elements and give boundary conditions
5. solve structural, thermal, modal and dynamics problems.
6. conduct coupled structural and thermal analysis

List of Experiments:

1. Assembly of knuckle joint
2. Assembly of plummer block
3. Structural analysis of 2D Truss
4. Analysis of Bicycle frame
5. 2D static analysis of bracket
6. Thermal Analysis of 2D chimney
7. 3D Fin Analysis
8. 2-D Transient mixed boundary
9. Design optimization
10. Velocity Analysis of fluid flow in a channel
11. Modal analysis of cantilever beam
12. Harmonic analysis of cantilever beam
13. Coupled structural and thermal analysis
14. Magnetic Analysis of solenoid actuator

18ME2074	OPERATIONS RESEARCH	L T P 3 0 0	C 3

Course Objectives: To impart knowledge on

1. Linear Programming techniques.
2. Job sequencing problems, Transportation and assignment problems.
3. Inventory models, PERT/CPM and Queuing theory.

Course Outcome: After completing the course the student will be able to

1. Correlate this subject knowledge with the engineering problems.
2. Construct flexible appropriate mathematical model to represent physical problem.
3. Schedule their engineering projects by using network analysis.
4. Analyze the transportation problem and optimize the resources and output.
5. Apply knowledge in solving their engineering queuing problems.
6. Develop their skills in decision making analysis by allocation of resources.

MODULE I - LINEAR PROGRAMMING PROBLEM (9 Lecture Hours)

Formulation of LPP – Graphical Method – Simplex Method –Artificial variable technique and two phase simplex method. Duality – Dual and simplex method – Dual Simplex Method – Sequencing: Job sequencing – single and multiple jobs through two machines and three machines.

MODULE II - TRANSPORTATION PROBLEM (9 Lecture Hours)

Transportation Model, finding initial basic feasible solutions using least cost method, Vogells's approximation method and North–West corner method, moving towards optimality through MODI method, Resolving degeneracy in transportation.

MODULE III - ASSIGNMENT PROBLEM (8 Lecture Hours)

Solution of an assignment problem, Multiple Solution, Hungarian Algorithm, Maximization in Assignment Model, Impossible Assignment.

MODULE IV - NETWORK ANALYSIS (9 Lecture Hours)

Network diagram – probability of achieving completion date – crash time –cost analysis – PERT & CPM-Forward and backward scheduling.

MODULE V – INVENTORY MODELS (9 Lecture Hours)

Economic order quantity models-purchase models with and without shortage, production models with and without shortage-ABC analysis-Two Bin system.

MODULE VI – QUEUING MODELS (9 Lecture Hours)

Structure of queuing models-Attributes and components of queuing models-application of queuing models- Kendall's Notation -Single service channel with finite and infinite queue size - Single service channel with finite and infinite population size.

Text Books:

1. S. Bhaskar, "Operations Research", Anuradha Agencies, Chennai 2013.
2. Natarajan A.M., Balasubramani P., Thamilarasi A., "Operations Research", Pearson Education, 1st Edition, 2014.

Reference Books:

1. HamdyTaha A., "Operations Research", 9th Edition Prentice – Hall of India Private Limited, New Delhi, 2014.
2. KantiSwarup, Manmohan, Gupta P.K., "Operations Research" Sultan Chand & Sons., 14th Edition 2014.
3. Srinivasan G., "Operations Research 3rd Edition", Prentice – Hall of India Private Limited, New Delhi, 2017.
4. Winston, "Operations Research, Applications and Algorithms" – Cengage Learning, 4th Edition, 2004.
5. S. Pannerselvam, "Operations Research 2nd Edition", Prentice – Hall of India Private Limited, New Delhi, 2006.

18ME2075	TECHNICAL APTITUDE	L T P C 1 0 0 1

Course Objectives: To impart knowledge on

1. To learn the basics of mechanical engineering subjects
2. To analyze various concepts of the subjects
3. To have a conceptual knowledge on the overall subjects

Course Outcome: After completing the course the student will be able to

1. Prepare for Aptitude Tests.
2. Simplify the acquired knowledge for clearing competitive exams.
3. Solve technical problems.
4. Use the techniques and skills for engineering practices.
5. Identify, formulate and solve engineering problems.
6. Function on multidisciplinary areas.

MODULE I – APPLIED MECHANICS (2 Lecture Hours)

Free-body diagrams and equilibrium - trusses and frames - virtual work - kinematics and dynamics of particles and of rigid bodies in plane motion - impulse and momentum (linear and angular) and energy formulations - collisions.

Module II – MECHANICS OF MATERIALS (2 Lecture Hours)

Stress and strain - elastic constants - Poisson's ratio - Mohr's circle for plane stress and plane strain - thin cylinders - shear force and bending moment diagrams - bending and shear stresses - deflection of beams - torsion of circular shafts - Euler's theory of columns - energy methods - thermal stresses - strain gauges and rosettes - testing of materials with universal testing machine - testing of hardness and impact strength.

MODULE III – THERMODYNAMICS, REFRIGERATION AND AIR-CONDITIONING (3 Lecture Hours)

Thermodynamic systems and processes - properties of pure substances - behavior of ideal and real gases - Zeroth and first laws of thermodynamics - calculation of work and heat in various processes - second law of thermodynamics - thermodynamic property charts and tables - availability and irreversibility - thermodynamic relations -Vapour and gas refrigeration and heat pump cycles - properties of moist air - Psychrometric chart, basic psychrometric processes.

MODULE IV – FLUID MECHANICS, TURBOMACHINERY AND I.C. ENGINES (3 Lecture Hours)

Fluid properties - fluid statics – Manometry – buoyancy - forces on submerged bodies - stability of floating bodies & control - volume analysis of mass - momentum and energy - fluid acceleration - differential equations of continuity and momentum - Bernoulli's equation - dimensional analysis - viscous flow of incompressible fluids - boundary layer - elementary turbulent flow - flow through pipes - head losses in pipes - bends and fittings - Impulse and reaction principles - velocity diagrams - Pelton-wheel - Francis and Kaplan turbines - Air-standard Otto - Diesel and dual cycles.

MODULE V – MATERIALS, METROLOGY AND INSPECTION (2 Lecture Hours)

Structure and properties of engineering materials - phase diagrams - heat treatment - stress-strain diagrams for engineering materials - Limits, fits and tolerances - linear and angular measurements – Comparators - Gauge design – Interferometry - form and finish measurement - alignment and testing methods - tolerance analysis in manufacturing and assembly.

MODULE VI – CIM AND INDUSTRIAL ENGINEERING (3 Lecture Hours)

Basic concepts of CAD/CAM and their integration tools - Forecasting models - aggregate production planning – scheduling - materials requirement planning - Deterministic models - safety stock inventory control systems - Operations Research - Linear programming - simplex method – transportation assignment - network flow models - simple queuing models - PERT and CPM.

Text Books:

1. IES Master Team, "GATE 2018 - Mechanical Engineering (31 Years Solution)", IES Master Publications, 2017.
2. B.Singh, "GATE 2018 Mechanical Engineering", Made Easy, 2017.

Reference Books:

1. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, "Mechanics of Materials 5th Edition", Tata McGraw Hill Publishing Co. Ltd., New Delhi 2012.
2. A Textbook of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications, 2011.
3. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
4. Williams D. Callister "Material Science and Engineering" John Wiley and sons Inc. 2014.
5. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems 6th Edition", John Wiley & Sons Inc, 2015.

18ME2076	THERMODYNAMICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. To learn about work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about application of I law and II law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.

Course Outcome: After completing the course the student will be able to

1. Understand the basic concepts in thermodynamics and its application in different fields.

2. Apply energy balance to systems and control volumes, in situations involving heat and work interactions.
3. Evaluate the performance of energy conversion devices.
4. Differentiate between high grade and low grade energies.
5. Apply gas laws to solve problems related to gas mixtures.
6. Evaluate changes in thermodynamic properties of substances.

MODULE I – FUNDAMENTALS (7 Lecture Hours)
Fundamentals - System and Control volume; Property, State and Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

MODULE II – FIRST LAW OF THERMODYNAMICS (7 Lecture Hours)
Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

MODULE III – FIRST LAW FOR FLOW PROCESSES (8 Lecture Hours)
First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

MODULE IV – SECOND LAW OF THERMODYNAMICS (7 Lecture Hours)
Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

MODULE V – ENTROPY AND SECOND LAW ANALYSIS (9 Lecture Hours)
Clausius inequality; Definitiojn of entropy S; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

MODULE VI – PROPERTIES OF PURE SUBSTANCE (8 Lecture Hours)
Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states and determination of properties, Mollier's chart. Basic Rankine cycle.

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013
2. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014

Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen G. J.,"Fundamentals of Thermodynamics 7th Edition", John Wiley and Sons, 2008.
2. Jones, J. B. and Duggan, R. E., Engineering Thermodynamics, Prentice-Hall of India, 1996.
3. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics, 8th Edition" ,John Wiley and Sons, 2014.
4. J.P. Holman, "Thermodynamics", 4thEdition, McGraw Hill, 2002
5. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.

18ME2077	APPLIED THERMODYNAMICS	L T P C 3 0 0 3

Prerequisite: Thermodynamics

Course Objectives: To impart knowledge on
1. Various practical power cycles and heat pump cycles.
2. Analysis of energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
3. High speed compressible flow phenomena and refrigeration and air conditioning

Course Outcome: After completing the course the student will be able to
1. Recognize the significance of I law for reacting systems and heating value of fuels.
2. Carry out analysis of various gas and vapour power cycles.
3. Conduct analysis of steam nozzles and turbines.
4. Analyze compressible flow phenomena.
5. Evaluate performance of reciprocating compressors.
6. Apply principles of refrigeration and air conditioning for analysis and performance evaluation.

MODULE I - COMBUSTION FUNDAMENTALS (8 Lecture Hours)
Introduction to solid, liquid and gaseous fuels– Stoichiometry. A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. combustion efficiency. Chemical equilibrium concepts.

MODULE II - VAPOUR AND AIR-STANDARD CYCLES (12 Lecture Hours)
Vapor power cycles - Rankine cycle with superheat, reheat and regeneration, Super-critical and ultra-super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Principle of combined gas and vapor power cycles.

MODULE III - STEAM NOZZLES AND TURBINES (12 Lecture Hours)
Flow of steam through nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and Reaction principles, compounding, Determination of work done and efficiency using velocity diagrams.

MODULE IV - COMPRESSIBLE FLOWS (10 Lecture Hours)
Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow.

MODULE V - AIR COMPRESSORS (9 Lecture Hours)
Reciprocating compressors, Work input representation on p-v diagram, Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

MODULE VI - PSYCHROMETRY, REFRIGERATION AND AIRCONDITIONING (9 Lecture Hours)
Vapor compression refrigeration cycle, super heat, sub cooling – Performance calculations - refrigerants and their properties, Working principle and description of vapour absorption systems- Ammonia – Water, Lithium bromide – water systems. Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point

Text Books:

1. P.K. Nag, “Engineering Thermodynamics”, Tata McGraw-Hill, 2013.
2. YunusCengel, “Thermodynamics”, Tata McGraw-Hill, 2014.

Reference Books:

1. J.P. Holman, “Thermodynamics”, 4th Edition, McGraw Hill, 2002.

2. T. Roy Choudhury, “Basic Engineering Thermodynamics”, Tata McGraw-Hill, 2000.
3. Vanwylen and Sontag, “Classical Thermodynamics”, Wiley Eastern, 1999.
4. R.K. Rajput, “A Textbook of Engineering Thermodynamics”, Laxmi Publications, 2016.
5. J. P. O'Connell and J. M. Haile, “Thermodynamics: Fundamentals for Applications,” Cambridge university press, 2005.

18ME2078	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

Co requisite: Thermodynamics

Course Objectives: To impart knowledge on
1. The performance evaluation of refrigeration, air conditioning systems and heat pumps
2. Performance evaluation of blower and compressor
3. Performance analysis of steam turbine

Course Outcome: After completing the course the student will be able to
1. Evaluate the performance of vapor compression refrigeration cycle
2. Evaluate performance of heat pump
3. Determine COP of air conditioning cycle
4. Evaluate performance of air blower
5. Evaluate performance of reciprocating air compressor
6. Evaluate performance of steam turbine

LIST OF EXPERIMENTS
1. Determination of coefficient of performance in a vapour compression refrigeration cycle
2. Determination of coefficient of performance in a heat pump apparatus
3. Determination of coefficient of performance in air–conditioning cycle
4. Determination of performance parameters on air blower
5. Determination of performance parameters on two stage reciprocating air compressor
6. Performance test and study on the steam turbine apparatus

Reference Book

Lab Manual

18ME2079	FLUID MECHANICS AND FLUID MACHINES	L	T	P	C
		3	1	0	4

Course Objectives: To impart knowledge on
1. Fluid statics, kinematics and dynamics. Measurement of pressure, computations of hydrostatic forces on structural components and the concepts of Buoyancy.
2. Analysis of engineering problems involving fluids – such as those dealing with pipe flow, open channel flow, jets, turbines and pumps.
3. Various concepts in hydraulics, hydraulic machinery and hydrology.

Course Outcome: After completing the course the student will be able to
1. Apply principles of fluid statics, kinematics and dynamics.
2. Describe the terminology in fluid mechanics
3. Contrast the different types of fluid flow
4. Apply the continuity, momentum and energy principles
5. Apply dimensional analysis.
6. Examine the characteristics of a boundary layer.

MODULE I – BASIC CONCEPTS AND DEFINITION (7 Lecture Hours)

Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.

MODULE II – FLUID STATICS (7 Lecture Hours)

Fluid Pressure: Pressure at a point, Pascals law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer, Micro manometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

MODULE III – FLUID KINEMATICS (7 Lecture Hours)

Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one, two and three dimensional flows; Stream line, path line, streak line and stream tube; stream function, velocity potential function. One-, two- and three -dimensional continuity equations in Cartesian coordinates.

MODULE IV – FLUID DYNAMICS (7 Lecture Hours)

Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation :Venturimeter, orifice meter and pitot tube.

MODULE V - DIMENSIONAL ANALYSIS (7 Lecture Hours)

Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Dimensional Analysis and Dynamic Similitude - Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number; Buckingham's π-Theorem.

MODULE VI - BOUNDARY LAYER THEORY (10 Lecture Hours)

Flat plate, conduits, curved solid bodies, universal velocity profile, and momentum eddy concept – simple applications. Modern trends in application of computation to Boundary layer flows.

Text Books:

1. A Textbook of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications, 2011
2. Frank M White., "Fluid Mechanics", Tata McGraw Hill, Eighth Edition, 2016.

Reference Books:

1. C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, "Fluid Mechanics and Machinery," Oxford University Press, 2010.
2. P M Modi and S M Seth, "Hydraulics and Fluid Mechanics 21st Edition", Standard Book House, 2018.
3. K. Subramanya, "Theory and Applications of Fluid Mechanics",Tata McGraw Hill, 2003.
4. R.L. Daugherty, J.B. Franzini and E.J. Finnemore, "Fluid Mechanics with Engineering Applications", International Student Edition, McGraw Hill.
5. Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, ninth edition, 2016.

18MR2001	METROLOGY AND MEASUREMENT SYSTEMS	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on

1. Science of measurement and measuring machines commonly used.
2. Limits, fits and tolerances, geometric dimensioning aspects
3. Methods of acceptance test for conventional machine tools.

Course Outcome: After completing the course the student will be able to

1. Use different measuring instruments in industries.
2. Utilize geometrical dimensioning and Tolerancing symbols and apply them in inspection and testing process.
3. Apply the concepts of laser metrology in quality control.
4. Examine the surface roughness of work pieces from various production processes.

5. Choose the modern manufacturing methods using advanced metrology systems.
6. Recommend calibration standards towards measuring instruments.

MODULE I – INTRODUCTION TO MECHANICAL MEASUREMENTS (8 Lecture Hours)
Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance. Precision and Accuracy.
MODULE II – GEAR MEASURING MACHINES (8 Lecture Hours)
Study of Measuring Machines, gear tooth measurement- measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions.
MODULE III – ELECTRON AND LASER MICROSCOPY (7 Lecture Hours)
Laser metrology and microscopy: Laser Metrology - Vision systems- Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications.
MODULE IV – CALIBRATION AND SURFACE ROUGHNESS MEASUREMENT (7 Lecture Hours)
Acceptance tests for machine tools and surface finish measurements, calibration of machine tools, introduction to ball bar measurement, Measurement of surface roughness.
MODULE V – GEOMETRIC DIMENSIONING AND TOLERANCING (8 Lecture Hours)
Introduction to Tolerancing and Dimensioning: Introduction; Indian Standard System of Limits and Fits (IS :919-2709) ; Designation of Holes ,Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T, Datum feature, Material Conditions.
MODULE VI – METROLOGY FOR QUALITY (8 Lecture Hours)
Tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.(7 hrs)

Text Books:
1. Ernest O Doeblin, "Measurement systems", McGraw Hill Publishers, 2003.
2. R. K . Jain, "Engineering Metrology", Khanna Publishers, New Delhi, 2009.

Reference books:
1. Geometric Dimensioning` and Tolerance for Mechanical Design,"Gene R. Cogorno, McGraw Hill, 2004
2. I.C Gupta, "Engineering Metrology", DanpatRai Publications, 2004.
3. Beckwith Thomas G, "Mechanical Measurements", Pearson Education, 2008.
4. M.Mahajan,"A Text Book of Metrology", DhanpatRai&Co. 2010
5. The Metrology Handbook, Jay L. Bucher, Amer Society for Quality, 2004.

18MR2002	FLUID POWER CONTROL AND AUTOMATION LABORATORY	L	T	P	C
		0	0	2	1

Course Objectives: To impart knowledge on
1. Application of fluid power symbols
2. Designing a suitable hydraulic or pneumatic circuits
3. Automating an industrial application.

Course Outcome: After completing the course the student will be able to
1. Recognize the standard symbols used in fluid power circuits.
2. Design and simulation of pneumatic and hydraulic circuits using fluid sim software
3. Testing of electro pneumatic and electro hydraulic multiple actuator circuits
4. Construct the hydraulic circuits for an industrial application.
5. Build a pneumatic circuit and apply them to real life problems.
6. Design and develop a plc controlled pneumatic circuit for industrial application.

LIST OF EXPERIMENTS:
1. Study of standard fluid power symbols.
2. Development of basic pneumatic logic Circuits.
3. Design of pneumatic speed control circuits.
4. Application of time delay valve and pressure Sequence Valves in a pneumatic circuit.

5. Design of pneumatic circuit for material handling system circuit using Cascade method.
6. Design of electro–pneumatic circuit by using relay, limit switch and solenoids.
7. Design of Electro–pneumatic circuit for cascade system of sequence A+B+C+A–B–C–.
8. Construct hydraulic speed control circuits and actuator regenerative circuit.
9. Create electro–hydraulic circuit for continuous reciprocation of DAC using limit switches.
10. Provide solution for an electro–hydraulic circuit using proximity sensors.
11. Design and develop PLC controlled pneumatic logic circuits.
12. Simulation of PLC controlled pneumatic circuit for material handling unit.

18MR2003	DESIGN OF MECHATRONICS SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Structure of microprocessors and their applications in mechanical devices
2. Principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
3. Micro-sensors and their applications in various fields

Course Outcome: After completing the course the student will be able to
1. Get an overview of mechatronics applications
2. Demonstrate knowledge of electrical circuits and logic design.
3. Implement engineering solutions and techniques to solve design problems.
4. Design mechatronic components and systems.
5. Use of micro-sensors and microprocessors.
6. Develop PLC programs for a given task.

MODULE I – INTRODUCTION (8 Lecture Hours)
Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.
MODULE II – SENSORS AND TRANSDUCERS (7 Lecture Hours)
Classification, Development in Transducer technology, Optoelectronics- Shaft encoders, CD Sensors, Vision System.
MODULE III – DRIVES AND ACTUATORS (8 Lecture Hours)
Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.
MODULE IV – SMART MATERIALS (7 Lecture Hours)
Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation.
MODULE V –MICROMECHATRONIC SYSTEMS (8 Lecture Hours)
Micro sensors, Micro actuators. Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.
MODULE VI -PROGRAMMABLE LOGIC CONTROLLER (7 Lecture Hours)
Introduction – Architecture – Input / Output Processing – LD Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

Text Books:
1. William Bolton, “Mechatronics: A Multidisciplinary Approach”, Pearson Education, 2012.
2. Devdas Shetty & Richard Kolk “Mechatronics System Design”, 3rd edition. PWS Publishing, 2009.

Reference Books:
1. R.K.Rajput, “A Textbook of Mechatronics”, S. Chand & Company Private Limited, 2014.
2. William Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, Prentice Hall, 2015

3. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2015.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Alciatore David G & Histand Michael B, “Introduction to Mechatronics and Measurement systems”, 4th edition, Tata McGraw Hill, 2006.

18MR2004	METALLURGY LABORATORY	L 0	T 0	P 2	C 1

Course Objectives: To impart knowledge on
1. Preparation of samples for metallurgical studies
2. Characterizing metal samples to understand microstructures
3. Basic knowledge on foundry sand and their properties

Course Outcome: After completing the course the student will be able to
1. Manipulate with the working of a metallurgical microscope
2. Interpret the strength properties of foundry sand
3. Evaluate the permeability of foundry sand
4. Understand procedures for preparing samples for metallurgical studies
5. Identify various types of steels based on their microstructure
6. Differentiate metal samples that are heat treated based on the microstructure

LIST OF EXPERIMENTS
1. Study and use of metallurgical microscope
2. Measurement of hardness
3. Determination of compression strength and tensile strength
4. Examination of microstructure under Optical microscope.
5. Measurement of grain size using Optical microscope.
6. Electrical Conductivity measurement

18MR2005	CAD/CAM LABORATORY	L 0	T 0	P 2	C 1

Course Objectives: To impart knowledge on
1. Usage of computers and modeling software in design and manufacturing.
2. Visualization of objects in three dimensions and producing orthographic views, sectional views and auxiliary views of it.
3. Writing codes for CNC,VMC and turning centres to produce components.

Course Outcome: After completing the course the student will be able to
1. Model the components using the commands such as extrude, revolve, fillet, hole pattern.
2. Use the commands rib, chamfer, draft and 3D sketch to modify the parts
3. Create an assembly model of knuckle joint and screw jack and convert them into orthographic views.
4. Write CNC codes for linear, circular interpolation step turning ball turning and external threading.
5. Write CNC codes for creating holes on components using CNC drilling machine.
6. Write CNC program for creating square pockets using vertical milling centre.

LIST OF EXPERIMENTS

1. 3D Modelling with Extrude, Round (Fillet) and Mirror Commands
2. 3D Modelling With Revolve, Hole Pattern Commands
3. 3D Modelling With Rib, Chamfer, Draft and 3D sketching Commands
4. Modelling, Assembly and Drafting of Knuckle Joint

5. Modelling, Assembly and Drafting of Screw Jack
6. Advanced modelling commands-Sweep and Blend (Loft)
7. Study of CNC XL Mill Trainer and CNC XL Turn trainer
8. Profile cut using linear and circular interpolation
9. Drilling in a CNC drilling machine.
10. Square pocketing and Drilling in a VMC/CNC drilling machine
11. Step turning and external thread cutting in a CNC lathe
12. Ball tuning in a CNC turning Centre

18ME3001	THERMODYNAMICS AND COMBUSTION	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Combustion principles and chemical kinetics.
2. Combustion in SI and CI engines.
3. Combustion in gas turbine and pollution aspects.

Course Outcomes: After completing the course the student will be able to
1. Compute air requirements and adiabatic flame temperatures.
2. Differentiate between laminar and turbulent combustion.
3. Recognize reasons for differences among operating characteristics of SI engine types and designs.
4. Recognize reasons for differences among operating characteristics of CI engine types and designs.
5. Compare and contrast requirements for efficient performance of gas turbines with differing configurations of combustion chambers.
6. Develop an understanding of the combustion process, engine emissions, pollutants and their harmful effects.

MODULE I – REVIEW OF FIRST AND SECOND LAW OF THERMODYNAMICS (8 Lecture Hours)
Energy balance analysis, application to closed and open systems. Second-law efficiency, concept of entropy, exergy analysis, availability analysis of simple cycles.

MODULE II – REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS (8 Lecture Hours)
Equations of State Compressibility, fugacity coefficient, Real gas mixtures, Ideal solution of real gases, Gibbs phase rule.

MODULE III – THERMODYNAMIC PROPERTY RELATIONS (8 Lecture Hours)
Thermodynamic Potentials, Maxwell relations, Generalized relations for changes in Entropy, Internal Energy and Enthalpy, C_p and C_v, Clausius Clayperon Equation, Joule- Thomson Coefficient.

MODULE IV – COMBUSTION PRINCIPLES (8 Lecture Hours)
Thermodynamics concepts of combustion, First law and second law of thermodynamics applied to combustion process, Heat of combustion, Adiabatic flame temperature, Stoichiometry and excess air, Statistical thermodynamics, statistical interpretations of first and second law and Entropy, Third law of thermodynamics, Nerst heat theorem Combustion calculations, Minimum air required for complete combustion of fuel.

MODULE V – CHEMICAL KINETICS (7 Lecture Hours)
Chemical equilibrium and dissociation, Theories of combustion - homogeneous mixture, Heterogeneous mixture, Laminar and Turbulent flame propagation in engines, Second law analysis of reacting mixture, Availability analysis of reacting mixture

MODULE VI – STATISTICAL AND THIRD LAW OF THERMODYNAMICS (6 Lecture Hours)
Statistical thermodynamics, statistical interpretations of first and second law and Entropy, Third law of thermodynamics, Nernst heat theorem.

Reference Books:

1. Cengel, ‘Thermodynamics’8th edition , Tata McGraw Hill Co., New Delhi, 2015.
2. G.J. Van Wylen& R.E. Sonntag., ‘Fundamentals of Thermodynamics’, Willy Eastern Ltd, 8th edition 2014.
3. V. Ganesan., 'Internal Combustion Engines', 4th edition, Tata McGraw Hill Publishing Company Ltd, 2012.
4. Rao Y.V.C., “Postulational and Statistical Thermodynamics”, Allied Publishers Inc, 1994.
5. Mathur M.L. and Sharma., 'A course in Internal Combustion Engines', Revised 7th edition , R.P Dhanpat Rai Publications, 2010.

18ME3002	ADVANCED FLUID DYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Continuity, momentum and energy equations of fluid flow.
2. Irrotational flows, flow past cylinders and Rankine body.
3. Concepts of boundary layer, Prandtl mixing length, turbulent theory, universal velocity profile.

Course Outcomes: After completing the course the student will be able to

1. Choose method to describe the fluid motion.
2. Solve fluid flow problems using conservation principles.
3. Analyze the forces acting on a fluid particle.
4. Distinguish between irrational and vortex flows.
5. Analyze the fluid flow over cylindrical and spherical bodies.
6. Recognize boundary layer formation in external and internal flows.

MODULE I – FLUID KINEMATICS (7 Lecture Hours)
Method of describing fluid motion– Lagrangian, Eulerian Method – Local and individual time rates of change, acceleration, - Eulerian and Lagrangian equation of continuity, Bernoulli's equation from Euler's equation – solved problems related to liquid motion, related to equation of continuity.
MODULE II – GOVERNING EQUATIONS OF FLUID MOTION (7 Lecture Hours) Forces and stress acting on fluid particles, Differential momentum equation. Navier Stokes Equations of Motion for simple cases in rectangular, cylindrical and spherical coordinate, Energy Equation.
MODULE III – IDEAL FLOWS (7 Lecture Hours)
Irrotational motion in two dimensions, sources and sink Complex potential due to a source, due to a doublet, Images with respect to straight line, solved problem. Vortex motion-Vortex tube, Helmohltz's vorticity theorem, velocity potential and stream function.
MODULE IV – FLOW OVER BODIES (7 Lecture Hours)
Flow over Circular cylinders, sphere, solution of Laplace equation, Flow past cylinder with and without circulation, flow past Rankine body. Liquid streaming past a fixed sphere and solved problems.
MODULE V – BOUNDARY LAYER THEORY (7 Lecture Hours)
Boundary layer principles, flat plate, conduits, curved solid bodies, universal velocity profile, and momentum eddy concept – simple applications. Modern trends in the application of CFD to Boundary layer flows.
MODULE VI – BASICS OF TURBULENCE (10 Lecture Hours)
Joukowshi transformation, Analytic function Conformal Transformation of infinite and semi – infinite strip, Prandtl mixing length turbulent theory, Von Karman integral equation to Boundary layer – with and without pressure gradient.

Reference Books:

1. Yunus A Cengel and John M Cimbala., "Fluid Mechanics: Fundamentals and applications" 3rd edition, Tata McGraw-Hill, 2014.
2. K. Muralidhar and Gautam Biswas, "Advanced Engineering Fluid Mechanics" 3rd edition, Narosa Publishing House, 2015.
3. M.D.Raisinghania., "Fluid Dynamics' S Chand, 5th Revised Edition, 2003.
4. Frank M White., "Fluid Mechanics", Tata McGraw Hill, 8th edition, 2016.
5. Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, 9th edition, 2016.

18ME3003	ADVANCED HEAT TRANSFER	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Conduction, convection, radiation, heat transfer during boiling and condensation.
2. Design of heat exchangers.
3. Principles of mass transfer.

Course Outcomes: After completing the course the student will be able to
1. Solve problems of heat transfer in complex systems by selecting appropriate choice between exact and approximate calculations.
2. Model heat transfer in complex internal flow systems and external flow configurations.
3. Design and analyze the performance of heat exchangers.
4. Model two-phase heat transfer problems in boiling and condensation.
5. Model mass transfer problems involving mass diffusion in gases.
6. Analyze radiative heat exchange between surfaces.

MODULE I – CONDUCTION (8 Lecture Hours)
Review of one dimensional heat conduction-Two dimensional heat conduction- Analytical method for two dimensional heat equations (The method of separation of variables). Finite difference method – formulation of nodal equation – solutions for two dimensional conduction problems. Transient conduction, the lumped capacitance method,semi-infinite solid.
MODULE II – CONVECTION (8 Lecture Hours)

Energy equation – thermal boundary layer. Forced convection – Practical correlations – flow over surfaces – internal flow. Natural convection, combined forced and free convection – combined convection and radiation in flows.

MODULE III – HEAT EXCHANGER (8 Lecture Hours)

Types – LMTD method and the effectiveness – NTU method. Heat Pipes-principle operation- heat transfer correlations in boiling and condensation.

MODULE IV – BOILING AND CONDENSATION (7 Lecture Hours)

Boiling – Pool and flow boiling, correlations. Condensation – modes and mechanisms – correlations and problems.

MODULE V – RADIATION (7 Lecture Hours)

Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, Radiative heat exchange between surfaces –Radiation shield- radiation shape factor – reradiating surfaces. Radiation in gases.

MODULE VI – MASS TRANSFER (7 Lecture Hours)

Mass transfer types – Fick's law of diffusion – mass diffusion equation, Equimolar counter diffusion – convective mass transfer. Evaporation of water into air. Fins, Heat pipes, check with AICTE 139.

Reference books:

1. Holman J.P., 'Heat and Mass Transfer', 10th edition, Tata McGraw Hill, 2009.
2. Allen D.Kraus., 'Extended Surface Heat Transfer', Wiley-Interscience., 2001.
3. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt., 'Fundamentals of Heat and Mass Transfer',7th edition., John Wiley & Sons, May 2011.
4. C.P. Kothandaraman., 'Fundamentals of Heat and Mass Transfer', 4th Ed., New Age International, 2012.
5. Kays, W.M, Crawford W and Bernhard Weigand., 'Convective Heat and Mass Transfer', McGraw Hill Inc., 2004.

18ME3004	DESIGN OF THERMAL POWER EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Boiler manufacturing regulations/code.
2. The design of various equipment used in thermal power plants.
3. Steam washing and ash separation from flue gases.

Course Outcomes: After completing the course the student will be able to

1. Compare and contrast different types of boilers for power plant application.
2. Design boilers for power plant applications according to standards.
3. Recognize waste heat recovery options in power plants using accessories such as economizers, super heaters, re-heaters and air pre-heaters.
4. Design chimney and fans for the draught system in thermal power plants.
5. Design condensers and cooling towers for steam power plants.
6. Recognize significance of water and steam purification and ash cleaning mechanisms in thermal power plants.

MODULE I –BOILER SERVICE REQUIREMENTS, IBR ACT AND FURNACE DESIGN (8 Lecture Hours)

Services requirements, Parameters to be considered in Boiler Design, IBR Code Furnace Design, Heat Transfer in Furnace, Heat balance, Types of refractory walls, Furnace, Water wall arrangements, Heat release rates, Furnace bottoms, Slag removal, Primary, secondary and tertiary air system, box assembly, Different types of furnaces for solids and liquids

MODULE II – WATER SIDE DESIGN (8 Lecture Hours)

Circulation-natural, Forced circulation ratio, Design of condensers, Economic selection of condensers, Types - Direct contact, Surface condensers, Vacuum efficiency, Air leakage into the condenser-air removal, Cooling tower Types and design for power plant application

MODULE III – PERFORMANCE OF BOILER (8 Lecture Hours)

Equivalent evaporation, Boiler efficiency, Boiler trial Heat losses in boiler, Economizers-types, design, Super Heater- Design, Economy of super heat, limit of super heat, Super heater performance, Steam mass flow, gas mass flow and pressure drop in super heater, Super heat temperature control, De superheater-design, Design of Reheater.

MODULE IV – WATER AND STEAM PURIFICATION (7 Lecture Hours)

Chemical treatment, Mechanical carry over, Silica carry over gravity separation, Drum internals, Steam washing typical arrangements of boiler drum internal in H.P. boilers.

MODULE V – AIR-PREHEATERS AND DRAFT SYSTEM DESIGN (7 Lecture Hours)

Types of Air heater, Recuperative and regenerative air-preheaters, Design considerations, Forced, induced, balanced drafts, Pressure losses.

MODULE VI – FAN, CHIMNEY DESIGN AND ASH SEPARATION (7 Lecture Hours)

Power requirement for forced and induced draft fans, Chimney design - Diameter and height, Ash separation by electrostatic precipitators, Flue gas desulphurization systems.

Reference Books:

1. P.K.Nag., Power Plant Engineering, **Tata McGraw Hill Education India,** 4th edition, 2014.
2. Thermal Power Plant: Design and Operation, Elsevier, 2015.
3. Steam plant operation, 10th Edition, Everett B. Woodruff, Herbert B. Lammers, Thomas F.Lammers, McGraw Hill Professional, 2016
4. El, Wakil, Power plant technology, McGraw-Hill, 2003.
5. Gebhartt, G. F., Steam power plant engineering, John Wiley & Sons, 2002.

18ME3005	REFRIGERATION SYSTEM DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Significance of refrigerants and their impact on the environment.
2. Working principle of various refrigeration cycles..
3. Performance of system components and their balancing in cycles..

Course Outcomes: After completing the course the student will be able to

1. Select the refrigerants.
2. Estimate the performance of a vapour compression cycle.
3. Compare different types of refrigeration cycles.
4. Identify the components of a refrigeration system.
5. Analyze the performance of different components in a refrigeration system.
6. Discuss the controls employed in refrigeration system.

MODULE I – REFRIGERANTS (6 Lecture Hours)

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants, alternatives to HCFCS, Secondary Refrigerants.

MODULE II – VAPOUR COMPRESSION REFRIGERATION CYCLE (9 Lecture Hours)

Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle- conditions for high COP-deviations from ideal vapor compression cycle, Multi pressure System, Cascade Systems-Analysis.

MODULE III – VAPOUR ABSORPTION AND AIR REFRIGERATION CYCLES (9 Lecture Hours)

Vapor Absorption Systems-Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration Thermo Electric Refrigeration, Air Refrigeration cycles and Heat pumps.

MODULE IV– REFRIGERATION SYSTEM COMPONENTS (6 Lecture Hours)

Compressor- Types, performance, Characteristics, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behavior with fluctuating load, cycling controls, other components such as Accumulators, Receivers, Oil Separators, Strainers, Driers, Check Valves, Solenoid Valves Defrost Controllers.

MODULE V – SYSTEM BALANCING (9 Lecture Hours)

Balance points and system simulation - compressor, condenser, evaporator and expansion devices performance – Complete system performance; graphical and mathematical analysis – sensitivity analysis.

MODULE VI – ELECTRICAL DRIVES & CONTROLS (6 Lecture Hours)

Electric circuits in Refrigeration systems, Refrigerant control devices, Types of Motors, Starters, Relays, Thermostats and Microprocessor based control systems, Pressure controls and other controls, Acoustics and noise controls.

Reference Books:

1. Arora C.P., Refrigeration and Air conditioning, McGraw Hill, 3rd Ed., 2010.
1. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version, 2001.
2. Jordan and Priester, Refrigeration and Air conditioning 1985.
3. 2. Kuehn T.H., Ramsey J.W. and Threlkeld J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.
4. Langley Billy C., ‘Solid state electronic controls for HVACR, Prentice-Hall 1986.
5. Rex Milter, Mark R.Miller., Air conditioning and Refrigeration, McGraw Hill, 2006.

18ME3006	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. Usage of computers and modeling software in design and manufacturing.
2. Visualization of objects in three dimensions and producing orthographic views, sectional views and auxiliary views of it.
3. Finite element analysis of beams, trusses, plates and frames.

Course Outcome: After completing the course the student will be able to

1. Model the components using the commands such as extrude, revolve, fillet, hole pattern.
2. Use the commands rib, chamfer, draft and 3d sketch to modify the parts
3. Create an assembly model of knuckle joint and screw jack and convert them into orthographic views.
4. Conduct structural analysis of trusses, frames and beams.
5. Conduct modal of structures
6. Conduct heat transfer analysis of solids and pipes

LIST OF EXPERIMENTS

1. 3D Modeling with Extrude, Round (Fillet) and Mirror Commands
2. 3D Modeling With Revolve, Hole Pattern Commands
3. 3D Modeling With Rib, Chamfer, Draft and 3D sketching Commands
4. Modeling, Assembly and Drafting of Knuckle Joint
5. Modeling, Assembly and Drafting of Screw Jack
6. Advanced modeling using variable sweep, helical sweep etc.
7. Structural analysis of Trusses
8. Structural analysis of Beams
9. Structural analysis of Frames
10. Plane stress/Plane strain analysis
11. Modal analysis of different structures
12. Steady state thermal analysis

18ME3007	ANALYSIS AND SIMULATION LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on
1. Mechanical engineering problems using advanced analysis package like ansys.
2. Simulation software like matlab to construct and execute goal-driven system models.
3. Various simulation and analysis tools to different real time applications.

Course Outcomes: After completing the course the student will be able to
1. Demonstrate the use of analysis software for various structural, thermal and flow related problems
2. Apply the suitable commands in solving the problems in analysis software.
3. Compare the various element types, material properties and boundary conditions with the real life problems to get an optimal solution.
4. Interpret the various mechanisms and problems into a simple model to carry out simulation.
5. Examine the model with suitable commands and constraints.
6. Evaluate the working and performance of various mechanisms using the simulation software.

ANALYSIS MODULE USING ANSYS WORKBENCH
1. Force and stress analysis using link elements in trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions
3. Stress analysis of flat plate (with circular hole) and simple shells.
4. Stress analysis of axi- symmetric component
5. Thermal stress and heat transfer analysis of a 2D component and cylindrical shells
6. Flow through a duct, elbow
7. Conductive and convective heat transfer analysis of a 2D component
8. Modal analysis of a beam
9. Harmonic, transient and spectrum analysis of simple systems.

SIMULATION MODULE USING MATLAB 2018R
1. Vibration based simple problems- a. simulation of an accumulator, b. linear damping force
2. Simulation of cam and follower mechanism
3. Simple exercise to determine stiffness
4. Simulation of four bar mechanism

Reference Books:
1. Lab Manual

18ME3008	ADVANCED HEAT TRANSFER LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on
1. Boiling and condensation of vapors in surfaces.
2. The working of air conditioning system.
3. Heat transfer in two-phase system.

Course Outcomes: After completing the course the student will be able to
1. Appreciate the mechanism of condensation process.
2. Distinguish between types of condensation.
3. Employ lumped thermal capacitance method for temperature estimation under transient mode.
4. Evaluate the performance of air-conditioning system.
5. Recognize bubble formation in the nucleate boiling regime.
6. Recognize transition from nucleate boiling to film boiling.

LIST OF EXPERIMENTS
1. Drop-wise and film-wise condensation
2. Investigation of lumped thermal capacitance method of transient temperature analysis
3. Cop test on air conditioning test rig
4. Nucleate boiling

5. Critical heat flux apparatus
6. Estimation of heat transfer coefficient of heat pipes (12 exp)

18ME3009	ADVANCED COMPUTATIONAL FLUID DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on
1. Finite volume computational fluid dynamics codes working strategies.
2. Actual setting up of the problem and solution procedure.
3. Data extraction, post processing and comparison with experimental/theoretical data.

Course Outcomes: After completing the course the student will be able to
1. Recognize applications of computing tools in fluid dynamics.
2. Model and analyze various heat transfer and fluid flow problems.
3. Select appropriate mesh type and boundary conditions.
4. Apply suitable solvers for problem solution.
5. Extract post processing data and compare them with available data.
6. Infer the pictorial results after post-processing.

LIST OF EXPERIMENTS
1. One dimensional steady state diffusion
2. One dimensional steady state diffusion with volume source
2. One dimensional steady state diffusion with surface source
3. One dimensional unsteady heat conduction
4. Conjugate heat transfer
5. Periodic flow and heat transfer
6. Laminar flow
7. Turbulent flow
8. Flow through porous media
9. Flow around an aerofoil
10. Modelling radiation and natural convection.

18ME3010	ADVANCED MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Different types of conventional manufacturing processes.
2. The mechanism and capabilities of non-conventional manufacturing processes.
3. The latest manufacturing process for micro-fabrication and devices.

Course Outcomes: After completing the course the student will be able to
1. Evaluate and select suitable manufacturing processes for particular applications.
2. Recognize the need for unconventional manufacturing processes for various applications.
3. Apply the latest manufacturing process for micro-fabrication.
4. Develop new products by making use of new materials and processes.
5. Establish newer manufacturing methods to replace conventional fabrication methods.
6. Adapt the powder metallurgy technique to fabricate components for diverse applications.

MODULE I – CASTING AND MOULDING (7 Lecture hours)
Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

MODULE II – BULK FORMING (7 Lecture hours)
Plastic deformation and yield criteria; Fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing).

MODULE III – SHEET METAL FORMING (7 Lecture hours)
Sheet metal characteristics – shearing, bending and drawing operations, design considerations – Stretch forming operations; Formability of sheet metal ; Hydro forming – Rubber pad forming –

Metal spinning–Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.

MODULE IV – NEWER MACHINING PROCESSES (8 Lecture hours)

Construction; working principle; steps; types; process parameters; derivations; problems, merits, demerits and applications of AJM – WJM - USM – CHM – ECM – EDM - Wire cut EDM - ECM – ECG - LBM – EBM ---*expand.*

MODULE V – MICRO-FABRICATION (8 Lecture hours)

Semiconductors; fabrication techniques; surface and bulk machining; LIGA Process; Solid free form fabrication; Wafer preparation techniques; PCB board hybrid and MCM technology; programmable devices and ASIC; electronic material and processing; stereo lithography SAW devices; Surface Mount Technology.

MODULE VI – ADVANCED JOINING / FASTENING PROCESSES(8 Lecture hours)

Physics of welding; joint preparation; design considerations in welding, Solid and liquid state joining processes; Thermit welding, submerged arc welding, Advanced welding techniques - Friction stir welding, friction stir processing, explosive welding; brazing and soldering; defects in welding and remedies.

Reference Books:

1. SeropeKalpakjian, Steven Schmid, Manufacturing Processes for Engineering Materials (5th Edition), 2003.
2. Julian W. Gardner , Vijay K. Varadan, Osama O. Awadelkarim “Micro sensors, MEMS& Smart Devices”, Wiley-Blackwell, 2002.
3. Nario Taniguchi, “Nano Technology”, Oxford University Press 1996.
4. Pandey P.C., Shan H. S, “Modern Machining Processes”, Tata McGraw Hill Education Private Limited, 2013.
5. Marc J. Madou,” Fundamentals of Micro-fabrication and Nanotechnology”, Third Edition, CRC Press, 2011.

18ME3011	ADVANCED METAL CUTTING THEORY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Fundamentals of metal cutting theory and nomenclature of cutting tools.
2. Measurement of cutting force and cutting temperature.
3. Mechanisms of tool wear and chatter in machining.

Course Outcomes: After completing the course the student will be able to

1. Understand mechanism and theories of metal cutting.
2. Select the cutting tool based on the operation to be done.
3. Understand thermal aspects in machining.
4. Analyze tool materials and tool life.
5. Measure cutting forces during machining processes.
6. Diagnose tool wear, vibration and chatter.

MODULE I – METAL CUTTING FUNDAMENTALS (7 Lecture hours)

Basic mechanism of chip formation-types of chips-Chip breaker-Orthogonal Vs Oblique cutting- force and velocity relationship and expression for shear plane angle in orthogonal cutting-Energy Consideration in machining-Modern theories in Mechanics of cutting -Review of Merchant and Lee Shaffer Theories.

MODULE II – TOOL NOMENCLATURE OF CUTTING TOOLS(7 Lecture hours)

Nomenclature of single point tool - Systems of tool Nomenclature and Conversion of rake angles - Nomenclature of multi point tools like drills, milling cutters and broaches.

MODULE III – THERMAL ASPECTS OF MACHINING (7 Lecture hours)

Thermodynamics of chip formation - Heat distributions in machining-Effects of various parameters on temperature - Method of temperature measurement in machining - Hot machining - cutting fluids, Surface finish and integrity.

MODULE IV – TOOL MATERIALS AND TOOL LIFE (8 Lecture hours)
Essential requirements of tool materials - Developments in tool materials-Tool Coating- ISO specifications for inserts and tool holders-Tool life- Taylor's tool life equation, optimum tool life - Conventional and accelerated tool life tests.
MODULE V – CUTTING FORCES AND ECONOMICS OF MACHINING (8 Lecture hours)
Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces. Concepts of machinability and machinability index - Economics of machining, Machining Time – Estimation of machining time in different machining operations.
MODULE VI – TOOL WEAR MECHANISMS AND CHATTER IN MACHINING (8 Lecture hours)
Reasons for failure of cutting tools and forms of wear-mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters-Mechanism of chatter based on Force Vs Speed graph.

Reference books:

1. B.L. Juneja and G.S. Sekhon - "Fundamentals of metal cutting and machine tools", New Age International (p) Ltd., 2015.
2. M.C. Shaw, "Metal cutting Principles ", Oxford Clarendon Press, 2005.
3. Bhattacharya. - "Metal Cutting Theory and Practice ", new central Book Agency pvt. Ltd., Calcutta 2016.
4. Boothroy.D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 1989.
5. Stephenson, D. A., &Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis, 2016.

18ME3012	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C
		3	0	0	3

Course objective: To impart knowledge on
1. The real engineering design processes.
2. In-depth practice in design, the use of a structured approach to design, an introductory knowledge of business practices.
3. Critical thinking, creativity, and independent learning.

Course outcome: After completing the course the student will be able to
1. Design the components suitable for various manufacturing process such as welding, casting, machining.
2. Identify and describe how the integrated design, manufacturing, process works.
3. Describe how the details of example production plans affect the product and can be designed for the ease of manufacturing and assembly besides reducing the overall costs of the product.
4. Update the knowledge of design process and methods.
5. Know the importance of material selection, quality, statistics in design and its help in designing a new product.
6. Learn the process of design based on the scientific method, to combine creative thinking with engineering principles to turn ideas into robust reality.

MODULE I – INTRODUCTION (8 Lecture Hours)
General Design principles for manufacturing – strength and mechanical factors, mechanisms selection, Process capability – Feature tolerances – Geometric tolerances – assembly limits – Datum Features – Functional datum, machining sequence, manufacturing datum, changing the datum. Examples.
MODULE II – FACTORS INFLUENCING FORM DESIGN (8 Lecture Hours)
Working Principle, Material, design for Manufacture – Possible solutions – Materials choice –Influence of materials on form design – form design of welded members, forgings and castings.
MODULE III – COMPONENT DESIGN – MACHINING CONSIDERATION (8 Lecture Hours)

Design features to facilitate machining – drills – milling cutters – keyways – Doweling-procedures, counter sunk screws – Reduction of machined area - simplification by separation – simplification by amalgamation – Design for machinability – Design for economy – Design for clampability – Design for Accessibility – Design for Assembly.

MODULE IV – COMPONENT DESIGN – CASTING AND WELDING CONSIDERATIONS (8 Lecture Hours)

Redesign of castings based on parting line considerations – minimizing core requirements, machined holes, Redesign of cast members to obviate cores. Redesign of weld members based on Weld joints-Material thickness-Specifying Welds-cost of welding-Weld distortion-Weld Strength-Finishing and Tolerancing considerations.

MODULE V – REDESIGN FOR MANUFACTURE AND CASE STUDIES (8 Lecture Hour)

Identification of uneconomical design – Modifying the design – group technology –Design for reliability and safety.

MODULE VI – CASE STUDIES (8 Lecture Hour)

Robust and quality design. Computer Application for Design for Manufacturing and Assembly.

Reference Books:

1. George E. Dieter, "Engineering Design: A Materials and Processing Approach", 3rd edition, McGraw-Hill, 2000.
2. Geoffrey Boothroyd, peter Dewhurst, Winston A Knight, " Product Design for Manufacture and Assembly, CRC Press, Taylor and Francis group, 2010.
3. Chitale.A.K.,Gupta.R.C., " Product Design and Manufacturing, Prentice Hall of India, 2007.
4. David.M.Anderson, "Design for Manufacturability and concurrent Engineering", CIM Press, 2004.
5. Harry Peck, "Designing for Manufacture", Pitman Publications, 2015.

18ME3013	ENGINEERING MATERIALS AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives: To impart the knowledge on

1. Structure, composition and behavior of metals.
2. Fracture behavior of materials.
3. The principles of design, selection and processing of materials.

Course Outcomes: After completing the course the student will be able to

1. Apply the concepts of materials science for material selections towards new product development.
2. Analyze the elastic and plastic behavior of materials.
3. Suggest modern metallic materials for engineering applications.
4. Evaluate fracture behavior of materials in engineering applications.
5. Appraise the utility of new age material for specific application.
6. Synthesize and develop the unique customized composites for special needs.

MODULE I – ELASTIC AND PLASTIC BEHAVIOR (8 Lecture Hours)

Atomic model of Elastic behavior – Rubber like Elasticity an elastic behavior - plastic deformation-slip- shear strength of perfect and real crystals- movement of dislocation.

MODULE II – FRACTURE BEHAVIOR (7Lecture Hours)

Ductile and Brittle fracture – Energy and stress intensity approach, fracture toughness- Ductile Brittle Transition Fatigue- Creep in Materials.

MODULE III – MATERIAL SELECTION ANDMODERN METALLIC MATERIALS (7 Lecture Hours)

Criteria for selection of materials, ASTM standards, Patented Steel wire - Steel martensite - microalloyed steels- precipitation hardened aluminum alloys- Maraging steels - HSLA steels, Dual phasesteels, duplex stainless steels. TRIP Steels.

MODULE IV – NEW AGE MATERIALS (8 Lecture Hours)

Shape memory alloys smart Materials- Ceramics and glasses: Properties, applications, Ceramic Structures- silicate ceramics- carbon –diamond- graphite imperfections and impurities in ceramics – applications. Materials for energy production, transmission, saving and harvesting.

MODULE V – SPECIAL PURPOSE MATERIALS (7 Lecture Hours)

Structure and types of smart materials, Piezoelectric Materials, Magneto Rheological materials – Introduction & Applications, Bio-compatible materials for medical implants. CNT, Graphene, Metallic glasses. Conducting polymers, Smart Gels and polymers.

MODULE VI – COMPOSITE MATERIALS (8 Lecture Hours)

Polymer Matrix Composites (PMC) -PMC processes - Hand layup processes – Spray up processes – Compression moulding –injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Metal Matrix Composites (MMC) - characteristics of MMC. Advantages of MMC, Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

Reference Books:

1. V. Raghavan, “Materials Science and Engineering – Prentice Hall of India (P) Ltd., New Delhi. 2004.
2. Thomas H. Courtney “Mechanical Behaviour of Materials” McGraw Hill International Edition, 2005.
3. Williams D, Callister “Material Science and Engineering” John Wiley and Sons Inc. 2009.
4. Joshua Pelleg, “Mechanical Properties Materials”, Springer, 2013.
5. Kenneth.G,Michael, K.Budinski, “ Engineering Materials”, Properties and selection, Prentice Hall, 2010.

18ME3014	ADVANCED METROLOGY AND MEASUREMENT SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Science of measurement and measuring machines commonly used.
2. Limits, fits and tolerances, geometric dimensioning aspects
3. Methods of acceptance test for conventional machine tools.

Course Outcomes: After completing the course the student will be able to

1. Use different measuring instruments in industries.
2. Utilize Geometrical Dimensioning and Tolerancing symbols and apply them in inspection and testing process.
3. Apply the concepts of Laser metrology in quality control.
4. Examine the surface roughness of work pieces from various production processes.
5. Choose the modern manufacturing methods using advanced metrology systems.
6. Recommend calibration standards towards measuring instruments.

MODULE I – INTRODUCTION TO MECHANICAL MEASUREMENTS (7 Lecture Hours)

Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance, Precision, accuracy and uncertainty in measurements.

MODULE II – GEAR MEASURING MACHINES (7 Lecture Hours)

Study of Measuring Machines, gear tooth measurement- measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions.

MODULE III – ELECTRON AND LASER MICROSCOPY (7 Lecture Hours)

Laser metrology and microscopy: Laser Metrology - Vision systems- Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications.

MODULE IV – CALIBRATION AND SURFACE ROUGHNESS MEASUREMEN (7 Lecture Hours)

Acceptance tests for machine tools and surface finish measurements, calibration of machine tools. Three ball or four ball measurement, Measurement of surface roughness.

MODULE V – GEOMETRIC DIMENSIONING AND TOLERANCING(7 Lecture Hours)
Introduction. Indian Standard System of Limits and Fits (IS:919-2709) ; Designation of Holes ,Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T, Datum feature, Material Conditions.

MODULE VI – METROLOGY FOR QUALITY (8 Lecture Hours)
Tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.

Reference books:

1. R. K . Jain, "Engineering Metrology", Khanna Publishers, New Delhi, 2009.
2. Geometric Dimensioning` and Tolerance for Mechanical Design,"Gene R. Cogorno, McGraw Hill, 2004
3. Beckwith Thomas G, "Mechanical Measurements", Pearson Education, 2008.
4. M.Mahajan,"A Text Book of Metrology", DhanpatRai&Co. 2010
5. The Metrology Handbook, Jay L. Bucher, Amer Society for Quality, 2004.

18ME3015	COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on
1. Usage of Manufacturing software in writing the codes for CNC, VMC and Turning centres to produce components
2. Concepts of CNC programming and simulation on CNC turning center and Machining center
3. Concepts of Robot programming and PLC programming

Course Outcomes: After completing the course the student will be able to
1. Machine complex profiles using CNC machines with the aid of auto generated CNC codes
2. Generate CNC program for turning and milling of component using Master CAM / Edge CAM softwares
3. Write CNC codes for linear, circular interpolation step turning ball turning and external threading.
4. Write CNC codes for creating holes on components using CNC drilling machine.
5. Write CNC program for creating square pockets using vertical milling centre.
6. Generate Robot programming and PLC programming

LIST OF EXPERIMENTS:
1. Study of different control systems and CNC codes
2. Programming and simulation for turning, taper turning, circular interpolation, thread Cutting and facing operation
3. Profile cut using linear and circular interpolation
4. Drilling in a CNC drilling machine.
5. Square pocketing and Drilling in a VMC/CNC drilling machine
6. Step turning and external thread cutting in a CNC lathe
7. Taper turning and internal thread cutting in a CNC lathe
8. Ball tuning in a CNC turning Centre
9. Programming using canned cycles
10. Robot programming for Material handling applications (2 exp)
11. PLC ladder logic programming

18ME3016	MECHATRONICS AND ROBOTICS LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on

1. Fundamentals of fluid power and Mechatronics systems and primary actuating systems.
2. Programming skills in Programmable logic controllers.
3. Principles of pneumatics and hydraulics and apply them to real life problems.

Course Outcomes: After completing the course the student will be able to

1. Apply Boolean algebra for logic design of pneumatic circuits.
2. Apply Boolean algebra for logic design of hydraulic circuits
3. Build logic circuits for industrial applications
4. Build cascade circuits for multiple cylinder applications.
5. Design automation circuits with PLC for industrial problems
6. Write Programme for robot movements

LIST OF EXPERIMENTS:

1. Standard Fluid Power Symbols
2. Pneumatic Basic Logic Circuit
3. Pneumatic Circuit for Material Handling System
4. Electro-Pneumatic Circuit Using Relay, Limit Switch and Solenoid Valves
5. Electro-Pneumatic Circuit for an Automation of Double Acting Cylinder by using Proximity Sensors and Cascade System of sequence A+B+C+A-B-C-.
6. Electro-Hydraulic Circuit using Proximity Sensors.
7. PLC Controlled Pneumatic Logic Circuits
8. PLC Controlled Pneumatic Circuit for Material Handling System
9. Control of Funuc robot
10. Robot programming for pick and place application
11. Assembly and disassembly of pic controller based mobile robot.
12. Programming for interfacing of sensors.

18ME3017	ADVANCED STRESS ANALYSIS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Mohr's circle and energy methods to predict stress, strain and deflection.
2. Stress distribution in thin walled section subjected to torsion and find shear center in beams.
3. The behavior of thin walled cylinders under pressure and stress distribution in rotating disks.

Course Outcomes: After completing the course the student will be able to

1. Find principals stress and strains in solids of two dimensions and three dimensions.
2. Determine deflection and stress at critical points in a structure using various methods.
3. Analysis of stress distribution of thin walled sections subjected to torsion.
4. Determine shear center of thin walled beams.
5. Design thin walled cylinders under pressure and determine stress in a rotating disk.
6. Identify method to determine contact stress and deflection for various load conditions.

MODULE I – THEORY OF ELASTICITY (8 Lecture Hours)

Analysis of stress, Analysis of strain, Elasticity problems in two dimension and three dimensions, Mohr's circle for three dimensional stresses. Stress tensor, Air's stress function in rectangular and polar coordinates.

MODULE II – ENERGY METHODS (8 Lecture Hours)

Energy method for analysis of stress, strain and deflection. Theorem of virtual work, theorem of least work, Castigliona's theorem, Rayleigh Ritz method, Galerkin's method and Elastic behavior of anisotropic materials like fiber reinforced composites.

MODULE III – THEORY OF TORSION (8 Lecture Hours)

Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of noncircular shaft

MODULE IV – UNSYMMETRICAL BENDING AND SHEAR CENTRE (7 Lecture Hours)

Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

MODULE V – PRESSURIZED CYLINDERS AND ROTATING DISKS (7 Lecture Hours)

Governing equations, stress in thick walled cylinder under internal and external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk with variable thickness, disk of uniform strength, Plastic action in thick walled cylinders and rotating disc.

MODULE VI – CONTACT STRESSES (7 Lecture Hours)

Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, stress for two bodies in line contact with load normal to contact area and load normal and tangent to contact area. Introduction to analysis of low speed impact.

Reference Books:

1. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
2. L. S. Srinath, "Advanced Mechanics of Solids", 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.
3. Ferdinand P. Beer, E. Russell Johnston, John T. DeWolff and David F. Mazurek Mechanics of Materials, 5th ed. in SI Units, McGraw-Hill, 2009.
4. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2003.
5. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.

18ME3018	FINITE ELEMENT METHODS IN ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Fundamentals of finite element analysis.
2. Various types of elements used in FEA.
3. Implementation of galerkin's formulation into the finite element method for the solution of ordinary and partial differential equations.

Course Outcomes: After completing the course the student will be able to

1. Acquire the fundamental theory of finite element analysis and develop element characteristic equation, global stiffness equation.
2. Derive element matrix equation using different methods by applying basic laws in mechanics and integration by parts.
3. Solve problems under dynamic conditions by applying various techniques.
4. Attain knowledge in error norms, convergence rates and refinement.
5. Use professional-level finite element software to solve engineering problems in structural mechanics, fluid mechanics and heat transfer.
6. Solve the real world engineering problems using FEA.

MODULE I – INTRODUCTION (7 Lecture Hours)

Basic concepts- General applicability of the method to structural analysis, heat transfer and fluid flow problems- general approach of finite element method with case studies - classical analysis techniques- finite element packages - Solution of equilibrium problems- solution of Eigen value problem - Solution of propagation problems.

MODULE II – GENERAL PROCEDURE (7Lecture Hours)

Discretization of Domain- basic element shapes- interpolation polynomials natural coordinates- formulation of element characteristic matrices and vectors-direct approach -variational approach and weighted residual approach-Continuity conditions.

MODULE III – FINITE ELEMENTS (8 Lecture Hours)

Formulation of one dimensional, two dimensional, three dimensional elements - isoparametric elements- curve sided elements-higher order elements-Lagrangian element-serendipity element-Shape functions and stiffness matrix- Error norms and Convergence rates – h-refinement with adaptivity – adaptive refinement.

MODULE IV – FIELD PROBLEMS (8 Lecture Hours)

Heat Transfer Problems- Basic equations of heat transfer derivation using finite element Method for 1D & 2D problems. Fluid mechanics problems- Basic equations- Solutions procedure-compressible flows- Galerkin approach. Structural Problems- Equations of elasticity- plane elasticity problems - Bending of elastic plates.

MODULE V – TORSION OF NON-CIRCULAR SECTION (8 Lecture Hours)

Two dimensional field equation- governing differential equations- Integral Equations for the element matrices- Element matrices- Triangular element, Rectangular element. Torsion of Non circular sections: General theory- Twisting of a square bar - shear stress components- Evaluation of the twisting torque.

MODULE VI – DYNAMIC ANALYSIS (7 Lecture Hours)

Dynamic equations of motion- consistent and lump mass matrices- Free vibration analysis – dynamic response calculation.

Reference Books:

1. Larry .J. Segerland. Applied Finite Element Analysis,Wiley India Pvt.Ltd.,2011.
2. Rao. S.S. "The Finite element method in Engineering", 2nd Ed., Pergamon Press, Oxford, 2003.
3. David. V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003.
4. Tirupathi. R. Chandrupatla, Ashok. D. Belegundu. Introduction to Finite Elements in Engineering', Prentice Hall of India, 2004.
5. J. N. Reddy. An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill Education, 2005.

18ME3019	ADVANCED VIBRATIONS AND ACOUSTICS	L	T	P	C
		3	0	0	3

Course Objective: To impart knowledge on

1. Fundamentals of vibrations and its practical applications.
2. Analyzing the vibration behavior of mechanical systems subjected to excitation.
3. Vibration control strategies.

Course Outcomes: After completing the course the student will be able to

1. Classify the systems of vibration and formulate equations of motion for vibratory systems.
2. Solve vibration problems with multi-degrees of freedom.
3. Suggest methods to control vibration and to perform vibration tests.
4. Categorize with international standards in acoustics and noise engineering.
5. Present the theoretical, experimental principles of mechanical vibrations to gain practical understanding in the field of vibration.
6. Understand unwanted vibration, noise in machines and proficient with instrumentation used in noise, vibration control tests.

MODULE I – VIBRATION OF SINGLE DEGREE OF FREEDOMSYSTEM (7Lecture Hours)

Introduction –Equation of motion - Newton's law, Energy methods – free vibration- forced vibration – damping models - Solutions of problems for one degree of freedom systems for transient and harmonic response.

MODULE II – VIBRATION OF TWO AND MULTI DEGREE FREEDOM SYSTEMS (8 Lecture Hours)

Equations of motion for Two Degree of freedom systems- –Influence coefficients- mode of vibration- principle modes-principle of orthogonal generalized coordinates– semi definite systems-Multi degree of freedom system-continuous system- Vibration equation, Natural frequency and mode shape for beams, rod.

MODULE III – NUMERICAL AND COMPUTER METHODS IN VIBRATIONS, (7 Lecture Hours)

Numerical methods in vibration problems to calculate natural frequencies - matrix iteration – Rayleigh-Ritz and Dunkerley's methods, method for Eigen-value calculations, Holzer's method, Stodola's method -mechanical impedance method –Matrix iteration technique.

MODULE IV – VIBRATION CONTROL (7 Lecture Hours)

Vibration isolation and transmissibility- Vibration Isolation methods- Dynamic Vibration absorber-Torsional and Pendulum Type Absorber-Active vibration control.

MODULE V – ENGINEERING ACOUSTICS (8 Lecture Hours)

Basic physical acoustics- acoustic levels and spectra- decibels, sound power, Sound pressure, power and intensity - Character of noise – Addition of two noise sources -Noise source identification. Noise radiation from vibrating bodies sound- properties of the various sources that create noise - Noise in machines and machine elements.

MODULE VI – VIBRATION MEASUREMENT AND ACOUSTIC STANDARDS (8 Lecture Hours)

Vibration instruments- vibration exciters - measuring devices- analysis- vibration Tests- Free, forced environmental vibration tests. Example of vibrations test- data acquisition – Modal and FFT analysis– Industrial case studies. Introduction to Acoustic Standards, Acoustic / Noise sensors, instrumentation, measurement and noise control instruments and noise propagation.

Reference Books:

1. Singiresu.S.Rao. Mechanical Vibrations, Addison Wesley Longman, 2003.
2. Benson H Tongue.Principles of vibration (2nd edition) Oxford University Press, 2002.
3. Thomson, W.T.Theory of Vibration with Applications, CBS Publishers and Distributers, NewDelhi, 2002.
4. Kelly.Fundamentals of Mechanical Vibrations, Mc Graw Hill Publications, 2000.
5. Rao V. Dukkipati, J. Srinivas. Vibrations : problem solving companion, Narosa Publishers, 2007.

18ME3020	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Various computer aided design tools for industrial applications.
2. Graphical entities of CAD /CAM and computer numerical programming.
3. Application of computers in manufacturing sectors.

Course Outcomes: After completing the course the student will be able to

1. Demonstrate the basic structure and components of cad.
2. Outline the process of representing graphical entities in a cad environment.
3. Construct the geometric model using different techniques to represent a product.
4. Illustrate various techniques and devices involved in cad hardware.
5. Analyze the models for design solutions using fem.
6. Discuss the various computer aided tools implemented in various industrial applications.

MODULE I – INTRODUCTION (7 Lecture Hours)

Introduction to CAD, Scope and applications in mechanical engineering, Need for CAD system, use of computer, Computer fundamentals, Computer aided design process, CAD configuration, CAD tools, advantages and limitations in CAD, CAD Standards – IGES, GKS and PDES, CAD/ CAM integration.

MODULE II – COMPUTER GRAPHICS (8 Lecture Hours)

Computer Graphics Display and Algorithms: Graphics Displays, DDA Algorithm – Bresenham's Algorithm – Coordinate systems – Transformation of geometry – Translation, Rotation, Scaling, Reflection, Homogeneous Transformations – 2D and 3D Transformations – Concatenation – line drawing-Clipping and Hidden line removal algorithms – viewing transformations.

MODULE III – GEOMETRIC MODELLING (8 Lecture Hours)
Wireframe models and entities – Curve representation – parametric representation of analytic curves – circles and conics – Hermite curve – Bezier curve – B-spline curves – rational curves. Surface Modeling – Surface models and entities – Parametric representation of analytic surfaces – Plane surfaces – Synthetic surfaces – Bicubic Surface and Bezier surface and B-Spline surfaces. Solid Modeling – Models and Entities – Fundamentals of solid modelling – B-Rep, CSG and ASM.

MODULE IV – CAD HARDWARE (8 Lecture Hours)
Introduction to hardware specific to CAD, Product cycle, CRT, Random scan technique, raster scan technique, CAD specific i/o devices, DVST, Raster display, Display systems, sequential scanning and interlaced scan.

MODULE V – FINITE ELEMENT METHOD (7 Lecture Hours)
Introduction to FEM, Principle of minimum potential energy, steps involved in FEM, discretization, types of nodes and elements, elemental stiffness matrix, elemental strain displacement matrix, types of force, elemental force matrix, assembly, shape function, introduction to 2 dimensional FEM.

MODULE VI – OPTIMIZATION AND NEW TECHNIQUES OF CAD (7 Lecture Hours)
Introduction to Optimization, Johnson method of optimization, normal specification problem, redundant specification problem, introduction to genetic algorithm. New Techniques: RPT, laser and non- laser process of RPT, STL format to CAD file, Introduction to reverse engineering and related software's viz. rapid form.

Reference Books:

1. Ibrahim Zeid, "CAD - CAM Theory and Practice", Tata McGraw Hill Publishing Co. Ltd., 2009.
2. Kunwoo Lee, "Principles of CAD/CAM/CAE Systems", Addison Wesley, 2005.
3. Rao. S.S. "The Finite Element Method in Engineering", 2nd Edition, Pergamon Press, Oxford, 2009.
4. P.N. Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill Publishing Co. Ltd., 2010.
5. Bathe K.J., "Finite Element Procedures", K.J. Bathe, Watertown, MA, Fourth edition, 2016

18ME3021	VIBRATION LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on
1. Fundamentals of digital data acquisition, signal processing, data reduction and display
2. Sensors, signal conditioning and associated instrumentation for vibration
3. Vibration measurement techniques

Course Outcomes: After completing the course the student will be able to
1. Study the effect of dynamics on vibration.
2. Recognize the instrumentation used in vibration control tests.
3. Understand the working principle of vibration measuring instruments
4. Adapt and evaluate the way to measure vibration
5. Gain knowledge of fundamental information about vibration phenomenon and find remedy of the vibration problems encountered in machineries
6. Understand the behavior of vibration in simple mechanical systems

LIST OF EXPERIMENTS
1. Longitudinal Vibration for single degree of freedom system
2. Torsional vibration for single degree of freedom system
3. Forced vibration for spring mass system
4. Multiple degree of freedom system
5. Transmissibility ratio in vibration table
6. Study of frequency and amplitude in vibration table
7. Vibration measurement using accelerometer for rotating machinery
8. Frequency measurement using Impact hammer

9. Real Time PC based vibration measurement
10. Measurement of Acoustic Emission signals
11. Generation of vibration signal by vibration controller
12. Study on the effect of material on load and deflection using tensile test

18ME3022	MULTIBODY DYNAMICS LABORATORY (ADAMS)	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on
1. Various linkage mechanisms
2. Simulation software like ADAMS
3. Kinematics and dynamics of mechanisms using software like ADAMS.

Course Outcomes: After completing the course the student will be able to
1. Illustrate the movements involved in various links and joints using software like ADAMS
2. Understand the various constraints and degree of freedom in the simple mechanism
3. Simulations of the mechanics involved in real life applications
4. Describe the mechanisms and motions of simple mechanical system
5. Find the DOF in various links and joints
6. Understand the working of different mechanism by relating it to simple computer simulation models using ADAMS software

LIST OF EXPERIMENTS
1. Simple motion analysis of one degree of freedom pendulum
2. Simulation of a slider crank mechanism
3. Simulation of a simple belt (open belt drive)
4. Simulation of a simple gear drive.
5. Velocity and Acceleration analysis
6. Angular velocity of a simple four bar mechanism
7. Position analysis of two degree of freedom link system
8. Vibration analysis of a spring mass system
9. Spring damper analysis
10. Quick return mechanism- simulation
11. Simulation of Hartnel governor
12. Simulation of IC engine crank multibody.

Reference Books:
1. Lab Manual

18ME3023	NUCLEAR POWER ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. The fundamental terms and concepts of nuclear power engineering.
2. The neutron life cycle, heat flow, radiation, fluidized bed reactor.
3. The safety principles and methods utilized in designing, constructing and operating a safe nuclear power plant.

Course Outcomes: After completing the course the student will be able to
1. Explain fundamental physics that applies to a broad range of nuclear technologies.
2. Understand the coolant channel orificing, hot spot factors.
3. Acquire knowledge on reactor hydraulics, different bed reactors.
4. Determine thermal reaction equation, temperature, pressure coefficient.
5. Estimate safety calculations in support of the preparation of an abbreviated safety analysis
6. Demonstrate an understanding of social, professional, and ethical issues related to the safe and wise development of nuclear science and engineering.

MODULE I – REVIEW OF NUCLEAR PHYSICS (8 Lecture Hours)
Nuclear Equations ,Energy from Nuclear Reactions and Fission ,Thermal neutrons , Nuclear Cross Sections ,Neutron Flux distribution in cores, slowing down , Neutron life cycle, Thermal Reaction Equation , Buckling Factors – Reactivity and Reactor Period , Radio activity, half-life ,neutron interactions, cross sections.
MODULE II – HEAT GENERATION IN REACTOR (8 Lecture Hours)
Reactor Heat generation and Removal – Volumetric Thermal source Strength – Heat flow in and out of solid fuel element – Temperature variations across Fuel elements.
MODULE III – REACTOR COOLING (8 Lecture Hours)
Coolant channel orificing – Hot spot factors – Absorption of Core radiation – Total heat generated in the core. Heat removal in solids subjected to radiation – Thermal Shield quality and void fractions in flow and non-flow systems.
MODULE IV – TYPES OF REACTOR (8 Lecture Hours)
Boiling water reactor hydraulics- Change of Phase reactor. Fluidized Bed Reactor, Gas Cooled Reactor steam Cycle- Simple and Dual Pressure Cycle, Pebble Bed Reactors, Fluid Fuelled Reactors – Types – Corrosion and Erosion Characteristics.
MODULE V – FUSION ENERGY CONVERSION (8 Lecture Hours)
Energy From Nuclear fusion, Thermonuclear Fusion, D-T Reaction, P-P Reaction, Fuel Cycle, Conditions for Fusion, Plasma confinement and Heating- Magnetic Confinement fusion, Inertial Confinement Fusion.
Module VI – SAFETY OF NUCLEAR PLANTS (8 Lecture Hours) Nuclear plant safety – safety systems-changes and consequences of an accident-criteria for safety.

Reference books:

1. Samuel Glasstone and Alexander Setonske, 'Nuclear reactors Engineering', 4th Edition, CBS Publishers and Distributors, 2004.
2. Singhal R.K., "Nuclear Reactors", New age international Private limited, 1st Edition 2014.
3. Vaidyanathan G "Nuclear Reactor Engineering", S. Chand &Company, 2012.
4. Kenneth D.Kok "Nuclear Engineering Handbook", CRC Press 2016.
5. John R Lamarsh "Introduction to Nuclear Engineering", Pearson 3rd Edition 2001.

18ME3024	ENERGY CONSERVATION AND MANAGEMENT	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on
1. Energy conservation.
2. Energy auditing.
3. Energy management.

Course Outcomes: After completing the course the student will be able to
1. Discuss the present status of national energy scenario.
2. Compare the different forms of energy.
3. Apply various energy auditing methods.
4. Analyze the energy conservation areas in thermal systems.
5. Estimate the energy conservation areas in electrical systems.
6. Choose the different financial management methods.

MODULE I – ENERGY SCENARIO (6 Lecture Hours)
Introduction – primary and secondary energy, commercial and non-commercial energy, renewable and non-renewable energy. Global energy reserves – Indian energy scenario. Energy strategy for the future – Energy conservation act.
MODULE II – BASICS OF ENERGY AND VARIOUS FORMS (6 Lecture Hours)
Various forms of energy – grades of energy. Electrical energy basics – Electricity tariff – Basics of thermal energy
MODULE III – ENERGY AUDIT (6 Lecture Hours)

Definition and Objectives of energy audit – Need for energy audit – Types of energy auditing – Instruments used for energy auditing

MODULE IV – ENERGY CONSERVATION IN THERMAL SYSTEMS (9 Lecture Hours)

Introduction - Energy conservation in thermal systems – Boilers, Furnaces and Heat Exchangers. Energy conservation in buildings - Tips for energy efficiency in thermal systems

MODULE V – ENERGY CONSERVATION IN ELECTRICAL SYSTEMS (9 Lecture Hours)

Introduction - Energy conservation in electrical systems - Electric motors – Refrigeration and Air-conditioning System – Pumps – Compressors - Tips for energy efficiency in electrical systems.

MODULE VI – ENERGY MANAGEMENT (9 Lecture Hours)

Energy management principles, need for organization and goal setting - Life cycle costing and other methods - Factors affecting economics - Introduction to financial management - Simple payback period - Net present value method – Internal rate of return method.

Reference books:

1. Albert Thumann, Plant Engineers and Managers guide to energy conservation, 10th Edition. Fairmount Press, 2011.
2. Shinskey E.G., Energy Conservation through control, Academic Press, 1978.
3. General Aspects of Energy Management and Energy Audit Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.
4. Energy Efficiency in Thermal Utilities Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.
5. Energy Efficiency in Electrical Utilities Guide Book, Bureau of Energy Efficiency, Third Edition, 2010

18ME3025	SOLAR ENERGY UTILIZATION	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Solar energy and techniques to utilize it efficiently and cost effectively.
2. Conversion of sunlight to heat for either direct usage or further conversion to other energy carriers.
3. Design a solar thermal system for a desired application.

Course Outcomes: After completing the course the student will be able to

1. Understand the available solar energy and the utilization processes.
2. Compare the different types of solar collectors.
3. Evaluate the performance of solar collectors.
4. Analyze the performance of solar air heaters.
5. Explain the energy storage system.
6. Apply the solar energy technology for various applications.

MODULE I – INTRODUCTION (9 Lecture Hours)

Energy alternatives – New energy technologies – Solar thermal process Solar Radiation – Solar constant – extra-terrestrial radiation – clear sky irradiation – solar radiation measurement – estimation of average solar radiation – solar radiation on tilted surface.

MODULE II – FLAT PLATE COLLECTORS (9 Lecture Hours)

Energy balances equation and collectors efficiency – collector performance – collector improvements, effect of incident angle, dust and shading – thermal analysis of flat plate collector and useful heat gained by the fluid - collector design – heat transfer factors.

MODULE III – CONCENTRATION COLLECTORS (9 Lecture Hours)

Parabolic concentrators, non-imaging concentrators, other forms of concentrating collectors. Tracking – receiver shape and orientation – performance analysis – reflectors – reflectors orientation – performance analysis.

MODULE IV – SOLAR AIR HEATERS (6 Lecture Hours)

Introduction – Performance analysis of a conventional air heater – Other types of air heaters – Testing procedures.

MODULE V – SOLAR ENERGY STORAGE (6 Lecture Hours)

Stratified storage – well mixed storage – comparison – Hot water system – practical consideration – solar ponds – principle of operation and description of Non-convective solar pond – extraction of thermal energy application of solar ponds.

MODULE VI – APPLICATIONS OF SOLAR ENERGY (6 Lecture Hours)

Solar electric power generation, photo voltaic cells. Solar furnace, Solar Chimney, heaters – power generation system. Tower concept – solar refrigeration system, thermoelectric refrigeration system.

Reference Books:

1. John.A. Duffie and Willam A.Beckman., 'Solar Engineering of Thermal Processes', Wiley, 2006.
2. Suhatme, S.P., 'Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 2008.
3. Kriender, J.M., 'Principles of Solar Engineering', McGraw Hill, 2000.
4. Mangal, V.S., 'Solar Engineering', Tata McGraw Hill, 1992.
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

18ME3026	**AIR-CONDITIONING SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Working principle of air-conditioning cycles.
2. Components of cooling load.
3. Air distribution system.

Course Outcomes: After completing the course the student will be able to

1. Analyze psychrometry processes.
2. Compare different types of air-conditioning systems.
3. Evaluate the space cooling load.
4. Design the duct.
5. Choose the fan for desired application
6. Design the water and refrigerant piping

MODULE I – PSYCHROMETRY AND AIR CONDITIONING PROCESSES (9 Lecture Hours)

Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Enthalpy potential and its insights.

MODULE II – TYPES OF AIR CONDITIONING SYSTEMS (6 Lecture Hours)

Thermal distribution systems – Single, multi zone systems, terminal reheat systems, Dual duct systems, variable air volume systems, water systems and unitary type systems.

MODULE III – COOLING LOAD ESTIMATION (9 Lecture Hours)

Thermal comfort – Design conditions – Solar Radiation-Heat Gain through envelopes – Infiltration and ventilation loads – Internal loads – Procedure for heating and cooling load estimation using ISHRAE Handbook

MODULE IV – DUCT DESIGN (6 Lecture Hours)

Flow through Ducts, Static and Dynamic Losses, Diffusers, Duct Design–Equal Friction Method.

MODULE V – FAN (6 Lecture Hours)

Fan and its types, Fan characteristics and laws. Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units – Control of temperature, humidity, air flow and quality.

MODULE VI – WATER PIPING AND REFRIGERANT PIPING DESIGN (9 Lecture Hours)

Basics of water and refrigerant piping – Design of chilled water piping – Design of refrigerant piping.

Reference Books:

1. Arora C.P., Refrigeration and Air conditioning, McGraw Hill, 3rd Ed., 2010.

2. ASHRAE , Fundamentals and equipment , 4 volumes-ASHRAE Inc. 2005
3. Jones, Air Conditioning Engineering, Edward Amold pub. 2001.
4. Langley, Billy C. Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall 1986.
5. Air-conditioning HandBook, ISHRAE, 2014.

18ME3027	GAS TURBINES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Fundamental principles of fluid mechanics and thermodynamics in the analysis of aircraft engines.
2. Gas turbine aircraft propulsion systems.
3. Selection of gas turbine systems.

Course Outcomes: After completing the course the student will be able to

1. Compare and contrast open and closed gas turbine cycles and appreciate their impact on environment.
2. Apply the gas dynamics principles and evaluate shock phenomenon.
3. Analyze gas turbine cycles for aircraft propulsion.
4. Select compressors for gas turbine systems.
5. Recognize various types of combustion system.
6. Evaluate performance of gas turbine systems.

MODULE I – SHAFT POWER CYCLES (8 Lecture Hours)
Introduction-shaft power cycles-ideal cycle, open cycle and closed cycle gas turbines-combined cycles-, comparative performance of practical cycles- Jet propulsion cycles and their analysis, environmental considerations and applications.
MODULE II – GAS DYNAMICS (8 Lecture Hours)
Energy and momentum equations for compressible fluid flows, stagnation state, velocity of sound, critical states, Mach number, flow through variable area ducts, flow through constant area ducts, normal shock, flow with oblique shock.
MODULE III – AIRCRAFT PROPULSION (7 Lecture Hours)
Gas turbine cycles for aircraft propulsion -simple turbojet cycle-the turbofan engine-turboprop engine-the turbo shaft engine-thrust augmentation-auxiliary power units.
MODULE IV – COMPRESSORS (8 Lecture Hours)
Centrifugal compressors-principle of operation-the diffuser-compressor characteristics and improvement, axial flow compressors- basic operation-degree of reaction- Blade materials, manufacturing techniques, blade fixing, blade design-axial flow compressor characteristics and improvement- mixed flow compressor, parameters affecting performance.
MODULE V – COMBUSTION SYSTEMS (6 Lecture Hours)
Types of combustion systems- various fuels and fuel systems, the combustion process-factors affecting combustor design-combustion chamber performance-gas turbine emissions.
MODULE VI – AXIAL AND RADIAL FLOW TURBINES (8 Lecture Hours)
Elementary theory of axial flow turbine-vortex theory-choice of blade profile, pitch and chord, estimation of stage performance, overall turbine performance- Problems of high temperature operation, blade cooling, and practical air cooled blades, the radial flow turbine

Reference Books:

1. HIH Saravanamuttoo, GFC Rogers, H Cohen, Gas turbine theory, Pearson education ltd, 5th edition, 2013.
2. V. Ganesan, "Gas Turbines", Tata McGraw Hill, 2014.

3. S.M.Yahya "Turbines, Compressors and Fans", Tata McGraw Hill, 2012.
4. Vincent "The theory and design of Gas Turbine and Jet Engines", McGraw Hill, 2015.
5. W W Bathic, "Fundamentals of Gas Turbines", John Wiley and Sons, 2007

18ME3028	ADVANCED INSTRUMENTATION IN THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. The working of measuring instruments and errors associated with them.
2. Error analysis and uncertainty of measurements.
3. The measurement and data acquisition applicable to a thermal systems.

Course Outcomes: After completing the course the student will be able to
1. Identify experimental data and predict correlation.
2. Interpret uncertainties in various measurements.
3. Apply measurement techniques of intensive and extensive properties.
4. Analyze specific functional characteristics of thermal instruments.
5. Estimate the control system parameters using analog and digital controllers.
6. Formulate concepts to reduce errors in measurements.

MODULE I – MEASUREMENT CHARACTERISTICS (8 Lecture Hours)
Introduction to measurements, errors in measurements, statistical analysis of data, regression analysis, correlation, estimation of uncertainty and presentation of data.
MODULE II – MEASUREMENTS IN THERMAL SYSTEMS (7 Lecture Hours)
Basic Electrical measurements, Transducers and its types, Measurement of temperature, pressure, velocity, flow - simple and advanced techniques.
MODULE III – MEASUREMENT OF THERMO-PHYSICAL PROPERTIES (8 Lecture Hours)
Thermal conductivity, viscosity, surface tension, specific heat capacity, radiation properties of surfaces.
MODULE IV – MEASUREMENT OF FUEL PROPERTIES (8 Lecture Hours)
Flame ionization detector, non-dispersive infrared analyzer, smoke meters, and gas chromatography
MODULE V – DATA LOGGERS (8 Lecture Hours)
Data logging and acquisition, sensors for error reduction, elements of computer interfacing, timers and counters.
MODULE VI – DESIGN OF EXPERIMENTS (8 Lecture Hours)
Modeling of thermal equipment. Examples applied to heat transfer problems and energy systems.

References Books:
1. Doebelin O.E., 'Measurement Systems and Design', McGraw Hill Co., 2003.
2. Holman J.P., 'Experimental Methods for Engineers', McGraw Hill Co, 2001.
3. Beckwit T.G. and Buck M.L., 'Mechanical Measurements', Addition Wesley, 2011.
4. B.C. Nakra 'Instrumentation measurement and Analysis', Tata McGraw-Hill Publishing Company, 2002
5. R.K. Jain, 'Mechanical and Industrial Measurements' Khanna Publishers, 2000.

18ME3029	BIOMASS ENERGY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Types of biomass resources and their properties.
2. Biomass conversion processes and application of conversion products.
3. Economics and sustainability of biofuels.

Course Outcomes: After completing the course the student will be able to
1. Select suitable biomass for conversion, based on its properties.

2. Analyze the performance of engines using biodiesel.
3. Design a community biogas plant.
4. Select conditions for biomass pyrolysis & develop a small size biomass gasifier.
5. Demonstrate techniques used for liquefaction of biomass.
6. Explain the economics of production processes of bio fuels.

MODULE I – BIOMASS AS ENERGY SOURCE (8 Lecture Hours)
Biomass energy usage in different countries – Advantages and disadvantages in use of biomass as energy source- Sources of biomass available for energy use- physical properties of biomass- proximate analysis- ultimate analysis- heating value analysis- Empirical relations for estimating heating values- Application of biomass conversion products.
MODULE II – BIODIESEL PRODUCTION (8 Lecture Hours)
Vegetable oil and animal fat characteristics- fatty acid composition-oil extraction processes-oil refining processes-Transesterification- ASTM characterization- Engine performance and exhaust emissions.
MODULE III – BIOGAS PRODUCTION (8 Lecture Hours)
Biomass parameters important in anaerobic digestion- Acid and methane forming microbes-advantages and disadvantages of anaerobic digestion processes- design of biogas digester- biogas utilization.
MODULE IV – PYROLYSIS AND GASIFICATION (10 Lecture Hours)
Pyrolysis processes based on heating rate- effect of temperature on product yields- applications of products from fast pyrolysis-bio oil characterization processes- bio oil upgrade processes- advantages and disadvantages of pyrolysis process. Chemistry of biomass gasification- various types of gasifiers- applications of biomass gasifiers- empirical chemical formula of biomass- air requirement for gasification- equivalence ratio calculations in a gasifier- syngas requirement in internal combustion engines.
MODULE V – BIOMASS LIQUEFACTION (7 Lecture Hours)
Bioethanol production - household and pilot scale ethanol production systems- Methanol production from synthesis gas- Fischer Tropsch processes- direct liquefaction processes- Advantages and disadvantages of biomass liquefaction processes.
MODULE VI – BIOFUELS COMBUSTION AND ECONOMICS (7 Lecture Hours)
Applications of biomass combustion systems- amount of CO_2 produced for every metric ton of biomass combusted- biomass combustion efficiency- Economics of production processes for major biofuels-measuring sustainability of biofuels.

Reference Books:

1. Sergio C. Capareda, "Introduction to Biomass Energy Conversions" CRC press, Taylor & Francis, 2014.
2. Prabir Basu, "Combustion and Gasification in Fluidized beds" CRC press, Taylor & Francis, 2009.
3. G.D. Rai, "Non-Conventional Energy Sources", 8th reprint, Khanna Publishers, 2013
4. O.P. Chawla, "Advances in Biogas Technology", Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2013.
5. K.M. Mital, "Biogas Systems: Principles and Applications", 1st Edition, New Age International Private Ltd, New Delhi, 2012.

18ME3030	**DESIGN AND ANALYSIS OF HEAT EXCHANGERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course objectives: To impart knowledge on
1. Classification of Heat exchangers.
2. Design of Shell and tube, compact heat exchangers.
3. Basic design methods of heat exchangers.

Course Outcomes: After completing the course the student will be able to
1. Identify the constructional aspects of various types of heat exchangers.
2. Predict the effectiveness of heat exchangers NTU method.

3. Calculate the design parameters of shell-and-tube heat exchanger.
4. Analyze compact heat exchanger.
5. Evaluate the performance of condensers.
6. Formulate concepts of single and multi-effect evaporators.

MODULE I – VARIOUS TYPES OF HEAT EXCHANGER (8 Lecture Hours)
Introduction, Recuperation and regeneration, Transfer processors, Geometry of construction, tubular heat exchangers, plate heat exchangers, extended surface heat exchangers ; Heat transfer mechanisms, Flow arrangements, Selection of heat exchangers.
MODULE II – BASIC DESIGN METHODS OF HEAT EXCHANGERS (7 Lecture Hours)
Arrangement of flow path in heat exchangers; basic equations in design; Overall heat transfer coefficient; LMTD and NTU methods for heat exchanger analysis, Heat exchanger design calculation, Variable overall heat transfer coefficient, Heat exchanger design methodology.
MODULE III – SHELL AND TUBE HEAT EXCHANGERS (8 Lecture Hours)
Basic components-shell types, tube bundle types, tubes and tube passes, tube layout in baffle type heat exchanger, allocation of stream; basic design procedure of a heat exchanger- unit size, performance rating.
MODULE IV – DESIGN OF DOUBLE PIPE HEAT EXCHANGERS(7 Lecture Hours)
Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop.
MODULE V – COMPACT HEAT EXCHANGE (8 Lecture Hours)
Plate-fin heat exchanger, tube-fin heat exchangers, Heat transfer, pressure drop in finned-tube and plate-fin heat exchanger.
MODULE VI – CONDENSERS AND EVAPORATORS (7 Lecture Hours)
Shell-and-tube condensers-horizontal shell-side condensers, vertical tube-side condensers, horizontal in-tube condensers , steam turbine exhaust condensers ; Plate condensers ; Air-cooled condensers ; Direct contact condensers ; Thermal design of shell-and-tube condensers**,** Single and multi-effect evaporators.

Reference Books:

1. Frass, A.P. and Ozisik, M.N., 'Heat Exchanger Design', John Wiley and Sons Inc., 1965.
2. Wlker G., 'Industrial Heat Exchangers', A basic guide, McGraw Hill V Book Co., 1980.
3. Standards of the Tubular Exchanger Manufacturer Association', 6^{th} Ed., Tubular Exchanger Manufacturers Association, New York, 2007
4. Donold Q Kern., 'Process Heat Transfer', McGraw Hill Book Co., 1988.
5. E.A.D. Saunders., 'Heat Exchangers', Longman Scientific and Technical, New York, 1988.

18ME3031	TWO PHASE FLOW AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge of
1. Two phase flow and circulation in boiler.
2. Heat transfer with change of phase in condensation and boiling.
3. Fluidized beds and gas-liquid fluidization.

Course Outcomes: After completing the course the student will be able to
1. Understand vertical, horizontal and inclined two phase flow.
2. Determine effective pressure head in boiler tubes.
3. Choose various types of fluidized beds.
4. Evaluate heat transfer during condensation.
5. Analyze heat transfer with change of phase in boiling.
6. Explain various gas- liquid fluidizations.

MODULE I – TWO PHASE FLOW (8 Lecture Hours)
Simultaneous flow of liquids and gases, horizontal two phase flow, lock hart and Martenelli procedure flow factor method, vertical two phase flow, two phase flow through inclined pipes.

MODULE II – CIRCULATION IN BOILER **(7 Lecture Hours)** Natural and forced circulation, effective pressure head in boiler tubes, variation of major parameters of drum during transient conditions, the hydrodynamics stability of vapor – liquid system.

MODULE III – FLUIDIZED BEDS **(8 Lecture Hours)** Simultaneous flow of fluids and solids, dynamics of particles submerged in fluids, flow through packed bed. Fluidization, calculation of pressure drop in fixed bed, determination of minimum fluidization velocity, Expanded bed, dilute phase, moving solids fluidization, Elutriation in fluidized Bed, Semi fluidization, applications, Pulsating column, oscillating fluidized beds.

MODULE IV – CONDENSATION **(7 Lecture Hours)** Film wise condensation of pure vapors, Drop wise condensation in plated surfaces, condensation in presence of non-condensable gas.

MODULEV – BOILING **(8 Lecture Hours)** Pool boiling, Boiling in forced flow inside tubing.

MODULE VI – GAS-LIQUID FLUIDIZATION **(7 Lecture Hours)** Gas liquid particle process, Gas liquid particle operation, Gas liquid fluidization. Flow of Gas - Bubble formation, bubble growth gas hold up, Gas mixing liquid holdup, liquid mixing, flow of liquid mixing, Gas liquid mass transfer.

Reference books:

1. Ginou J.N., 'Two Phase Flow & Heat Transfer', McGraw Hill, New York, 1978.
2. Mc Adams., 'Heat Transmission', McGraw Hill, 1954.
3. Daugherty and Franzini., 'Fluid Mechanics with Engineering Applications', McGraw Hill, 1997.
4. S.C. Kutateladeze., 'Problems of Heat Transfer and Hydraulics of Two Phase Media', Pergamon Press, 2013.
5. L.S. Tong., 'Boiling Heat Transfer and Two Phase Flow', 2nd edition Wiley, New York, 1997.

18ME3032	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Governing equations in fluid dynamics.
2. Solution methodologies of discretized equations.
3. Turbulence and combustion models.

Course Outcome: After completing the course the student will be able to

1. Develop governing equations for fluid flow and heat transfer.
2. Demonstrate the physical behaviors of flow.
3. Perform cfd analysis.
4. Impose boundary conditions while solving CFD problems.
5. Applying turbulence and combustion models in problem solving.
6. Develop various types of grids for solving CFD problems.

MODULE I – GOVERNING EQUATIONS AND BOUNDARY CONDITIONS (8 Lecture Hours)

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Physical boundary conditions – Time averaged equations for Turbulent flow - Turbulence -Kinetic –Energy Equations.

MODULE II – DIFFUSION **(8 Lecture Hours)**

Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

MODULE III – CONVECTION AND DIFFUSION **(8 Lecture Hours)**

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.

MODULE IV – SOLUTION METHODOLOGIES (7 Lecture Hours)

Solution methodologies: Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE algorithm and its variants.

MODULE V – GRID GENERATION (7 Lecture Hours)

Introduction, Structured and Unstructured Grids, Hybrid Grids, Algebraic, Elliptic, Hyperbolic Grid generation. Unstructured grids of triangular and Tetrahedral, Unstructured grids of Quadrilateral and Hexahedral, Cartesian Mesh, Adaptive Mesh.

MODULE VI – TURBULENCE AND COMBUSTION (7 Lecture Hours)

Turbulence models: mixing length model, two equation (k-E) models. Combustion models: pre mixed combustion, diffused combustion.

Reference Book

1. Anderson, J.D., "Computational fluid dynamics – the basics with applications", 1995.
2. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics:The Finite Volume Method", Longman, 1998
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw- Hill Publishing Company Ltd., 1998.
4. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", McGraw-Hill, 1980. Ane-Books2004 Indian Edition.
5. Bose, T.K., "Numerical Fluid Dynamics", Narosa publishing House, 1997.

18ME3033	ADVANCED IC ENGINES	L	T	P	C
		3	0	0	3

Course objectives: To impart knowledge on

1. Performance of SI and CI engines.
2. Understand recent trends in engine technology.
3. Engine exhausts emission control and alternate fuels.

Course Outcomes: After completing the course the student will be able to

1. Classify different types of internal combustion engines.
2. Analyze performance of spark ignition and compression ignition engines.
3. Identify recent technology trends in engine.
4. Study about friction reduction and light weighting technologies.
5. Predict concentrations of primary exhaust pollutants.
6. Analyze the performance and emissions of alternate fuels.

MODULE I – SPARK IGNITION ENGINES (8 Lecture Hours)

Mixture requirements of air-fuel ratio, Fuel injection system, Monopoint, Multipoint & Direct injection -Stages of combustion, Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers, New technologies employed in 3 way catalytic convertor, stoichiometric and lean combustion.

MODULE II – COMPRESSION IGNITION ENGINES (7 Lecture Hours)

Diesel Fuel Injection Systems, Stages of combustion, Knocking, Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Fuel Spray behavior, Spray structure and spray penetration, Air motion, Introduction to Turbo charging, Advanced trends in Diesel oxidation catalyst (DOC), and Diesel particulate filter(DPF).

MODULE III – POLLUTANT FORMATION AND CONTROL (8 Lecture Hours)

Pollutant, Sources, Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter, Methods of controlling Emissions. Catalytic converters, Latest emission control techniques used in selective Catalytic Reduction and Particulate Traps, Methods of measurement, Emission norms.

MODULE IV – NON CONVENTIONAL I.C. ENGINES (7 Lecture Hours)

Introduction, Duel fuel / Multi fuel engine, stratified charge, adiabatic engine, Variable Compression Ratio engine, Free piston engine, Sterling engine, Wankel engine, HCCI engine.

MODULE V – ALTERNATIVE FUELS (8 Lecture Hours)

Bio Diesel, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Ethanol and Methanol– Properties, Suitability, Merits and Demerits – Engine Modifications. Latest technology in alternative sources of energy.

MODULE VI – AUTOMOTIVE FUEL INJECTION SYSTEM (7 Lecture Hours)

Air assisted Combustion, Supercharging, Adiabatic combustion, friction reduction, light weighting, composite engine materials, Current trends in multi-point fuel injection system, Gasoline Direct Injection Systems, Hybrid Electric, downsizing and de-rating of engines.

Reference Books:

1. R.P.Sharma and M.L.Mathur: "A course in Internal Combustion Engines", D.Rai & sons.2016.
2. S.S. Thipse, "Alternative Fuels", Jaico Publications, 2010.
3. S.S. Thipse, "IC Engines", Jaico Publications, 2014.
4. Robert Bosch, "Automotive Hand Book", SAE 9th Edition, 2014.
5. Ganesan. V., "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2012 .

18ME3034	ADVANCED TURBO MACHINERY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Various types of turbine, pump and compressor.
2. Performance analysis of turbines, pumps and compressors.
3. Application of turbo machines.

Course Outcomes: After completing the course the student will be able to

1. Classify types of turbine, pump, and compressors.
2. Demonstrate knowledge of turbines, pumps and compressors.
3. Compare the performance of turbo machines.
4. Select turbo machines for specific applications.
5. Analyze flow patterns in turbo machines.
6. Design micro and small turbo machines.

MODULE I – CLASSIFICATION OF TURBO MACHINERY (7 Lecture Hours)

Introduction, definition of turbo machine, parts of turbo machines, comparison with positive displacement machines, classification, dimensionless parameters and their significance, effect of Reynolds's number, unit and specific quantities, model studies, application of first and second law's of thermodynamics to turbo machines, efficiencies of turbo machines, problems

MODULE II – THERMODYNAMICS OF FLUID FLOW (7 Lecture Hours)

Static and Stagnation states- Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency and polytropic efficiency for compression and expansion processes. Reheat factor for expansion process.

MODULE III – ENERGY EXCHANGE IN TURBO MACHINES (7 Lecture Hours) Euler's turbine equation, alternate form of Euler's turbine equation, velocity triangles for different values of degree of reaction, components of energy transfer, degree of Reaction, utilization factor, relation between degree of reaction and utilization factor, problems.

MODULE IV – GENERAL ANALYSIS OF TURBO MACHINES (8 Lecture Hours) Radial flow compressors and pumps, expression for degree of reaction, velocity triangles, effect of blade discharge angle on energy transfer, degree of reaction, and performance, theoretical head capacity relationship, general analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, problems.

MODULE V – STEAM TURBINES (8 Lecture Hours)

Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor, Reaction turbine, Parsons turbine, condition for maximum utilization factor, reaction staging problems.

MODULE VI – HYDRAULIC TURBINES (8 Lecture Hours)

Classification, Different efficiencies, Pelton turbine, velocity triangles, design parameters, maximum efficiency, Francis turbine -velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines -velocity triangles, design parameters, problems.

Reference Books:

1. A.Valan Arasu, "Turbo machines" Vikas publishing house pvt Ltd, 2012
2. Lee, 'Theory and Design of Steam and Gas Turbine', McGraw Hill, 2011.
3. S.M Yahya., 'Turbines, Compressions and Fans', Tata McGraw Hill, 2015.
4. D.G. Stephard, 'Principles of Turbo machines', Macmillan Co., 2005.
5. Bathe W N, 'Fundamentals of Gas Turbines', Willey and Sons, 2006.

18ME3035	DESIGN OF SOLAR AND WIND SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Fundamental principles of thermodynamics and heat transfer for performance analysis of solar energy collectors.
2. Small scale wind mills.
3. Various alternative energy sources for power generation.

Course Outcomes: After completing the course the student will be able to

1. Identify renewable energy sources for power generation.
2. Obtain solar radiation data.
3. Analyze the performance of solar energy collectors.
4. Select wind power generators for specific applications.
5. Recognize various types of fuel cells and solar pv systems.
6. Recognize different sources of alternate energy and evaluate performance of thermoelectric power generators.

MODULE I – INTRODUCTION TO ENERGY SOURCES (7 Lecture Hours)

Energy consumption as a measure of prosperity-world energy futures- energy sources and their availability-conventional energy sources- new energy technologies-renewable energy sources-prospects of renewable energy sources.

MODULE II – SOLAR RADIATION AND ITS MEASUREMENT (7 Lecture Hours)

Solar constant-solar radiation at the earth's surface- solar radiation geometry- solar radiations measurements- solar radiation data- estimation of average solar radiation- solar radiation on tilted surfaces- solar energy utilization.

MODULE III – SOLAR ENERGY COLLECTORS AND STORAGE (8 Lecture Hours)

Flat plate collectors- energy balance equation and collector efficiency- concentrating collectors-performance analysis of solar collectors- selective absorber coatings- solar air heaters- solar energy storage systems- thermal energy storage- solar pond.

MODULE IV – WIND ENERGY (8 Lecture Hours)

Basic principles of wind energy conversion- wind data and energy estimation- site selection considerations- components of wind energy conversion system- types of wind machines- performance of wind machines- applications of wind energy- interconnected system- safety systems- environmental aspects.

MODULE V – SOLAR PHOTO-VOLTAICS, MHD AND FUEL CELLS (7 Lecture Hours)

Photovoltaic cells- solar cell modules, applications, advantages and disadvantages of photovoltaic solar energy conversion- principle of MHD power generation, MHD systems, advantages, materials for MHD generators- principle of operation of a fuel cell, types, advantages and disadvantages, applications, batteries.

MODULE VI – OTHER ALTERNATE ENERGY SOURCES (8 Lecture Hours)

Thermionic generation- analysis of thermionic generator- thermoelectric power generator, performance analysis, thermoelectric materials- energy from biomass- biomass conversion technologies, biogas generation, classification of biogas plants- hydrogen energy, hydrogen production, storage, transportation and utilization- geothermal- geothermal sources, geothermal power plants, advantages and disadvantages, applications.

Reference Books:

1. G.D.Rai, Non-conventional energy sources, Khanna publishers, 5th edition, 2011
2. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2010.
3. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2014.
4. N.K. Bansal "Non-Conventional Energy Sources" Vikas publishing, 2014
5. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 2006

18ME3036	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Basic concepts in total quality management
2. Statistical process control
3. Reliability computation and reliability improvement

Course Outcomes: After completing the course the student will be able to

1. Apply the basic tools of quality in product development
2. Analyze the basic tools of quality in improving or redesigning the production process
3. Adopt/adept TQM and SPC tools in product/process industries
4. Conduct experiments and to analyze the significance of proceeds parameters
5. Compute reliability of parallel, series and mixed configurations
6. Improve the reliability of the systems by redundancy

MODULE I – BASIC CONCEPTS (6 Lecture Hours)

Basic concepts in quality engineering and management, TQM, Cost of quality, quality engineering, concept of quality auditing, customer satisfaction.

MODULE II – QUALITY LEVEL (7 Lecture Hours)

Six sigma concept, Six Sigma sustainability, Six Sigma and lean production. Review of Probability and Statistics, Frequency distributions and Histograms, Test of Hypothesis.

MODULE III – STATISTICAL PROCESS CONTROL (9 Lecture Hours)

DMAIC process for process and design improvement, Acceptance Sampling, Statistical Process Control (SPC), Process Capability, Gage Reproducibility and Repeatability, Quality Function Deployment.

MODULE IV – FAILURE ANALYSIS (7 Lecture Hours)

Failure mode effect analysis, Fault-tree analysis APQP, Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles.

MODULE V – DESIGN OF EXPERIMENTS (8 Lecture Hours)

Procedure for DOE, Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design.

MODULE VI – RELIABILITY (8 Lecture Hours)

Definition, Survival and Failure rates-Series and parallel and mixed systems-Mean time between failure, Mean time to failure,-Availability models-redundancy

Reference Books:

1. Evans, J R and W M Lindsay, “An Introduction to Six Sigma and Process Improvement”, 2nd Edition, Cengage Learning, 2015.
2. J.M.Juran, “Quality planning and analysis”,McGraw Hill, 5th Edition,1**5** thReprint 2015
3. Montgomery, “Design and analysis of Experiments”, Wiley India, 5thEdition 2004
4. AmitavaMitra, “Fundamentals of quality control and Improvement”, Wiley India, 3rdEdition 2013
5. M.Mahajan, “Statistical Quality Control”, Dhanpat Rai Sons, 11th Edition 2007

18ME3037	MANUFACTURING SYSTEM AND SIMULATION	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Various modeling techniques.
2. Random number generation.
3. Manual and computer assisted simulation techniques.

Course Outcomes: After completing the course the student will be able to

1. Create model of the real manufacturing system.
2. Generate random numbers for simulation experiments.
3. Resolve practical problems in manufacturing sectors using simulation.
4. Analyse material handling problem and to give solutions.
5. Optimize the performance of a discrete system.
6. Verify and validate the simulation model.

MODULE I – BASICS OF SIMULATION (8 Lecture Hours)

Simulation-Introduction, advantages and limitations, areas of application, systems and system environment, components of a system, discrete and continuous system, models of a system, Types of models, Discrete event system simulation, steps in simulation study.

MODULE II – INFORMATION SYSTEMS (8 Lecture Hours)

Fundamentals of information technology, information networking, parts oriented production information systems, and computerized production scheduling, online production control systems. Computer based production management systems, principles and effectiveness of CIM, factory automation, FMS.

Module III – SIMULATION OF INVENTORY AND MAINTENANCE PROBLEMS(8 Lecture Hours)

Random number generations Random numbers generation- methods and techniques - Montecarlo simulation to solve inventory problem and maintenance problem. Queuing models: Review of terminology and concepts, characteristics of queuing systems, Queuing notations, Transient and steady state behavior-long run measures of performance of queuing systems.

MODULE IV – DISCRETE EVENT SIMULATION (7 Lecture Hours)

Concepts in discrete event simulation: Event scheduling/Time advance algorithm-manual simulation using event scheduling-list processing Programming for discrete event systems in GPSS.

MODULE V – MANUFACTURING SIMULATION (7 Lecture Hours)

Simulation of manufacturing & material handling system, manufacturing models - Types and uses, material handling –Goal and performance measures-Issues in Manufacturing &Material handling simulation-case studies-Introduction to softwares-SIMFACTORY,AIM,ARENA and TAYLOR II.

MODULE VI – VERIFICATION AND VALIDATION (7 Lecture Hours)

Simulation experiments, Verification and validation of simulation models. –Face validity-Validation of model assumptions, validation of input-output transformation-input-output validation.

Reference books:

1. Jerry Banks and John S. Carson, “Discrete –Event System Simulation”, Prentice Hall Inc, 2009.
2. Gordon G, “System Simulation”, Prentice Hall of India Ltd, 2009

3. D.S.Hira, “System Simulation”, S.Chand& Company Ltd, 2010.
4. Law.M.Kelton, “Simulation Modeling and Analysis”, McGraw Hill, NY, 2007
5. GeoferyGordan, Systems Simulation, Prentice Hall, 2013.

18ME3038	FLEXIBLE MANUFACTURING SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Demonstrates basics and components of FMS to learners
2. Discover the use of computers in FMS
3. Formulate the scheduling techniques of FMS

Course Outcomes: After completing the course the student will be able to
1. Understand the basic concepts and components of FMS
2. Identify Automated material handling systems used in FMS
3. Infer FMS control using computers
4. Formulate the modeling of FMS.
5. Analyze the data base for manufacturing systems
6. Compose the scheduling of FMS

MODULE I – INTRODUCTION TO FMS (8 Lecture Hours)
Definition of an FMS - Need for FMS - types and configuration - types of flexibilities and performance measures - Economic justification of FMS - Development and implementation of FMS - planning phases – integration - system configuration - FMS layouts - simulation.

MODULE II – AUTOMATED MATERIAL HANDLING AND STORAGE (8 Lecture Hours)
Functions – types - analysis of material handling systems - primary and secondary material handling systems – conveyors - Automated Guided Vehicles - working principle – types - traffic control of AGVs - Role of robots in material handling - Automated storage systems - storage system performance – AS/RS-carousel storage system - WIP storage systems - interfacing handling and storage with manufacturing.

MODULE III – COMPUTER CONTROL OF FMS (8 Lecture Hours)
Planning - scheduling and computer control of FMS - Hierarchy of computer control - supervisory computer. DNC system- communication between DNC computer and machine control unit - features of DNC systems.

MODULE IV – COMPUTER SOFTWARE AND SIMULATION (7 Lecture Hours)
System issues - types of software – specification and selection - trends - application of simulation and its software.

MODULE V – DATA BASE OF FMS (7 Lecture Hours)
Manufacturing Data systems - planning FMS data base - Modeling of FMS- analytical – heuristics – queuing - simulation and petrinets modeling techniques.

Module VI – SCHEDULING OF FMS (7 Lecture Hours)
Scheduling of operations on a single machine- two machine flow shop scheduling - two machine job shop scheduling, - three machine flow shop scheduling- scheduling ‘n’ operations on ‘n’ machines, knowledge based scheduling - scheduling rules - tool management of FMS - material handling system schedule.

Text Books:
1. Nand K. Jha “Hand-book of Flexible Manufacturing Systems” Academic Press, 1991
2. Raouf, A. and Ben-Daya, M., Editors, “Flexible manufacturing systems: recent development”, Elsevier Science, 1995.

Reference Books:
1. Parish.D.J., “Flexible Manufacturing”, Butter worth-Heinemann Ltd,1990.
2. Groover. M. P., “Automation production systems and computer integrated manufacturing”, Prentice hall of India pvt.Ltd, 1989.
3. TaiichiOhno, “Toyota production system: beyond large-scale production” Productivity Press (India) Pvt. Ltd. 1992.

4. Buffa .E.S. and Sarin, “Modern Production and Operations Management”, Wiley Eastern, 1987.
5. Radhakrishnan P. and Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd.,New Age International Ltd., 1994.

18ME3039	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. The use of computers in the area of manufacturing.
2. New technology in the area of manufacturing.
3. Artificial intelligence and expert systems in manufacturing systems.

Course Outcomes: After completing the course the student will be able to
1. Employ computers in the area of manufacturing to reduce manual processing.
2. Understand group technology
3. Apply computer aided process planning
4. Examine Material Requirement Planning (MRP) and Enterprise Resource Planning (ERP)
5. Apply computer aided quality control and Flexible manufacturing systems
6. Recommend Artificial intelligence and Expert systems

MODULE I – INTRODUCTION (8 Lecture Hours)
Objectives of a manufacturing system-identifying business opportunities and problems classification production - systems-linking manufacturing strategy and systems-analysis of manufacturing operations.
MODULE II – GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING (7 Lecture Hours)
Introduction-part families-parts classification and cooling - group technology machine cells benefits of group - technology. Process planning function CAPP - Computer generated time standards.
MODULE III – COMPUTER AIDED PLANNING AND CONTROL(7 Lecture Hours)
Production planning and control-cost planning and control-inventory management-Material requirements planning - (ERP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology automated data collection system.
MODULE IV – PRODUCTION MONITORING (7 Lecture Hours)
Types of production monitoring systems-structure model of manufacturing process-process control & strategies direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.
MODULE V – INTEGRATED MANUFACTURING SYSTEM (8 Lecture Hours)
Definition - application - features - types of manufacturing systems-machine tools-materials handling system computer control system - DNC systems manufacturing cell.
MODULE VI – FLEXIBLE MANUFACTURING SYSTEMS (8 Lecture Hours)
Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS – variable mission manufacturing system. Human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

Reference Books:
1. Mikell .P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2009.
2. YoremKoren, "Computer control Manufacturing Systems", McGraw Hill, 1999.
3. Kant Vajpayee, S, Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2007.
4. James A Retrg, Herry W Kraebber, Computer Integrated Manufacturing‖, Pearson Education, Asia, 2001.
5. Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

18ME3040	COMPUTER APPLICATIONS IN DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. How computers can be used in mechanical engineering design.
2. Basics of CAD modeling (surface and solid) and Visual realism.
3. The techniques for assembly of parts, tolerance analysis, mass property calculation, Solid modeling techniques and rapid prototyping.

Course Outcomes: After completing the course the student will be able to
1. Summarize the applications of computers Mechanical Engineering Design.
2. Categorize and use various surface and curve techniques for 3d modelling
3. Make use of solid modelling techniques for complex part designs.
4. Develop complex parts based on Visual realism techniques
5. Create part assemblies; apply tolerance analysis and mass property calculations.
6. Analyze simple truss and beam structures using FEA and construct using rapid prototyping techniques.

MODULE I – INTRODUCTION TO CAD FUNDAMENTALS (8 Lecture Hours)
Introduction to CAD- Design Process-Product cycle - Sequential and concurrent engineering- Graphics displays - Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

MODULE II – CURVES AND SURFACES MODELLING (9 Lecture Hours)
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

MODULE III – NURBS AND SOLID MODELING (8 Lecture Hours)
NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations – boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

MODULE IV – VISUAL REALISM (7 Lecture Hours)
Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

MODULE V – PART ASSEMBLY AND PRODUCT DATA EXCHANGE (7 Lecture Hours)
Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

MODULE VI – FINITE ELEMENT ANALYSIS (6 Lecture Hours)
Introduction to Finite element analysis/method – computer aided analysis of simple truss and beam – Computer aided mechanism simulation, Rapid prototyping- application of computers in RP.

Reference Books:

1. Ibrahim Zeid,CAD/CAM- Theory and Practice McGraw Hill, Indian Edition,2005
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Mikell. P. Grooves and emory, W. Zimmers Jr. "CAD/CAM Computer aided Design and Manufacturing " prentice Hall of Inc., 2002
4. Hall and Allen, 'Machine Design', S.Schaum's Series, .Ist edition 2001
5. Joseph Edward Shighley, 'Mechanical Engineering', McGraw Hill, 2002

18ME3041	DESIGN OF FLUID POWER SYSTEMS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Laws and governing equations for hydraulics and pneumatics with ISO symbolic representations.
2. Working principles of hydraulic and pneumatic drives and develop circuits for engineering applications.
3. Trouble shooting the hydraulic and pneumatic systems.

Course Outcomes: After completing the course the student will be able to

1. Interpret the standard symbols and laws used in FPC Systems.
2. Infer the working principles of pumps and motors.
3. Identify the suitable elements of fluid power systems for a particular application.
4. Examine hydraulic circuits for an industrial application.
5. Assess the optimal components of pneumatic system.
6. Build a logic circuit for industrial problems.

MODULE I – FLUID POWER ELEMENTS (8 Lecture Hours)

Industrial Prime Movers, basic laws, applications, types of fluid power systems, fluid types and properties. Comparison of power systems, Fluid power symbols. fluid reservoir , Cylinders, Mechanics of cylinder loading, Pressure accumulators-types, DCV,FCV, relief valve, hydraulic servo systems, Cartridge valves, Hydraulic fuses, Temperature and pressure switches, Shock Absorbers , electromechanical devices like relays and solenoids.

MODULE II – HYDRAULIC PUMPS AND MOTORS (8 Lecture Hours)

Types – design and construction , gear pumps, vane pumps, piston pumps and pump performance, numerical problems, Hydraulic Motors –Types, theoretical torque , power and flow rate, performance and numerical problems.

MODULE III – DESIGN OF HYDRAULIC CIRCUITS (9 Lecture Hours)

Reciprocation, quick return, Speed control circuits, sequencing, synchronizing circuits, clamping and accumulator circuits, press circuits and hydro-pneumatic circuit.

MODULE IV – DESIGN OF PNEUMATIC CIRCUITS (8 Lecture Hours)

Basic elements -Compressor, Cylinders, DCV,FCV, other special valves, Boolean algebra, truth tables, reciprocation, quick return circuit, cascade circuits/ sequencing circuits like A+B+ A- B- , electro-pneumatic circuits.

MODULE V – INDUSTRIAL APPLICATIONS (8 Lecture Hours)

MPL control of Fluid power circuits, fluidic elements and fluidic sensors, Basic concepts of programmable logical control, Fail-safe Circuits, Intensifier circuits, Box-sorting System, Electrical Control of Regenerative Circuit, Hydro-pneumatic circuit.

MODULE VI – FAULT FINDING AND MAINTENANCE (4 Lecture Hours)

Trouble Shooting in Fluid Power Systems, Preventive Maintenance, Piping Design for Fluid Power Systems.

Reference books:

1. R.Srinivasan "Hydraulic and Pneumatic Controls" 2nd Edition ,Tata McGraw - Hill Education 2008.
2. Anthony Esposito," Fluid Power with Applications", Pearson Education Inc., Seventh Edition, 2014. ISBN 9780135136904.
3. John J Pippenger, Adrian Mitchell, Richard J Mitchell, "Fluid Power Maintenance Basics and Troubleshooting," Hardcover, Edition: 01, 1997.
4. M.K. Medhat, Dr.Khalil "Electro-Hydraulic Components and Systems: Hydraulic Systems Volume 2" Hardcover – Import, 1 Jan 2017.
5. S.R.Majumdar, "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2002.

18ME3042	TOTAL QUALITY MANAGEMENT	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Concepts, principles and applications of TQM.
2. Tools and techniques of TQM.
3. Control charts and process capability.

Course Outcomes: After completing the course the student will be able to

1. Apply the tools and techniques of TQM in manufacturing and service sectors.
2. Assess the barriers of TQM implementation.
3. Formulate and implement quality circles in their workplace.
4. Apply six sigma concepts in manufacturing and service sectors.
5. Apply TPM principles in manufacturing sectors.
6. Improve the processes by using control charts.

MODULE I **(8 Lecture Hours)**

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & Satisfaction, customer complaints, customer retention; costs to quality.

MODULE II **(8 Lecture Hours)**

TQM principles; leadership, strategic quality planning; Quality councils- employee Involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

MODULE III **(8 Lecture Hours)**

Tools of Quality :The seven traditional tools of quality; New management tools; Six sigma- concepts, Methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

MODULE IV **(7 Lecture Hours)**

TQM Techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

MODULE V **(7 Lecture Hours)**

CONTROL CHARTS: Control for process capability: variable control charts- Attribute control charts-Process capability-Process capability index-Application of control

MODULE VI **(7 Lecture Hours)**

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, Documentation, Quality auditing, QS 9000, ISO 14001 - concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

Reference Books:

1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
5. Kevin Otto and Kristin Wood, ‘Product Design’, Pearson Educational Inc. 2004.

18ME3043	INDUSTRIAL AUTOMATION AND MECHATRONICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Basic principles of automation, tool transfer and implementation of automated flow line.
2. Design aspects and analysis of material handling system.
3. Principles of Mechatronics for design industrial and domestic applications.

Course Outcomes: After completing the course the student will be able to

1. Develop intelligent automated system and manufacturing data base system.
2. Implement the concepts of a productive system in automation.
3. Apply the knowledge of automated flow lines for industrial and other applications.
4. Design and analysis of material handling systems for automated assembly lines.
5. Select proper sensor and actuator for a given application.
6. Balance automated assembly lines.

MODULE I – PRODUCTION AND AUTOMATION STRATEGIES (8 Lecture Hours)
Plant Layout, production concepts and mathematical models, Automatic loading Systems-Automated flow lines, Methods of work flow - transport transfer mechanisms, buffer storage, Control functions, Automation for machining operations.

MODULE II – DESIGN AND FABRICATION CONSIDERATIONS (8 Lecture Hours)
Analysis of transfer lines without storage -partial automation automated flow lines with storage buffers implementing of automatic flow lines-Line balancing problems, Considerations in assemble line design-Manual assembly lines - line balancing problem.

MODULE III – FLEXIBLE MANUAL ASSEMBLY LINES (8 Lecture Hours)
Automated assembly systems, Analysis of multi station assembly-Manufacturing Cells, Automated Cells, Analysis of Single Station Cells, design and analysis of material handling system, conveyor system. Automated guided vehicle system-Automated storage and Retrieval systems, Transfer lines, Design for Automated Assembly, Partial Automation, Communication Systems in Manufacturing.

MODULE IV – OVERV IEW OF MECHATRONIC PRODUCTS (7 Lecture Hours)
Intelligent Machine vs Automatic Machine, Economic and social justification. Actuators and Motion Control. Control parameters and system objectives. Mechanical configurations. Popular control system configurations-S-curve, Motor/Load inertia matching, design with linear slides. Motion control Algorithms: significance of feed forward control loops, shortfalls.

MODULE V – FUNDAMENTAL CONCEPTS OF ADAPTIVE AND FUZZY CONTROL (7 Lecture Hours)
Fuzzy logic compensatory control of transformation and deformation non-Z linearities- Introduction to Microprocessor and programmable logic controllers and identification of system, System design Classification. Motion control aspects in Design.

MODULE VI – MANUFACTURING DATA BASES (7 Lecture Hours)
Sensor Interfacing: Analog and Digital Sensors for Motion Measurement, Digital Transducers, Human - Machine and Machine - Machine Interfacing. Machine Vision: Feature and Pattern Recognition methods, concepts of perception and cognition in decision making.

References Books

1. Mikell P. Groover, “Automation, Production Systems and CIM”, Printice Hall of India, 2008.
2. Singh, “System Approach to Computer Integrated Design and Manufacturing”, John Wiley 1996.
3. Michel B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems” Tata McGraw Hill, 2011.
4. C.W. De Silva, “Sensors and Actuators: Control system Instrumentation”, CRC Press, 1st Edition, 2011.

18ME3044	CONTROL OF CNC MACHINE TOOLS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. CNC programming, hydraulic system
2. CNC interpolation, DDA integrator
3. CNC control loops and architecture

Course Outcomes: After completing the course the student will be able to
1. Design control systems for CNC machine tool
2. Understand the principles of motors and hydraulic system
3. Compare the interpolation methods in CNC control system
4. Recommend PID controllers, servo controller, Numerical control Kernel types
5. Select the components of CNC architecture
6. Propose the PLC programming Languages

MODULE I – INTRODUCTION TO CNC SYSTEMS AND PROGRAMMING **(8 Lecture Hours)**
Introduction to CNC systems, Coordinate systems of CNC machines, Economics. CNC programming-Interpolation, CNC programming - feed, tool and spindle functions (G-codes).

MODULE II – CNC DRIVES AND CONTROLLERS **(8 Lecture Hours)**
CNC drives Hydraulic systems, servo and stepping motors, response analysis, Feedback devices and counter.

MODULE III – CNC HARDWARE INTERPOLATORS **(8 Lecture Hours)**
CNC Interpolation – Hardware interpolators- DDA integrator, linear, circular, complete interpolators,

MODULE IV – CNC SOFTWARE INTERPOLATORS **(7 Lecture Hours)**
Software interpolators, Tustin method, NURBS and polynomial interpolators, Acceleration and deceleration control techniques.

MODULE V - CNC CONTROL LOOPS **(7 Lecture Hours)**
CNC control loops, PID control, servo controller, gain tuning, feed forward control, Mathematical analysis of control loops.

MODULE VI - CNC ARCHITECTURE **(7 Lecture Hours)**
CNC Architecture - Numerical control kernel- types, PLC, programming, languages, Human-Machine Interface functions, structure, Introduction to Open CNC architecture.

Reference books:

1. Suk-Hwan Suh and Ian Stroud, Gloud "Theory and Design of CNC Systems", Springer, 2008.
2. YoramKoren and Joseph Ben Uri, "Numerical Control of Machine Tools", Khanna Publishers, 2000.
3. YoramKoren, "Computer Control of Manufacturing Systems" McGraw-Hill, 1985.
4. Yusuf Altintas, "Manufacturing Automation Metal Cutting Mechanics, Machine Tool, Vibrations, and CNCDesign", Second edition, Cambridge University Press, 2012.

18ME3045	ENGINEERING PRODUCT DESIGN AND DEVELOPMENT STRATEGIES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Modeling, simulation, material selection and GD & T.
2. Important practices followed during designing and developing a product in industries.
3. Product life cycle right from its conceptual stage to its development stage.

Course Outcomes: After completing the course the student will be able to
1. Apply the appropriate design process and modelling techniques to design components.
2. Categorize the models used in product design and use appropriately for product analysis.
3. Choose the right material selection process and calculate the economics of materials.

4. Design a product for sustainability, environment friendly considering human factors engineering.
5. Use GD & T principles for better product manufacturing.
6. Apply the principles of reliability, safety, robust design and design optimization.

MODULE I – NATURE AND SCOPE OF PRODUCT ENGINEERING (8 Lecture Hours)
Importance of product design, Design Constraints, Safety and reliability considerations, The Design process-A simplified approach, Consideration of a Good Design, Detail description of Design process (Morphology of Design), Technological Innovation and the design process; Product and Process cycle. Green Technology Application-Integrated CAD/CAM, Statistical process controls (SPC).
MODULE II – MODELING AND SIMULATION (8 Lecture Hours)
The role of Models in Engineering Design-Mathematical modeling, Similitude and scale modeling, Simulation, Finite-Difference method, Geometric modeling on the computer, Finite Element Analysis-Introduction to simulation modeling-Simulation programming software-Monte Carlo Simulation
MODULE III – MATERIAL SELECTION AND MATERIALS IN DESIGN (8 Lecture Hours)
Relation of Materials Selection to Design, Performance Characteristics of materials, The Materials Selection process – Design process and materials selection, Ashby charts, Material selection in Embodiment design, Economics of materials, Methods of material selection- Selection with Computer-Aided database, Weighted Property Index, Value analysis, Design examples- Materials systems, Material substitution; simple problems.
MODULE IV – DESIGN FOR SUSTAINABILITY AND ENVIRONMENT (7 Lecture Hours)
The Environmental Movement- Sustainability -Challenges of Sustainability for Business- End-Of-Life Product Transformations -Role of Material Selection in Design for Environment-Tools to Aid Design for the Environment and Sustainability- Influence of Space, Size, Weight, etc., on Form design, Aesthetics- Human factors Design-Industrial Ergonomic considerations.
MODULE V – GEOMETRIC DIMENSIONING AND TOLERANCING (7 Lecture Hours)
Introduction to Dimensioning-Dimensioning Characteristics and Definitions-Fundamental Dimensioning Rules-Dimensioning Symbols-Dimensioning Systems - Introduction to GD&T Symbols - Datums -Applying Material Condition and Material-Boundary Symbols-Limits of Size Application - Perfect Form Boundary -Applying Regardless of Feature Size and-Regardless of Material Boundary - Applying Maximum and Least Material Condition - Quality-Robust Design and optimization.
MODULE VI – RELIABILITY, SAFETY, ROBUST DESIGN AND OPTIMIZATION (7 Lecture Hours)
Introduction - Probabilistic Approach to Design - Reliability Theory - Design for Reliability (Problems) - Failure Mode and Effects Analysis (FMEA) - Defects and Failure Modes - Design for Safety – Concept of Total Quality - Quality Control and Assurance - Statistical Process Control-Process Capability - Taguchi Method - Robust Design - Optimization Methods - Design Optimization- Ergonomics in Product Design

Reference Books:
1. Dieter. G. E, ‘Engineering Design’, 5th Ed. Tata McGraw Hill, 2010.
2. David A. Madsen, ‘Engineering Drawing and Design’, Delmar Thomson Learning Inc. 2002,
3. Jones J.C., ‘Design Methods’, Inderscience, 2008
4. Kevin Otto and Kristin Wood, ‘Product Design’, Pearson Educational Inc. 2004.
5. Karl T Ulrich, Steven D Eppinger, ‘Product Design and Development’, Irwin Homeward Boston Publishers, 2004.

18ME3046	ADVANCED TOOL DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Tool design and advanced cutting tool materials.
2. Design of cutting tools, forming tools and jigs.
3. Press tool design and fixtures for CNC machines.

Course Outcomes: After completing the course the student will be able to

1. Select appropriate materials for tool, jigs and fixtures.
2. Understand the requirements and challenges in the development of cutting tools.
3. Design Jigs and fixtures for conventional machines.
4. Develop Jigs and fixtures for CNC machines.
5. Design Dies and Press tools for conventional machines.
6. Develop Dies and Press tools for CNC machines.

MODULE I – INTRODUCTION TO TOOL DESIGN (7 Lecture Hours)
Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances.

MODULE II – DESIGN OF CUTTING TOOLS (9 Lecture Hours)
Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

MODULE III – DESIGN OF JIGS (8 Lecture Hours)
Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing.

MODULE IV – DESIGN OF FIXTURES AND PRESS TOOLS (7 Lecture Hours)
Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations. Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

MODULE V – TOOL DESIGN FOR CNC MACHINE TOOL (8 Lecture Hours)
Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

MODULE VI – TOOL MATERIALS (7 Lecture Hours)
Tooling Materials- Ferrous and Non-ferrous Tooling Materials- Carbides, Ceramics and Diamond – Non-metallic tool materials. Designing with relation to heat treatment.

Reference books:
1. C. Donaldson, G. H.Lecain and V. C.Gold , Tool Design, Tata McGraw- Hill, 2007.
2. E.G.Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2004.
3. Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000.
4. Beckwith Thomas G, “Mechanical Measurements”, Pearson Education, 2008.
5. Venkataraman K., “Design of Jigs, Fixtures and Presstools”, TMH, 2005.

		L	T	P	C
18ME3047	**INDUSTRIAL ROBOTICS**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Robot configurations.
2. Sensors and transducers.
3. Actuating systems and Robot programming skills.

Course Outcomes: After completing the course the student will be able to
1. Infer the robot history and configurations.
2. Assess various components of a robot and choose the control system.
3. Compute the kinematic equations and select an actuator for robot configurations.

4. Identify the suitable sensor for a particular robot application.
5. Write a robot Program for an industrial application.
6. Identify the robot application for a unique operation.

MODULE I – AUTOMATION AND ROBOTICS CONCEPTS (7 Lecture Hours)
Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

MODULE II – ROBOT GRIPPERS AND SENSORS (7 Lecture Hours)
Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

MODULE III – CONTROL SYSTEMS AND DRIVES (9 Lecture Hours)
Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.

MODULE IV – KINEMATICS AND DYNAMICS (6 Lecture Hours)
Transformation matrices and their arithmetic, link and joint description, Denavit–Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:-Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations.

MODULE V – MACHINE VISION AND PROGRAMMING LANGUAGES (7 Lecture Hours)
Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming:- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.

MODULE VI – PLANT AUTOMATION AND ARTIFICIAL INTELLIGENCE (9 Lecture Hours)
Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics:- Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics.

Reference Books:
3. Mikell P. Grooveret. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
4. Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw Hill, 2003.
5. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2002Raymond A Higgins "Engineering Materials (Applied Physical Metallurgy) English Language book, society, 2003.
6. John J. Craig, "Introduction to Robotics: Mechanics and Control", by Pearson India, ISBN: 9788131718360, 8131718360. Edition: 3rd Edition, 2008.
7. Industrial Automation: W.P. David, John Wiley and Sons.

18ME3048	ADVANCED MACHINE DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Applications and design of mechanical system elements.
2. Applying the design concept in product design and development.
3. Using standard data's for design of machine components.

Course Outcomes: After completing the course the student will be able to
1. Understand the design principles of mechanical systems.
2. Design the machine elements and systems.
3. Design the material handling equipment.
4. Learn about construction, working principle and design of the conveyor systems.
5. Select appropriate machine elements for mechanical systems.
6. Design and develop new products which can be used in mechanical systems.

MODULE I – MATERIAL HANDLING EQUIPMENTS (7 Lecture Hours)
Types, Selection and applications, Method for determining stresses-Terminology and ligament efficiency-application.

MODULE II – STRESSES IN PRESSURE VESSELS (8 Lecture Hours)
Stresses in a circular ring, cylinder-Membrane stress analysis of vessels shell components-Cylinder shells, to spherical heads, conical heads-Thermal stresses, Dis-continuity stresses in pressure vessels.

MODULE III– DESIGN OF PRESSURE VESSELS (8Lecture Hours)
Design of tall cylinder self-supporting process columns-Supports for short vertical vessels Stress concentration at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement.

MODULE IV – DESIGN OF AUTOMOTIVE TRANSMISSION SYSTEM (7 Lecture Hours)
Clutches – power transmitted brake – Brakes: Shoe, band and cone types. Cams – Multispeed gear box - Design of arresting gear.

MODULE V – DESIGN OF HOISTING ELEMENTS (8 Lecture Hours)
Welded and roller chains-Hemp and wire ropes. –Design of ropes, pulleys, pulley system, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks crane grabs-lifting magnets-Grabbing Attachments.

MODULE VI – CONVEYORS (7 Lecture Hours)
Types-description-Design and applications of belt conveyors, apron conveyors and escalators, pneumatic conveyors, screw conveyors and vibratory conveyors.

Reference Books:

1. Richard G. Budynas, J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw Hill, 2016.
2. John.F.Harvey, "Theory & Design of Pressure Vessels", "CBS Distributors", 2014.
3. Rudenko.N, "Materials Handling Equipments", Elnvee Publishers, 2011.
4. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
5. Henry.H.Bedner "Pressure Vessels", Design Hand Book, CBS Publishers & Distributors, 1987.

18ME3049	ADVANCED STRENGTH OF MATERIALS	L T P C 3 0 0 3

Course Objective: To impart knowledge on
1. Understanding of advanced topics concerning the response of materials and structural elements to applied forces of deformation.
2. Material behaviour under various stress conditions.
3. Stresses in the material for various shape and loading conditions.

Course Outcomes: After completing the course the student will be able to

1. Apply concepts in stress, displacement, and transformations to 2d, and 3d solids under load.
2. Apply concepts in elasticity for calculating strength on components subjected to concentrated loads.
3. Determine strength, predict failure, and incorporate design considerations in shafts and beams.
4. Determine stresses in open and closed sections in torsion and bending of standard sections.
5. Apply stress functions, and calculate stresses in plates and shells, thick circular cylinders, and discs.
6. Apply and use energy methods to find force, stress, and displacement in simple structures.

MODULE I – ANALYSIS OF STRESS AND STRAIN (8 Lecture Hours)

Introduction-Definition and Components of Stress-internal Force-Resultant and Stress Relations- -Stress Transformation- Principal Stresses and Maximum In-Plane Shear Stress-Mohr's Circle for Two-Dimensional Stress-Three-Dimensional Stress Transformation-Principal Stresses in Three Dimensions-Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact. Deformation-Strain Defined-Equations of Compatibility-State of Strain at a Point-Measurement of Strain: Strain Rosettes.

MODULE II – PROBLEMS IN ELASTICITY (7 Lecture Hours)

Introduction-Plain Elastic Problems-Governing Equations- Conversion between plane stress and plane strain problems-Airy's Stress Function-Solution of Elasticity Problems-Thermal Stresses-Basic Relations in Polar Coordinates-Stresses Due to Concentrated Loads- Stress Distribution Near Concentrated Loads-Stress Concentration Factors.

MODULE III – FAILURE CRITERIA (8 Lecture Hours)

Introduction-Failure-Failure by Yielding-Failure by Fracture-Yield and Fracture Criteria-Maximum Shearing Stress Theory-Maximum Distortion Energy Theory-Octahedral Shearing Stress Theory-Comparison of Yielding Theories-Maximum Principal Stress Theory-Mohr's Theory-Coulomb-Mohr Theory-Fracture Mechanics-Fracture Toughness-Failure Criteria for Metal Fatigue-Impact or Dynamic Loads-Dynamic and Thermal Effects.

MODULE IV – TORSION OF PRISMATIC BARS (8 Lecture Hours)

Introduction-Elementary Theory of Torsion of -Stresses on Inclined Planes-General Solution of the Torsion Problem-Prandtl's Stress Function-Prandtl's Membrane Analogy-Torsion of Narrow Rectangular Cross Section-Torsion of Multiply Connected Thin Walled Sections-Fluid Flow Analogy and Stress Concentration-Torsion of Restrained Thin-Walled Members of Open Cross Section.

MODULE V – APPLICATIONS OF ENERGY METHODS (7 Lecture Hours)

Introduction-Work Done in Deformation-Strain Energy-Components of Strain Energy-Saint-Venant's Principle-Reciprocity Theorem-Castigliano's First Theorem-Complementary Energy Theorem-Castigliano's Second Theorem-Statically Indeterminate Systems-Principle of Virtual Work-Principle of Minimum Potential Energy-Rayleigh-Ritz Method.

MODULE V1 – UNSYMMETRICAL BENDING AND SHEAR CENTRE (7 Lecture Hours)

Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

Reference Books:

1. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
2. L. S. Srinath, "Advanced Mechanics of Solids", 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.
3. Ferdinand P. Beer, E. Russell Johnston, John T. DeWolff and David F. Mazurek Mechanics of Materials, 5th ed. in SI Units, McGraw-Hill, 2009.
4. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2003.
5. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.

18ME3050	ENGINEERING FRACTURE MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Stress and strain field around a crack in a body for different fracture modes.
2. Factors governing crack growth, crack arrest and fatigue.
3. The applications of fracture mechanics.

Course Outcomes: After completing the course the student will be able to
1. Estimate stress and strain field around a crack.
2. Understand plastic material behavior around the crack tip.
3. Estimate the fracture toughness value of a material for various fracture modes.
4. Design of components that contain crack under static and fatigue load condition.
5. Provide solution to prevent crack growth and fatigue failures.
6. Analyze of fatigue crack propagation using empirical methods.

MODULE I – ELEMENTS OF SOLID MECHANICS (8 Lecture Hours)
The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor

MODULE II –STATIONARY CRACK UNDER STATIC LOADING (8 Lecture Hours)
Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

MODULE III – ENERGY BALANCE AND CRACK GROWTH (8 Lecture Hours)
Griffith analysis – stable and unstable crack growth – Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves – determination of collapse load

MODULE IV – FATIGUE CRACK GROWTH (7 Lecture Hours)
Empirical relation describing crack growth law – life calculations for a given load amplitude –effects of changing the load spectrum -- rain flow method– external factors affecting the KIC values.- leak before break analysis.

MODULE V – TESTING METHODS FOR DETERMING CRACK GROWTH (7 Lecture Hours)
Test methods for determining critical energy, release rate, critical stress intensity factor, J-Integral.

MODULE VI – APPLICATIONS OF FRACTURE MECHANICS (7 Lecture Hours)
Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

Reference Books:

1. Brook D, "Elementary engineering fracture mechanics", 2009.
2. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill,2009
3. T.L. Anderson, "Fracture mechanics fundamentals and applications", CRC Press, 2005.
4. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley, 2014
5. TribikramKundu, "Fundamentals of Fracture Mechanics", CRC, Press, 2012.

18ME3051	ADVANCED MECHANISM DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. The fundamentals of a mechanism and machines.
2. Kinematics of a mechanism.
3. Forces in the joints and links of a mechanism and a robot.

Course Outcomes: After completing the course the student will be able to
1. Identify the type and find degree of freedom of a given mechanism.
2. Conduct kinematic analysis of a mechanism.

3. Apply the path curvature theories in the analysis of a mechanism.
4. Synthesis of a mechanism for a given application.
5. Investigate forces in the joints and links of a mechanism.
6. Employ the capabilities of a robot in design.

MODULE I – INTRODUCTION (8 Lecture Hours)
Review of fundamentals of kinematics- mobility analysis- formation of one degree of freedom. Multiloop kinematic chains, Network formula- Gross motion concepts. Kinematic Analysis: Position Analysis- Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration. Analysis - four bar linkage - Jerk analysis. Plane Complex mechanisms.

MODULE II – PATH CURVATURE THEORY (8 Lecture Hours)
Fixed and moving centroids, inflection points and inflection circle. Euler Savary equation, Bobilier's construction - Cubic of stationary curvature.

MODULE III – SYNTHESIS OF MECHANISMS (8 Lecture Hours)
Type synthesis- Number synthesis- Associated Linkage concept. Dimensional synthesis –function generation, path generation, motion generation, Graphical methods. Cognate linkage- coupler curve synthesis, Design of six-bar mechanisms. Algebraic methods. Application of instant center in linkage design. Cam Mechanisms- determination of optimum size of Cams.

MODULE IV – DYNAMICS OF MECHANISMS (7 Lecture Hours)
Static force analysis with friction – inertia force analysis- combined static and inertia force analysis, shaking force, kinetostatic analysis. Introduction to force and moment balancing of linkages.

MODULE V – COUPLER CURVES (7 Lecture Hours)
Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

MODULE VI – SPATIAL MECHANISM AND ROBOTICS (7 Lecture Hours)
Introduction, topology arrangements of robotics arms, Kinematic Analysis of spatial mechanism. Denavait- Hartenberg parameters, Forward and inverse kinematic of Robotic manipulators. Study of mechanism using simulation software packages.

Reference Books:

1. Uicker J.J., Pennock G.R., and Shigley J. E. "Theory of Mechines and Mechanism", Oxford International Student Edition, 3rd Editon 2009".
2. Robert L.Nortan ,"Design of Machinery',Tata McGraw Hill Edition, 2007.
3. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley, 2014
4. Amitabha Ghosh and Ahsok Kumar Mallik, "Theory of mechanism and Machines", EWLP, Delhi, 1999.
5. David Myszka, "Machines and Mechanisms: Applied Kinematic Analysis", 4^{th} Edition, Pearson, 2012.

18ME3052	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Application of basic theories of friction, wear and lubrication.
2. Frictional behavior of commonly encountered sliding interfaces.
3. Various testing methods for tribological properties.

Course Outcomes: After completing the course the student will be able to
1. Apply concepts of friction mechanisms and analyze performance of design components based on relative motion.
2. Identify wear mechanism on macro-scale in metals.
3. Recombined lubrications based on the type of lubrication.
4. Outline the methods to improve surface engineering.
5. Generate performance reports of the lubrications using tribo testing methods.
6. Understand the fundamentals of tribology and associated parameters.

MODULE I – FRICTION (8 Lecture Hours)
Friction – Adhesion – Ploughing – Energy dissipation mechanisms Friction Characteristics of metals – Friction of non-metals. Friction of lamellar solids – friction of Ceramic materials and polymers – Rolling Friction – Source of Rolling Friction – Stick slip motion – Measurement of Friction.

MODULE II – WEAR (8 Lecture Hours)
Types of wear – Simple theory of Sliding Wear. Mechanism of sliding wear of metals – Abrasive wear – Materials for Adhesive and Abrasive wear situations – Corrosive wear – Surface Fatigue wear situations – Brittle Fracture – wear – Wear of Ceramics and Polymers – Wear Measurements.

MODULE III – LUBRICANTS, FILM LUBRICATION THEORY AND LUBRICATION TYPES (8 Lecture Hours)
Types and properties of – Hydrodynamic Lubrication – Elasto–hydrodynamic lubrication – Boundary Lubrication – Solid Lubrication– Hydrostatic Lubrication. Fluid film in simple shear – Viscous flow between very close parallel plates – Shear stress variation Reynolds Equation for film Lubrication – High speed unloaded journal bearings – Loaded journal bearings – Reaction torque on the bearings – Virtual Co–efficient of friction.

MODULE IV – SURFACE ENGINEERING AND MATERIALS FOR BEARINGS (8 Lecture Hours)
Topography of Engineering surfaces – Contact between surfaces – Sources of sliding Surface modifications – Thermo chemical processes – Surface coatings – Plating and anodizing – Fusion Processes – Vapour Phase processes – Materials for marginally lubricated and dry bearings.

MODULE V – DYNAMIC TRIBOLOGY AND TESTING METHODS (7 Lecture Hours)
Dynamic testing machines and test methods, dry sand–rubber wheel test.

MODULE VI – TRIBOLOGY TESTING METHODS (7 Lecture Hours)
Wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin–on–disk wear test, rolling wear test, drum wear test, drill wear test. Lubricants, testing methods - Four ball tribo test.

Reference books:

1. PrasantaSahoo, "Engineering Tribology", Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, "Tribology in Industries", S. Chand Publishers, 2005.
3. Stachowiak G. W. and Batchelor A. W., Engineering Tribology, 3rd Edition (Indian), Butterworth-Heinnmann (Elsevier), 2010
4. A. Cameron, "Basic Lubrication Theory", Longman, U.K., 2011.
5. B. Bhushan , "Principles and Application of Tribology", Wiley, 2013.

18ME3053	ROTOR DYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Rotor dynamics phenomena with the help of simple rotor models
2. Behavior of fluid film lubrication and rotor bearing system in rotor system
3. Performance of bearings under dynamic conditions

Course Outcomes: After completing the course the student will be able to
1. Apply the principles of rotor dynamics in design and analysis of mechanical components
2. Analyze the bearing behavior under dynamic conditions
3. Acquire knowledge in rotor balancing.
4. Measure vibration and conduct dynamic analysis in rotating machine elements
5. Model a rotating machine element theoretically
6. Study the effect of vibration in rotating machinery

MODULE 1 – INTRODUCTION (8 Lecture Hours)
Brief history of rotor dynamics - overview of rotor dynamics phenomena and Recent trends - development of rotor dynamics analysis tools - software for rotor dynamic analysis - different rotor

models - Torsional vibrations in rotating machinery - Equation of motion - Problems in torsional vibration - single and multiple rotor system - Transfer Matrix Methods for Torsional Vibration.

MODULE II – INSTABILITY IN ROTATING MACHINES (8 Lecture Hours)

Oil whip and Oil whirl - stability analysis using linearized stiffness and damping coefficients - Instability due to stream whirl and seals - Theory of Balancing of Rotors - Rigid rotor classification - Balancing criteria - Balancing of rigid rotors -Balancing of flexible rotors - Balance criteria for flexible rotors

MODULE III – ROTOR MODELS (8 Lecture Hours)

Single DOF un damped rotor model for both free and forced vibration - single DOF damped rotor model - attenuation of vibration - Rankine rotor model - Jeffcott rotor model - simple rotor systems with Gyroscopic effects - synchronous motion, asynchronous rotational motion - Asynchronous General Motion - Gyroscopic Effects by the Dynamics Approach

MODULE IV – BEARING IN ROTORS (7 Lecture Hours)

Rolling element bearings - Hydrodynamic oil lubricated journal bearing - types of hydrodynamic bearing - Reynolds equation and its basic assumptions - Basic concepts and assumptions of fluid - film bearing models - Short and long hydrodynamic radial bearings - Dynamic characteristics of fluid - film bearings - Dynamic seals and its classifications.

MODULE V – ROTOR VIBRATION AND CRITICAL SPEEDS (7 Lecture Hours)

Rotor vibration and Rotor critical speeds - support stiffness on critical speeds - Stiffness and damping coefficients of journal bearings - computation and measurements of journal bearing coefficients - Mechanics of Hydro dynamic Instability

MODULE VI – SIGNAL PROCESSING AND CONDITION MONITORING IN ROTOR DYNAMICS (7 Lecture Hours)

Vibration generating mechanism - Condition monitoring - Noise spectrum - Signal processing in rotating machineries - Measurements in rotating machineries - Real time analysis & Knowledge based (data base) - Expert systems - Display of vibration measurement instruments - Signature Analysis of Common Rotor Faults - Signature Analysis of Common Rotor Faults.

Reference Books:

1. Rao J.S., ‘Rotor Dynamics’, New Age International, New Delhi, 2012.
2. Genta G., ‘Dynamics of Rotating Systems’, Springer, New York, 2005.
3. Muszynska A., ‘Rotor dynamics’, Series: Dekker Mechanical Engineering, Vol. 188, CRC Press, 2005.
4. Robert B.M., ‘Rotating Machinery: Practical Solutions to Unbalance and Misalignment’, CRC Press, 2003.
5. Rao J.S., ‘Vibratory Condition Monitoring of Machines’, Narosa Publishing House, New Delhi, 2000.

18ME3054	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. The need and origin of the optimization methods.
2. The various applications of optimization methods used in engineering.
3. Optimization of various components

Course Outcomes: After completing the course the student will be able to

1. Outline the importance of optimization of industrial process management.
2. Apply basic concepts of mathematics to formulate an optimization problem
3. Analyze and appreciate variety of performance measures for various optimization problems
4. Select engineering minima/maxima problems into optimization framework
5. Develop an efficient computational procedures to solve optimization problems.
6. Developing skill for formulating and solving the engineering optimization problems

MODULE I – INTRODUCTION TO OPERATION RESEARCH (8 Lecture Hours)

Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.

MODULE II – LINEAR PROGRAMMING (8 Lecture Hours)

Introduction to Linear Programming and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.

MODULE III – TRANSPORTATION & ASSIGNMENT PROBLEM (7 Lecture Hours)

Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.

MODULE IV – NETWORK ANALYSIS (7 Lecture Hours)

Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.

MODULE V – SEQUENCING (7 Lecture Hours)

Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines. Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

MODULEVI – QUEUING MODELS (8 Lecture Hours)

Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process. Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies. Introduction & steps of simulation method, distribution functions and random number generation.

Reference Books:

1. K Sharma, Operations Research Theory and Applications, MacMillan India Ltd. 2016
2. N D Vohra, Quantitative Techniques in management, Tata McGraw Hill, 2011.
3. Handy A Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi, 2008.
4. Hillier F S and Lieberman G J, Operations Research, Holden Day Inc., San Francisco, 2009.
5. Payne T A, Quantitative Techniques for Management: A Practical Approach, Reston Publishing Co. Inc., Virginia, 2012.

18ME3055	CONDITION BASED MONITORING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Health monitoring and condition monitoring of structures and machines.
2. Basics of signal processing and various types of signals.
3. Basics of Vibration Systems, vibration analysis and condition monitoring.

Course Outcomes: After completing the course the student will be able to

1. Explain the aim and the basics of CM
2. Appreciate and understand the basic idea behind vibration-based structural health
3. Monitor the vibration-based condition monitoring, and to know the general stages of CM.
4. Apply some basic techniques for analysis of random and periodic signals
5. Identify the basic instrumentation used for machinery and structural vibration-based monitoring
6. Aware of some basic faults in rotating machinery, their manifestation and methods for detection and recognition.

MODULE I – HEALTH MONITORING (8 Lecture Hours)

The basic idea of health monitoring and condition monitoring of structures and machines. Some basic techniques.

MODULE II – SIGNAL PROCESSING (8 Lecture Hours)

Basics of signal processing: Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions of commonly found systems, spectral analysis

MODULE III – FOURIER TRANSFORM (8 Lecture Hours)

Fourier transform: the basic idea of Fourier transform, interpretation and application to real signals. Response of linear systems to stationary random signals: FRFs, resonant frequencies, modes of vibration.

Module IV – VIBRATION-BASED MONITORING (7 Lecture Hours)

Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments.

MODULE V – APPLICATIONS OF CONDITION MONITORING (7 Lecture Hours)

Typical applications of condition monitoring using vibration analysis to rotating machines.

MODULE VI – SPECIAL TYPES OF HEALTH MONITORING TECHNIQUES (7 Lecture Hours)

Special types of health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications.

Reference Books

1. M.Adams, rotating machinery analysis - from analysis to troubleshooting, Marcel Dekker, New York, 01, ISBN 0-8247-0258-1.
2. Cornelius Scheffer Paresh Girdhar, Practical Machinery Vibration Analysis and Predictive Maintenance, Newnes, 1st Edition, 04, Paperback ISBN: 9780750662758

18ME3056	MULTI-BODY DYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Equation of motion for the bodies
2. Differential equations for multi-body dynamics
3. Intellectual skill to incorporate in the project and presentation

Course Outcomes: After completing the course the student will be able to

1. Derive equations of motion for interconnected bodies in multi-body systems with three dimensional motion.
2. Implement and analyze methods of formulating equations of motion for interconnected bodies.
3. Write programs to solve constrained differential equations for analyzing multi-body systems.
4. Simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.
5. Lead team projects in academic research or the industry that require modeling and simulation of multi-body systems.
6. Demonstrate an improved technical writing and presentation skills.

MODULE I – INTRODUCTION (8 Lecture Hours)

The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.

MODULE II – BASIC PRINCIPLES FOR ANALYSIS OF MULYI-BODY SYSTEMS (8 Lecture Hours)

The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of nonlinear equations. Geometry of masses. The principle of virtual work and Lagrange's equations.

MODULE III – DYNAMICS OF PLANAR SYSTEMS (8 Lecture Hours)

Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initial value problems. The method of Baumgartner for the solution of mixed differential-algebraic equations of motion. The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.

MODULE IV – KINEMATICS OF RIGID BODIES IN SPACE (7 Lecture Hours)

Reference frames for the location of a body in space. Euler angles and Euler parameters. Formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters

MODULE V – KINEMATIC ANALYSIS OF SPATIAL SYSTEM (7 Lecture Hours)

Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, and spherical). Equations of motion of constrained spatial systems.

MODULE VI – COMPUTATION OF FORCES (7 Lecture Hours)

Computation of spatial generalized forces for external forces and for actuator-spring-damper element. Computation of reaction forces from Lagrange's multi- pliers.

Reference Books:

1. De Jalo n, J.C., Bayo, E., Kinematic and Dynamic Simulation of Multibody Systems, Springer-Verlag, 2004.
2. Schielen, W. ed., Multibody Systems Handbook, Springer-Verlag, Berlin, 2001.
3. Huston, R.L., Multibody Dynamics, Butterworth-Heinemann, 2009.
4. Haug, E.J., Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods, Allyn and Bacon, 2003.
5. Roberson, R.E., Schwertassek, R., Dynamics of Multibody Systems, Springer-Verlag, Berlin, 2009.

18ME3057	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		2	0	0	2

Course Objectives: To impart knowledge on

1. Principles of academic and scientific research
2. Literature Review and Research ethics
3. Principles and practices of IPR

Course Outcomes: After completing the course the student will be able to

1. Understand research problem formulation.
2. Review the relevant literature
3. Analyze research related information
4. Follow research ethics
5. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
6. Understand that when IPR would take such important place in growth of individuals & nation,

MODULE I – INTRODUCTION (7 Lecture Hours)

Meaning of research problem, Sources of research problem, Criteria. Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

MODULE II – LITERATURE REVIEW (7 Lecture Hours)

Effective literature studies approaches, analysis Plagiarism, Research ethics and Research principles

MODULE III – TECHNICAL WRITING (7 Lecture Hours)

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and

Assessment by a review committee

MODULE IV – IPR (8 Lecture Hours)

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE V – PATENTS **(8 Lecture Hours)**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
MODULE VI – NEW DEVELOPMENTS IN IPR **(8 Lecture Hours)**
Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Reference Books:

1. Stuart Melville and Wayne Goddard,"Research methodology: an introduction for science& engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

18ME3058	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

Course objectives: To impart knowledge on
1. Understand the role of business analytics and analyze data using statistical techniques.
2. Formulate and solve business problems using decision-making tools.
3. Manage business process using analytical and management tools.

Course Outcomes: After completing the course the student will be able to
1. Understand the concept of business analytics.
2. Model and solve business problems using regression analysis.
3. Apply technical skills in predicative and prescriptive modeling.
4. Understand the forecasting techniques, Monte Carlo simulation and risk analysis
5. Analyze and solve business problems using decision-making tools
6. Understand recent trends in Embedded and collaborative business intelligence.

MODULE I – BUSINESS ANALYTICS **(8 Lecture Hours)**
Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.
MODULE II – TRENDINESS AND REGRESSION ANALYSIS **(7 Lecture Hours)**
Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.
MODULE III – VARIOUS TECHNIQUES IN BUSINESS ANALYTICS (7 Lecture Hours)
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.
MODULE IV – FORECASTING TECHNIQUES, MONTE CARLO SIMULATION AND RISK ANALYSIS **(8 Lecture Hours)**
Forecasting Techniques, Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.
MODULE V – DECISION ANALYSIS **(8 Lecture Hours)**

Formulating Decision Problems, Decision Strategies with the Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

MODULE VI – RECENT TRENDS (8 Lecture Hours)

Recent trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference Books:

1. 1.Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications, Pearson FT Press, 2015.
2. James Evans, Business Analytics, persons Education, 2016.

18ME3059	**INDUSTRIAL SAFETY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Recognition, investigation, analysis, and control of hazards.
2. Management's role in safety and assess the importance
3. The multiple hazards associated with welding

Course Outcomes: After completing the course the student will be able to

1. Apply the basic concepts and scope of engineering safety.
2. Implement the standards of professional conduct that are published by professional safety organizations and certification bodies.
3. Illustrate the importance of safety of employees while working with machineries
4. Express Safety in terms of Risk and to recognize unacceptable/inappropriate levels of Risk
5. Identify hazards arising from runaway reactions, explosions and fires
6. Suggest the various methods to prevent the hazards working with machineries

MODULE I – SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES (7 Lecture Hours)

General safety rules, Occupational Safety and Health act of USA– OSHAS 18000 – ISO 14000 – Benefits and Elements principles, maintenance, Inspections of manufacturing machines, hazards, Risks. Applications of ergonomic principles in the shop floor.

MODULE II – PRINCIPLES OF MACHINE GUARDING: GUARDING DURING MAINTENANCE (8 Lecture Hours)

Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards – point of operation protective devices.

MODULE III – SAFETY IN WELDING AND GAS CUTTING (8 Lecture Hours)

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, personal protective equipment, training, safety precautions during welding.

MODULE IV – SAFETY IN COLD FORMING AND HOT WORKING OF METALS (7 Lecture Hours)

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism.

MODULE V – SAFETY IN FINISHING, INSPECTION AND TESTING (7 Lecture Hours)

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing. Applicable standards in Industrial safety management.

Reference books:

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly "Accident Prevention Manual" NSC, Chicago, 2009.
2. Charles D. Reese, "Occupational Health and Safety Management", CRC Press, 2015.
3. John Davies, Alastair Ross, Brendan Wallace, Safety Management: A Qualitative Systems Approach, CRC Press, 2003.

4. Accident Prevention Manual, National Safety Council (NSC), Chicago, 1982. 2. Occupational safety Manual, BHEL, Trichy, 1988.
5. John V. Grimaldi and Rollin H. Simonds, Safety Management, All India Travelers Book Seller, New Delhi, 1989.
6. N.V. Krishnan, Safety in Industry, Jaico Publishery House, 1996.
7. Indian Boiler Acts and Regulations, Government of India.

18ME3060	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Linear Programming techniques.
2. Job sequencing problems, Transportation and assignment problems.
3. Inventory models, PERT/CPM and Queuing theory.

Course Outcomes: After completing the course the student will be able to
1. Correlate this subject knowledge with the engineering problems.
2. Construct flexible appropriate mathematical model to represent physical problem
3. Schedule their engineering projects by using network analysis
4. Analyze the transportation problem and optimize the resources and output
5. Apply their knowledge in solving their engineering queuing problems.
6. Develop their skills in decision making analysis by allocation of resources

MODULE I – LINEAR PROGRAMMING PROBLEM (9 Lecture Hours)

Formulation of LPP – Graphical Method – Simplex Method –Artificial variable technique and two phase simplex method. Duality – Dual and simplex method – Dual Simplex Method – Sequencing: Job sequencing – n jobs through two machines and three machines

MODULE II – TRANSPORTATION PROBLEM (9 Lecture Hours)

Transportation Model, finding initial basic feasible solutions using least cost method, Vogells's approximation method and North–West corner method, moving towards optimality through MODI method, Resolving degeneracy in transportation.

MODULE III – ASSIGNMENT PROBLEM (8 Lecture Hours)

Solution of an Assignment problem, Multiple Solution, Hungarian Algorithm, Maximization in Assignment Model, Impossible Assignment.

MODULE IV – NETWORK ANALYSIS (9 Lecture Hours)

Network diagram – probability of achieving completion date – crash time –cost analysis – PERT & CPM-Forward and backward scheduling.

MODULE V – INVENTORY MODELS (9 Lecture Hours)

Economic order quantity models-purchase models with and without shortage, production models with and without shortage-ABC analysis-Two Bin system.

MODULE VI – QUEUING MODELS (9 Lecture Hours)

Structure of queuing models-Attributes and components of queuing models-application of queuing models- Kendall's Notation -Single service channel with finite and infinite queue size - Single service channel with finite and infinite population size

Reference books:

1. S. Bhaskar, "Operations Research", Anuradha Agencies, Chennai 2013
2. Natarajan A.M., Balasubramani P., Thamilarasi A., "Operations Research", Pearson Education, 1st Edition, 2014.
3. HamdyTaha A., "Operations Research", 6th Edition Prentice – Hall of India Private Limited, New Delhi, 2010.
4. KantiSwarup, Manmohan, Gupta P.K., "Operations Research" Sultan Chand & Sons., 14th Edition 2014.
5. Srinivasan G., "Operations Research", Prentice – Hall of India Private Limited, New Delhi, 2010.

18ME3061	COST MANAGEMENT OF ENGINEERING PROJECTS	L T P C 3 0 0 3

Course objectives: To impart knowledge on
1. The concept of cost management process and projects
2. Project cost and materials.
3. Budgetary Control and quantitative techniques for cost management.

Course Outcomes: After completing the course the student will be able to
1. Identify various costs.
2. Understand the elements of engineering project.
3. Analyze and control project cost.
4. Understand various cost management techniques.
5. Analyze and control Budget.
6. Apply quantitative techniques for cost management.

MODULE I – INTRODUCTION TO STRATEGIC COST MANAGEMENT PROCESS (8 Lecture Hours)

Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

MODULE II – ENGINEERING PROJECT (7 Lecture Hours)

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts, Types and contents. Project execution, Bar charts and Network diagram, Project commissioning.

MODULE III – PROJECT COST CONTROL (8 Lecture Hours)

Mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Standard Costing and Variance Analysis, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing, Costing of service sector.

MODULE IV – COST MANAGEMENT TECHNIQUES (7 Lecture Hours)

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

MODULE V – BUDGETARY CONTROL (7 Lecture Hours)

Budgetary Control, Flexible Budgets, Performance budgets, Zero-based budgets, Measurement of Divisional profitability pricing decisions including transfer pricing.

MODULE VI – QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT (8 Lecture Hours)

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. Charles T. Horngren, George Foster, Srikant M. Datar, Madhav V. Rajan, Chris M. Ittner, Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2008.
2. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, Prentice Hall, 2003.

Reference Books:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 2005.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

18ME3062	COMPOSITE MATERIALS	L T P C 3 0 0 3

Objectives: To impart knowledge on
1. Composite materials and their applications.
2. Fabrication, analysis, and design of composite materials and structures.
3. Prediction of the mechanical response of multi layered materials and structures.

Course Outcomes: After completing the course the student will be able to
1. Predict elastic properties of composites and
2. Predict mechanical properties of fiber reinforced composite materials.
3. Design a composite laminate for a given load condition.
4. Describe fundamental fabrication processes for polymer matrix composites.
5. Analyze the stresses using laminated plate theories.
6. Compare and contrast different processes of manufacture of polymer composites.

MODULE I – INTRODUCTION COMPOSITES (7 Lecture Hours)
Definition – need- General Characteristics, applications, Fibers- Glass, Carbon, Ceramic and Aramid fibers. Matrices- polymer, Graphite, Ceramic and Metal Matrices- Characteristics of fibers and matrices. Smart Materials- type and Characteristics

MODULE II – MECHANICS AND PERFORMANCE (7 Lecture Hours)
Characteristics of fiber-reinforced lamina-laminates-interlaminar stresses – Static Mechanical properties- Fatigue and Impact properties- Environmental Effects - Fracture behaviour and Damage Tolerance.

MODULE III – POLYMER MATRIX COMPOSITES (8 Lecture Hours)
PMC processes - Hand layup processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

MODULE IV – METAL MATRIX COMPOSITES (8 Lecture Hours)
Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix composite , Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

MODULE V – ANALYSIS (8 Lecture Hours)
Stress analysis of laminated Composite beams, plates, shells- vibration and stability analysis – reliability of composites- equivalent orthographic/layered Finite Elements- finite element method of analysis of composites- analysis of sandwich structures.

MODULE VI – DESIGN AND TESTING (7 Lecture Hours)
Characterization of composite products – laminate design consideration- bolted and bonded joints design examples- non-destructive testing- failure mode Predictions.

Reference Books:

1. Mallick, P.K., “Fiber- Reinforced composites: Materials, Manufacturing and Design” Maneel Dekker inc. 2004.
2. Agarwal, B.D., and Broutman L.J., “ Analysis and Performance of fiber composites”, John Wiley and Sons, New York, 2011.
3. Halpin, J. C., “Primer on Composite Materials, Analysis” Techomic Publishing Co., 2009.
4. Mallick, P.K. and Newman, S., “ Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 2012.
5. Williams D, Callister “ Material Science and Engineering” John Wiley & sons inc. 2015.

18ME3063	WASTE TO ENERGY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. List the various biomass energy sources and their conversion processes.
2. Develop a small scale gasifier and biogas plant.
3. Determine the power generation from biomass waste.

Course Outcomes: After completing the course the student will be able to

1. Explain the working principle of biomass conversion processes.
2. Estimate the liquid fuel production from pyrolysis process.
3. Analyze the composition of synthesis gas using gas chromatography.
4. Design a community type biogas plant.
5. Design and develop a biogas stove.
6. Determine the amount of power generation from I C engines using alcohol fuels.

MODULE I – INTRODUCTION TO ENERGY FROM WASTE (7 Lecture Hours)

Classification of waste as fuel – agro based, forest residue, industrial waste – municipal solid waste – conversion devices – incinerators, gasifiers, and digesters- biomass resources and their classification, biomass energy programme in India, Urban waste to energy conversion.

MODULE II – BIOMASS PYROLYSIS (7 Lecture Hours)

Pyrolysis – slow pyrolysis, flash pyrolysis and fast pyrolysis – Manufacture of charcoal – methods - yields and application – manufacture of pyrolytic oils and gases, properties of pyrolysis oil and composition of pyrolysis gases- application.

MODULE III – BIOMASS GASIFICATION (8 Lecture Hours)

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

MODULE IV – BIOMASS COMBUSTION (8 Lecture Hours)

Biomass stoves – improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, fluidized bed combustors, design, construction and operation - biomass combustors- operation, fuel, efficiency and maintenance.

MODULE V – BIOGAS (8 Lecture Hours)

Properties of biogas - biogas plant technology and status - bio energy system - design and constructional features - biomass conversion processes - thermo chemical conversion processes - direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion processes - anaerobic digestion- types of biogas Plants – applications- maintenance problem.

MODULE VI – ALCOHOL PRODUCTION FROM BIOMASS (7 Lecture Hours)

Ethanol production from wood by acid hydrolysis- ethanol from sugar cane-fermentation systems- methanol production- properties of liquid fuel- bio diesel production- performance of alcohol in I.C engines.

Reference Books:

1. G.D.Ral , “Non-conventional energy sources”, Khanna publishers, 5th edition, 2011
2. Desai, Ashok V, “Non-Conventional Energy”, Wiley Eastern Ltd., 2010.
3. Khandelwal, K. C. and Mahdi, S. S., “Biogas Technology - A Practical Hand Book - Vol. I and II”, Tata McGraw Hill Publishing Co. Ltd., 2013.
4. Challal, D. S., “Food, Feed and Fuel from Biomass”, IBH Publishing Co. Pvt. Ltd., 2001.
5. C. Y. WereKo-Brobby and E. B. Hagan, “Biomass Conversion and Technology”, John Wiley & Sons, 2006.

18ME3064	DISASTER MANAGEMENT	L T P C 2 0 0 2

Course objectives: To impart knowledge on
1. Critical understanding of key concepts in disaster risk reduction and humanitarian response
2. Disaster risk reduction and humanitarian response policy and practice from multiple perspectives
3. Understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

Course Outcomes: After completing the course the student will be able to
1. Understand Definitions and Terminologies used in Disaster Management
2. Apply Disaster Concepts to Management
3. Analyzing Relationship between Development and Disasters
4. Classify Categories of Disasters and
5. Understand the Challenges posed by Disasters
6. Enumerate the responsibilities to society

MODULE I – INTRODUCTION (7 Lecture Hours)
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.
MODULE II – REPERCUSSIONS OF DISASTERS AND HAZARDS (8 Lecture Hours)
Economic Damage, Loss of Humanand Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.
MODULE III – DISASTER PRONE AREAS IN INDIA (7 Lecture Hours)
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics
MODULE IV – DISASTER PREPAREDNESS AND MANAGEMENT (8 Lecture Hours)
Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.
MODULE V – RISK ASSESSMENT (8 Lecture Hours)
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global andNational Disaster Risk Situation. Techniques of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.
MODULE VI – DISASTER MITIGATION (7 Lecture Hours)
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.

Reference Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Challenges and Strategies", New Royal book Company, 2007.
2. Sahni, Pardeep Et. Al., "Disaster Mitigation: Experiences and Reflections", Prentice Hall of India, New Delh, 2001.
3. Goel S. L., "Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi, 2007.
4. Singh B.K., "Handbook of Disaster Management: Techniques & Guidelines", Rajat Publication, 2008.
5. Ghosh G.K., "Disaster Management" APH Publishing Corporation, 2006.

18ME3065	CONSTITUTION OF INDIA	L T P C 2 0 0 2

Course objectives: To impart knowledge on

1. Basic information about Indian constitution.
2. Identification of individual role and ethical responsibility towards society.
3. Human rights and its implications

Course Outcomes: After completing the course the student will be able to

1. Have general knowledge and legal literacy and thereby to take up competitive examinations
2. Understand state and central policies, fundamental duties
3. Understand Electoral Process, special provisions
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies
5. Understand Engineering ethics and responsibilities of Engineers.
6. Have an awareness about basic human rights in India

MODULE I – INTRODUCTION (6 Lecture Hours)

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations

MODULE II – DUTIES OF PRIME MINISTER, PRESIDENT AND SUPREME COURT (6 Lecture Hours)

Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.

MODULE III – DUTIES OF GOVERNOR, CHIEF MINISTER HIGH COURT AND ELECTION COMMISSION (6 Lecture Hours)

State Executives – Governor Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42^{nd}, 44^{th}, 74^{th}, 76^{th}, 86^{th}& 91^{st} Amendments.

MODULE IV – PROVISONS FOR SC/ST, WOMEN, CHILDREN AND BACKWARD CLASSES (7 Lecture Hours)

Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India .

MODULE V – ETHICS AND RESPONSIBILITY OF ENGINEERS (6 Lecture Hours)

Scope & Aims of Engineering Ethics, Responsibility of Engineers, Impediments to Responsibility, Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering

MODULE VI – POWERS AND FUNCTIONS OF MUNICIPALITIES, PANCHAYATS AND SOCITIES (6 Lecture Hours)

Powers and functions of Municipalities, Panchayats and Co - Operative Societies

Reference Books:

1. Durga Das Basu, “Introduction to the Constitution on India”, Prentice Hall of India, 2001.
2. Charles E. Harieset, al, “Engineering Ethics”, Thompson Asia, 2003.
3. M.V.Pylee, “An Introduction to Constitution of India”, Vikas Publishing, 2002.
4. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, “Engineering Ethics”, Prentice Hall of India,2004.
5. Brij Kishore Sharma, “Introduction to the Constitution of India” , Prentice Hall of India, 2011.

18ME3066	PEDAGOGY STUDIES	L T P C 2 0 0 2

Course Objectives: To impart knowledge on

1. Understanding the meaning, philosophies and theories of education.
2. Identify critical evidence gaps to guide the development.
3. Summarize existing evidence on the review topic to inform programme design and policy making undertaken by agencies and researchers.

Course Outcomes: After completing the course the student will be able to

1. Demonstrate knowledge of major theories and values of education in relation to class room management and social life.
2. Analyze the implications of thoughts and theories of education on teaching, learning processes, curriculum, class room management and social changes.
3. Outline how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
4. Demonstrate skills in curriculum management and implementation
5. Evaluate how philosophy, thoughts and theories of education affect learning processes.
6. Explain what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries

MODULE I – INTRODUCTION AND METHODOLOGY (7 Lecture Hours)

Aims and rationale- policy background- conceptual framework and terminology- meaning of education- theories of learning, curriculum and teacher education- conceptual framework- research questions- overview of methodology and searching.

MODLUE II – THEMATIC OVERVIEW (7 Lecture Hours)

Pedagogical practices- used by teachers in formal and informal classrooms in developing countries- curriculum and teacher education- critical pedagogy and standards- pedagogy and models of teacher knowledge.

MODULE III – EFFECTIVENESS OF PEDAGOGICAL PRACTICES(8 Lecture Hours)

Methodology for the in depth stage, quality assessment of included studies, teacher education - curriculum and guidance materials - best support effective pedagogy- theory of change- strength and nature of the body of evidence for effective pedagogical practices.- pedagogic theory and pedagogical approaches.- teachers attitudes and beliefs and pedagogic strategies.

MODULE IV – PROFESSIONAL DEVELOPMENT (8 Lecture Hours)

Alignment with classroom practices and follow-up support- peer support - support from the head teacher and the community- curriculum and assessment- barriers to learning- limited resources and large class sizes.

MODULE V – RESEARCH GAPS AND FUTURE DIRECTIONS (8 Lecture Hours)

Research design - contexts - pedagogy - teacher education- dissemination and research impact- great teachers- examples- parents as primary educators- education and technology- future visions- moral education.

MODULE VI – PEDAGOGY APPROACHES (7 Lecture Hours)

Educational philosophy and theory- pedagogy approaches- equality and diversity- learning principles to guide pedagogy- constructivist pedagogy- critical pedagogy-pedagogic theory- pedagogic strategies- teaching generation next.

Reference Books:

1. Ackers J, Hardman F, Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261, 2001
2. Agrawal M, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379, 2004
3. Akyeampong K, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID, 2003

4. Akyeampong K, Lussier K, Pryor J, Westbrook J Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282, 2013
6. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell, 2001.