FRANCIS XAVIER ENGINEERING COLLEGE

AN AUTONOMOUS INSTITUTION

ACCREDITED BY NBA

ISO 9001:2015 Certified | DST-FIST Supported Institution

Recognized under Section 2(f) & 12(B) of the UGC Act, 1956

Vannarpettai, Tirunelveli - 627003, Tamil Nadu

CURRICULUM AND SYLLABUS

B.E.Mechanical Engineering

Regulations 2019

FRANCIS XAVIER ENGINEERING COLLEGE
AN AUTONOMOUS INSTITUTION
Accredited BY NBA | AICTE Sponsored Margdarshan Mentor Institution
DST-FIST Supported Institution | ISO 9001:2015 Certified
Recognized under Section 2(f) & 12(B) of the UGC Act, 1950
/fxengg /fxengg /fx_ec /fxengg
/francisxavierengineeringcollege

Department of Mechanical Engineering

B.E. Mechanical Engineering

Curriculum & Syllabus

REGULATIONS 2019

(CBCS)

Approved by

TABLE OF CONTENT

Sl. No	CONTENT	PAGE
1	TABLE OF CONTENTS	3
2	VISION AND MISSION OF THE DEPARTMENT	5
3	PROGRAM EDUCATIONAL OBJECTIVES (PEOS)	6
4	PROGRAM OUTEOPCOMES (POS)	7
5	PROGRAM SPECIFIC OBJECTIVES (PSOS)	8
6	PEO PO MAPPING	9
7	CREDIT DISTRIBUTION	10
8	SUMMARY OF CREDIT DISTRIBUTION	11
9	I – VIII SEMESTERS CURRICULUM	13
10	PROFESSIONAL ELECTIVES	17
11	INDUSTRIAL SUPPORTIVE COURSE	23
12	SPECIALIZATION COURSE	24
13	VALUE ADDED COURSES	25
14	ONLINE COURSES	26
15	I TO VIII SEMESTERS SYLLABI	27
16	ANNEXURE – II MANDATORY NON CGPA COURSES (ACADEMIC)	269
17	ANNEXURE – III LIST OF VALUE ADDED COURSES	270
18	ANNEXURE – IV LIST OF ONLINE COURSES	277
19	LIST OF ONLINE COURSE PORTALS	279

20	**ANNEXURE – V MANDATORY NON CGPA COURSES (NON-ACADEMIC)**	**280**
21	**ANNEXURE – VI INDUSTRIAL TRAINING/INTERNSHIP**	**285**
22	**ANNEXURE – VII CRITICAL & CREATIVE THINKING**	**287**

VISION AND MISSION OF THE DEPARTMENT

VISION

To produce competent Mechanical Engineers of excellent technical and managerial skills for national and global development

MISSION

To provide best education in Mechanical Engineering, encouraging innovation and entrepreneurship through professional and moral ethics and to improve the quality of the people worldwide.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Bachelor of Mechanical Engineering curriculum is designed to impart Knowledge, Skill and Attitude on the graduates to

PEO 1	Have a successful career in Mechanical Engineering and allied industries
PEO 2	Have expertise in the areas of Design, Thermal, Materials and Manufacturing
PEO 3	Contribute towards technological development through academic research and industrial practices
PEO 4	Practice their profession with good communication, leadership, ethics and social responsibility.
PEO 5	Graduates will adapt to evolving technologies through life-long learning

PROGRAM OUTCOMES (POs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following

PO 1	Engineering Knowledge	Demonstrate knowledge of fundamental mathematics, science, and mechanical engineering principles and apply these to solve complex problems.
PO 2	Problem Analysis	Identify, formulate and analyze complex problems related to mechanical engineering and allied fields
PO 3	Design/Development of Solutions	An ability to design of mechanical system or process to improve its performance, satisfying its constraints
PO 4	Conduct Investigations of Complex Problems	An ability to conduct complex mechanical engineering experiments; collect, analyze and interpret the data
PO 5	Modern Tool Usage	An ability to apply various techniques and modern engineering tools and techniques to improve the efficiency of the system
PO 6	The Engineer and Society	An ability to conduct themselves to uphold the professional and social obligations
PO 7	Environment and Sustainability	An ability to identify the impact of solutions to mechanical engineering problems with environment consciousness and sustainable development
PO 8	Ethics	An ability to adopt and apply ethical principles to professional mechanical engineering practice.
PO 9	Individual and Team Work	An ability to contribute effectively as an individual and as a member or as a leader in multi-disciplinary teams to achieve desired goals
PO 10	Communication	An ability to communicate, write reports and express research findings in a scientific community pertaining to Mechanical Engineering
PO 11	Project Management and Finance	An ability to implement cost effective and improved system using engineering and financial management principles
PO 12	Life-Long Learning	An ability to continue professional development by engaging in lifelong learning.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following

PSO 1. Apply the knowledge gained in Mechanical Engineering for design and development and manufacture of engineering systems.

PSO 2. Apply the knowledge acquired to investigate research oriented problems in Mechanical Engineering with due consideration for environmental and social impacts.

PEO / PO MAPPING

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)	PROGRAMME OUTCOMES (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
PEO 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PEO 2	✓	✓	✓		✓			✓				
PEO 3		✓		✓	✓	✓		✓				
PEO 4					✓	✓	✓		✓			
PEO 5		✓	✓	✓	✓							✓

B.E. MECHANICAL ENGINEERING

REGULATIONS 2019

CHOICE BASED CREDIT SYSTEM

CREDIT DISTRIBUTION

Sl. No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS IN %
		I	II	III	IV	V	VI	VII	VIII		
1	HSS	3	2		2	3				**10**	6.1
2	BS	12	4	4						**20**	12.2
3	ES	7	12		4					**23**	14
4	PC			19	17	18	5	7		**66**	40.2
5	PE					3	9	6	3	**21**	12.8
6	OE						3	3	3	**9**	5.5
7	EEC						2	3	10	**15**	9.2
TOTAL		**22**	**18**	**23**	**23**	**24**	**19**	**19**	**16**	**164**	100%

HSS - Humanities and Social Sciences

BS - Basic Sciences

ES - Engineering Sciences

PC - Professional Core

PE - Professional Elective

OE - Open Elective

EEC - Employability Enhancement Course

B.E. MECHANICAL ENGINEERING

REGULATIONS 2019

CHOICE BASED CREDIT SYSTEM

SUMMARY OF CREDIT DISTRIBUTION

Course Category	Semester	Course Code	Course Title	Credit
HSS	I	19GE1101	English for Professional Communication	3
	II	19GE2101	Technical Communication	2
		19ME2306	Environmental Engineering	-
	IV	19GE4M01	Interpersonal Skills–Listening and Speaking	2
	V	19ME5501	Professional Ethics for Engineers	3
			Total Credits	**10**
BS	I	19GE1202	Matrices and Advanced Calculus	4
		19GE1304	Engineering Physics for Mechanical Engineers	3
		19GE1404	Engineering Chemistry for Mechanical Engineers	3
		19ME1311	Physics and Chemistry Laboratory	2
	II	19MA2202	Application of PDE and Transform	4
	III	19ME3201	Statistics and Numerical Methods	4
			Total Credits	**20**
ES	I	19CS1503	Problem solving and python programming	4
		19ME1502	Engineering Graphics	3
	II	19ME2503	Basic Civil and Building Engineering	2
		19ME2504	Electrical Drives and Controls	3
		19ME2505	Engineering Mechanics	3
		19ME2511	Engineering Practices Laboratory	2
		19ME2512	Electrical Machines Laboratory	2
	IV	19ME4505	Electronics and Microprocessor	4
			Total Credits	**23**
PC	III	19ME3602	Manufacturing Technology – I	4
		19ME3603	Engineering Thermodynamics	4
		19ME3604	Fluid Mechanics and Machinery	4
		19ME3605	Engineering Materials and Metallurgy	3
		19ME3611	Fluid Mechanics and Machinery Laboratory	2
		19ME3612	Computer Aided Drafting Laboratory	2
	IV	19ME4601	Manufacturing Technology – II	3
		19ME4602	Strength of Materials	4
		19ME4603	Thermal Engineering	3
		19ME4604	Kinematics of Machines	3
		19ME4611	Manufacturing Technology Laboratory	2
		19ME4612	Thermal Engineering Laboratory	2

Course Category	Semester	Course Code	Course Title	Credit
PC	V	19ME5602	Heat and Mass Transfer	3
		19ME5603	Dynamics of Machines	3
		19ME5604	Machine Design	3
		19ME5605	Metrology and Measurements	3
		19ME5611	CAD / CAM Laboratory	2
		19ME5612	Heat and Mass Transfer Laboratory	2
		19ME5613	Metrology and Dynamics Laboratory	2
	VI	19ME6601	Design of Transmission Systems	3
		19ME6611	Computer Aided Engineering Laboratory	2
	VII	19ME7601	Power Plant Engineering	3
		19ME7602	Mechatronics	4
			Total Credits	**66**
PE	V	E1	Elective – I	3
	VI	E2	Elective – II	3
		E3	Elective – III	3
		E4	Elective – IV	3
	VII	E6	Elective – VI	3
		E7	Elective – VII	3
	VIII	E9	Elective – IX	3
			Total Credits	**21**
OE	VI	E5	Elective – V	3
	VII	E8	Elective – VIII	3
	VIII	E10	Elective – X	3
			Total Credits	**9**
EEC	III	19GE3M01	Communication and Soft Skills	
	V	19GE5M01	Interpersonal Skills Essential	
	VI	19ME6912	Design and Fabrication Project	2
		19GE6M01	Professional Communication – Advanced Reading and Writing	
	VII	19ME7911	Technical Seminar	1
		19ME7912	Comprehension	2
		19ME7M13	Aptitude skills	
	VIII	19ME8911	Project Work	10
			Total Credits	**15**

B.E.MECHANICAL ENGINEERING

REGULATIONS 2019

CHOICE BASED CREDIT SYSTEM

I – VIII SEMESTERS CURRICULUM

FIRST SEMESTER

Code No.	Course	Category	L	T	P	C	H
19GE1101	English for Professional Communication	HSS	3	0	0	**3**	3
19GE1202	Matrices and Advanced Calculus	BS	3	1	0	**4**	4
19GE1304	Engineering Physics for Mechanical Engineers	BS	3	0	0	**3**	3
19GE1404	Engineering Chemistry for Mechanical Engineers	BS	3	0	0	**3**	3
19CS1503	Problem solving and Python programming	ES	2	0	4	**4**	6
19ME1502	Engineering Graphics	ES	1	0	4	**3**	5
19ME1311	Physics and Chemistry Laboratory	BS	0	0	4	**2**	4
		TOTAL	**15**	**1**	**12**	**22**	**28**

SECOND SEMESTER

Code No.	Course	Category	L	T	P	C	H
19GE2101	Technical Communication	HSS	2	0	0	**2**	2
19MA2202	Application of PDE and Transform	BS	3	1	0	**4**	4
19ME2503	Basic Civil and Building Engineering	ES	2	0	0	**2**	2
19ME2504	Electrical Drives and Controls	ES	3	0	0	**3**	3
19ME2505	Engineering Mechanics	ES	3	0	0	**3**	3
19GE2M01	Environmental Science and Engineering	BS	2	0	0	-	2
19ME2511	Engineering Practices Laboratory	ES	0	0	4	**2**	4
19ME2512	Electrical Machines Laboratory	ES	0	0	4	**2**	4
		TOTAL	**15**	**1**	**8**	**18**	**24**

THIRD SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
19ME3201	Statistics and Numerical Analysis	BS	3	1	0	**4**	4
19ME3602	Manufacturing Technology – I	PC	3	0	2	**4**	5
19ME3603	Engineering Thermodynamics	PC	3	1	0	**4**	4
19ME3604	Fluid Mechanics and Machinery	PC	3	1	0	**4**	4
19ME3605	Engineering Materials and Metallurgy	PC	3	0	0	**3**	3
19ME3611	Fluid Mechanics and Machinery Laboratory	PC	0	0	4	**2**	4
19ME3612	Computer Aided Drafting Laboratory	PC	0	0	4	**2**	4
19GE3M01	Communication and Soft Skills	EEC	0	0	2	**-**	2
		TOTAL	**15**	**3**	**12**	**23**	**30**

FOURTH SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
19ME4601	Manufacturing Technology – II	PC	3	0	0	**3**	3
19ME4602	Strength of Materials	PC	3	0	2	**4**	5
19ME4603	Thermal Engineering	PC	3	0	0	**3**	3
19ME4604	Kinematics of Machines	PC	3	0	0	**3**	3
19ME4505	Electronics and Microprocessor	ES	3	0	2	**4**	5
19ME4611	Manufacturing Technology Laboratory	PC	0	0	4	**2**	4
19ME4612	Thermal Engineering Laboratory	PC	0	0	4	**2**	4
19GE4M01	Interpersonal Skills – Listening and Speaking	HSS	0	0	4	**2**	4
		TOTAL	**15**	**2**	**16**	**23**	**33**

FIFTH SEMESTER

Code No.	Course	Category	L	T	P	C	H
19ME5501	Professional Ethics for Engineers	HSS	3	0	0	**3**	3
19ME5602	Heat and Mass Transfer	PC	3	0	0	**3**	3
19ME5603	Dynamics of Machines	PC	3	0	0	**3**	3
19ME5604	Design of Machine Elements	PC	3	0	0	**3**	3
19ME5605	Metrology and Measurements	PC	3	0	0	**3**	3
E1	Elective – I	PE	3	0	0	**3**	3
19ME5611	CAD / CAM Laboratory	PC	0	0	4	**2**	4
19ME5612	Heat and Mass Transfer Laboratory	PC	0	0	4	**2**	4
19ME5613	Metrology and Dynamics Laboratory	PC	0	0	4	**2**	4
19GE5M01	Interpersonal Skills Essential	EEC	0	0	2	**-**	2
		TOTAL	**18**	**3**	**14**	**24**	**36**

SIXTH SEMESTER

Code No.	Course	Category	L	T	P	C	H
19ME6601	Design of Transmission Systems	PC	3	0	0	**3**	3
E2	Elective – II	PE	3	0	0	**3**	3
E3	Elective – III	PE	3	0	0	**3**	3
E4	Elective – IV	PE	3	0	0	**3**	3
E5	Elective – V	OE	3	0	0	**3**	3
19ME6611	Computer Aided Engineering Laboratory	PC	0	0	4	**2**	4
19ME6912	Design and Fabrication Project	EEC	0	0	4	**2**	4
19GE6M01	Professional Communication – Advanced Reading and Writing	EEC	0	0	2	**-**	2
		TOTAL	**15**	**1**	**10**	**19**	**26**

SEVENTH SEMESTER

Code No.	Course	Category	L	T	P	C	H
19ME7601	Power Plant Engineering	PC	3	0	0	**3**	3
19ME7602	Mechatronics	PC	3	0	1	**4**	4
E6	Elective – VI	PE	3	0	0	**3**	3
E7	Elective – VII	PE	3	0	0	**3**	3
E8	Elective – VIII	OE	3	0	0	**3**	3
19ME7911	Technical Seminar	EEC	0	0	2	**1**	2
19ME7912	Comprehension	EEC	0	0	4	**2**	4
19ME7M13	Aptitude skills	EEC	0	0	2	**-**	2
		TOTAL	**15**	**0**	**9**	**19**	**24**

EIGTH SEMESTER

Code No.	Course	Category	L	T	P	C	H
E9	Elective – IX	PE	3	0	0	**3**	3
E10	Elective – X	OE	3	0	0	**3**	3
19ME8911	Project Work	EEC	0	0	20	**10**	20
		TOTAL	**6**	**0**	**20**	**16**	**26**

Total Credits: 164

L – Lecture, T – Tutorial, P – Practical, H –Hours

PROFESSIONAL ELECTIVES

SEMESTER V

Course Code	Course Name	L	T	P	C	H
DESIGN AND ANALYSIS STREAM						
19ME5701	Applied Hydraulics and Pneumatics	3	0	0	3	3
19ME5702	Design of Jigs, Fixtures and Press Tools	3	0	0	3	3
MANUFACTURING AND MATERIALS STREAM						
19ME5703	Additive Manufacturing	3	0	0	3	3
19ME5704	Polymer Technology	3	0	0	3	3
THERMAL AND FLUID STREAM						
19ME5705	Advanced I.C. Engines	3	0	0	3	3
19ME5706	Alternative fuels	3	0	0	3	3

SEMESTER VI

Course Code	Course Name	L	T	P	C	H
DESIGN AND ANALYSIS STREAM						
19ME6701	Mechanical Vibrations and Controls	3	0	0	3	3
19ME6702	Finite Element Analysis	3	0	0	3	3
19ME6703	Mechanical Behaviour of Materials	3	0	0	3	3
19ME6704	Design for Manufacturing and Assembly	3	0	0	3	3
19ME6705	Product design and development	3	0	0	3	3
19ME6706	Supply Chain Management and Logistics	3	0	0	3	3
MANUFACTURING AND MATERIALS STREAM						
19ME6707	Composite Materials and Engineering	3	0	0	3	3
19ME6708	Modern Machining Processes	3	0	0	3	3
19ME6709	Computer Integrated Manufacturing	3	0	0	3	3
THERMAL AND FLUID STREAM						
19ME6710	Air Breathing Engines	3	0	0	3	3
19ME6711	Refrigeration and Air Conditioning	3	0	0	3	3
19ME6712	Gas Dynamics and Jet Propulsion	3	0	0	3	3
19ME6713	Design of Heat Exchanger	3	0	0	3	3
19ME6714	Renewable Sources of Energy	3	0	0	3	3
INDUSTRY AUTOMATION AND MANAGEMENT						
19ME6715	Principles of Management	3	0	0	3	3

SEMESTER VII

Course Code	Course Name	L	T	P	C	H
DESIGN AND ANALYSIS STREAM						
19ME7701	Design of Pressure Vessels & Piping	3	0	0	3	3
19ME7702	Design and Analysis of Experiments	3	0	0	3	3
19ME7703	Reverse Engineering	3	0	0	3	3
MANUFACTURING AND MATERIALS STREAM						
19ME7704	Flexible Manufacturing Systems	3	0	0	3	3
19ME7705	Rapid Prototyping	3	0	0	3	3
19ME7706	Welding Technology	3	0	0	3	3
19ME7707	Introduction to Nano Technology	3	0	0	3	3
THERMAL AND FLUID STREAM						
19ME7708	Computational Fluid Dynamics	3	0	0	3	3
19ME7709	Automobile Engineering	3	0	0	3	3
19ME7710	Energy Conservation and Waste heat recovery	3	0	0	3	3
19ME7711	Turbo Machinery	3	0	0	3	3
19ME7712	Advanced Thermodynamics	3	0	0	3	3
19ME7713	Fuel cell Technology	3	0	0	3	3
INDUSTRY AUTOMATION AND MANAGEMENT						
19ME7714	Maintenance Engineering	3	0	0	3	3
19ME7715	Total Quality Management	3	0	0	3	3
19ME7716	Process Planning and Cost Estimation	3	0	0	3	3
19ME7717	Industrial Robotics	3	0	0	3	3
19ME7718	Industrial Safety Engineering	3	0	0	3	3
19ME7719	Resource Management Techniques	3	0	0	3	3

SEMESTER VIII

Course Code	Course Name	L	T	P	C	H
DESIGN AND ANALYSIS STREAM						
19ME8701	Failure Analysis and Design	3	0	0	3	3
19ME8702	Precision Machine Design	3	0	0	3	3
19ME8703	Industrial Tribology	3	0	0	3	3
MANUFACTURING AND MATERIALS STREAM						
19ME8704	Non Destructive Testing	3	0	0	3	3
19ME8705	Precision Manufacturing	3	0	0	3	3
THERMAL AND FLUID STREAM						
19ME8706	Fundamentals of Combustion	3	0	0	3	3
19ME8707	Nuclear Engineering	3	0	0	3	3
19ME8708	Cryogenics	3	0	0	3	3
19ME8709	Solar Cell – Fundamentals And Materials	3	0	0	3	3

Course Code	Course Name	L	T	P	C	H
INDUSTRY AUTOMATION AND MANAGEMENT						
19ME8710	Industrial Engineering & Management	3	0	0	3	3
19ME8711	Lean Six Sigma	3	0	0	3	3
19ME8712	Production Planning and Control	3	0	0	3	3
19ME8713	Industry 4.0	3	0	0	3	3
19ME8714	Entrepreneurship Development	3	0	0	3	3
19ME8715	Engineering Economics and Cost Analysis	3	0	0	3	3
19ME8716	Current trends in Indian Economy	3	0	0	3	3
19ME8717	Intellectual Property Rights	3	0	0	3	3
19ME8718	Human Resource and Management	3	0	0	3	3
19ME8719	Entrepreneurship Development	3	0	0	3	3

PROFESSIONALELECTIVES – STREAM – SEMESTER WISE

DESIGN AND ANALYSISSTREAM

Course Code	Course Name	Category	L	T	P	C
FIFTH SEMESTER						
19ME5701	Applied Hydraulics and Pneumatics	PE	3	0	0	3
19ME5702	Design of Jigs, Fixtures and Press Tools	PE	3	0	0	3
SIXTH SEMESTER						
19ME6701	Mechanical Vibrations and Controls	PE	3	0	0	3
19ME6702	Finite Element Analysis	PE	3	0	0	3
19ME6703	Mechanical Behaviour of Materials	PE	3	0	0	3
19ME6704	Design for Manufacturing and Assembly	PE	3	0	0	3
19ME6705	Product design and development	PE	3	0	0	3
19ME6706	Supply Chain Management and Logistics	PE	3	0	0	3
SEVENTH SEMESTER						
19ME7701	Design of Pressure Vessels & Piping	PE	3	0	0	3
19ME7702	Design and Analysis of Experiments	PE	3	0	0	3
19ME7703	Reverse Engineering	PE	3	0	0	3
EIGTH SEMESTER						
19ME8701	Failure Analysis and Design	PE	3	0	0	3
19ME8702	Precision Machine Design	PE	3	0	0	3
19ME8703	Industrial Tribology	PE	3	0	0	3

MANUFACTURING AND MATERIALS STREAM

Course Code	Course Name	Category	L	T	P	C
FIFTH SEMESTER						
19ME5703	Additive Manufacturing	PE	3	0	0	3
19ME5704	Polymer Technology	PE	3	0	0	3
SIXTH SEMESTER						
19ME6707	Composite Materials and Engineering	PE	3	0	0	3
19ME6708	Modern Machining Processes	PE	3	0	0	3
19ME6709	Computer Integrated Manufacturing	PE	3	0	0	3
SEVENTH SEMESTER						
19ME7704	Flexible Manufacturing Systems	PE	3	0	0	3
19ME7705	Rapid Prototyping	PE	3	0	0	3
19ME7706	Welding Technology	PE	3	0	0	3
19ME7707	Introduction to Nano Technology	PE	3	0	0	3

Course Code	Course Name	Category	L	T	P	C
EIGTH SEMESTER						
19ME8704	Non Destructive Testing	PE	3	0	0	3
19ME8705	Precision Manufacturing	PE	3	0	0	3

THERMAL AND FLUID STREAM

FIFTH SEMESTER						
19ME5705	Advanced I.C. Engines	PE	3	0	0	3
19ME5706	Alternative fuels	PE	3	0	0	3
SIXTH SEMESTER						
19ME6710	Air Breathing Engines	PE	3	0	0	3
19ME6711	Refrigeration and Air Conditioning	PE	3	0	0	3
19ME6712	Gas Dynamics and Jet Propulsion	PE	3	0	0	3
19ME6713	Design of Heat Exchanger	PE	3	0	0	3
19ME6714	Renewable Sources of Energy	PE	3	0	0	3
SEVENTH SEMESTER						
19ME7708	Computational Fluid Dynamics	PE	3	0	0	3
19ME7709	Automobile Engineering	PE	3	0	0	3
19ME7710	Energy Conservation and Waste heat recovery	PE	3	0	0	3
19ME7711	Turbo Machinery	PE	3	0	0	3
19ME7712	Advanced Thermodynamics	PE	3	0	0	3
19ME7713	Fuel cell Technology	PE	3	0	0	3
EIGTH SEMESTER						
19ME8706	Fundamentals of Combustion	PE	3	0	0	3
19ME8707	Nuclear Engineering	PE	3	0	0	3
19ME8708	Cryogenics	PE	3	0	0	3
19ME8709	Solar Cell – Fundamentals And Materials	PE	3	0	0	3

INDUSTRY AUTOMATION AND MANAGEMENT STREAM

Course Code	Course Name	Category	L	T	P	C
SIXTH SEMESTER						
19ME6715	Principles of Management	3	0	0	3	3
SEVENTH SEMESTER						
19ME7714	Maintenance Engineering	PE	3	0	0	3
19ME7715	Total Quality Management	PE	3	0	0	3
19ME7716	Process Planning and Cost Estimation	PE	3	0	0	3
19ME7717	Industrial Robotics	PE	3	0	0	3
19ME7718	Industrial Safety Engineering	PE	3	0	0	3
19ME7719	Resource Management Techniques	PE	3	0	0	3
EIGTH SEMESTER						
19ME8710	Industrial Engineering & Management	PE	3	0	0	3
19ME8711	Lean Six Sigma	PE	3	0	0	3
19ME8712	Production Planning and Control	PE	3	0	0	3
19ME8713	Industry 4.0	PE	3	0	0	3
19ME8714	Entrepreneurship Development	PE	3	0	0	3
19ME8715	Engineering Economics and Cost Analysis	PE	3	0	0	3
19ME8716	Current trends in Indian Economy	PE	3	0	0	3
19ME8717	Intellectual Property Rights	PE	3	0	0	3
19ME8718	Human Resource and Management	PE	3	0	0	3
19ME8719	Entrepreneurship Development	PE	3	0	0	3

INDUSTRIAL SUPPORT COURSES (SIXTH SEMESTER)

Course Code	Course Name	Category	L	T	P	C
19ME6i01	Industrial frontiers tools	PE	3	0`	0	3

Specialization Course on Additive Manufacturing

CURRICULUM AND SYLLABI

Offered one course per semester starting from 3rd semester							
Course code	Course	Category	L	T	P	C	H
19MEAM01	Additive Manufacturing Technologies and Applications	AM	3	0	0	3	3
19MEAM02	CAD for Additive Manufacturing	AM	3	0	2	4	5
19MEAM03	3D Printing and Prototyping	AM	3	0	2	4	5
19MEAM04	Design for Additive Manufacturing	AM	3	0	0	3	3
19MEAM05	Prototyping project	AM	0	0	8	4	8

VALUE ADDED COURSES

(Offered by the Department of Mechanical Engineering)

19ME0V01	3D Modelling For Design Engineer
19ME0V02	3D Printing
19ME0V03	Applied Finite Element Analysis
19ME0V04	Process Design and CNC Programming
19ME0V05	Non Destructive Testing

ONLINE COURSES

19ME0001	Swayam	https://swayam.gov.in/
19ME0002	NPTEL	https://nptel.ac.in/
19ME0003	MIT Open Courseware	https://ocw.mit.edu/index.htm
19ME0004	GIAN	https://gian.iitkgp.ac.in/
19ME0005	Coursera	https://www.coursera.org/
19ME0006	Edx	https://www.edx.org/
19ME0007	Saylor	https://www.saylor.org/
19ME0008	Udemy	https://www.udemy.com/

I to VIII SEMESTERS SYLLABI

19GE1101	**ENGLISH FOR PROFESSIONAL COMMUNICATION**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:

- Widen the basic reading and writing skills of first year Engineering and Technology students
- To develop listening skills, and enhance the ability of comprehending
- To hone speaking skills and speak confidently in real life situations
- To master vocabulary both General and Technical
- To draft letters and write abstracts

Prerequisite: Basic knowledge in English Language

SHARING INFORMATION **9**

Reading – Short Comprehension Passages – Day-to-day conversation; Writing – Reframing sentences from the jumbled words – Creating Coherence; Listening – Listening to TED talks, texts, short formal and informal conversations; Speaking – introducing oneself to the audience giving importance to characteristics, strengths and weaknesses; Language development – Framing Yes/No questions, Question tag, Vocabulary development – Formation of words– verb – Noun – Adjectives, standard abbreviations

READING AND WRITING I **9**

Reading – Extensive Reading – short narratives and news items from newspapers; Writing – Sentence structure – short passages on the working principle of any gadget, describing an Electronic/ mechanical gadget, importance of punctuation, organizing paragraphs; Listening – Listening to telephonic conversations and Lectures by native speakers; Speaking – introducing a device to the audience – specifications, descriptions, merits and demerits. Language development – Framing 'Wh' Questions, Writing a complete sentence using the fragments given. Vocabulary development – Prefix and suffix

READING AND WRITING II **9**

Reading – Comprehensive Reading – Technical Passages; Writing – Rearranging Jumbled Sentences, Writing Short Essays; Listening – listening to short English episodes and filling in the blanks – cloze test. Speaking – asking for opinions using do/does; Language development – Direct Speech and Indirect Speech – Framing Indirect Questions – Vocabulary development – Select single word substitute, Prepositions, Articles

DEVELOPING LETTER WRITING SKILLS **9**

Reading – Comprehending Articles from magazines, understanding the writing style – Writing – letter writing – Job Application – Resume; Listening – listening to dialogues or conversations and completing exercises based on them; Speaking – Language development – Tenses – simple present – simple past – present continuous and past continuous – Vocabulary development – synonyms, antonyms, phrasal verbs

EXTENDED WRITING **9**

Reading – Comprehending Articles from Journals –Writing – Writing Abstracts – developing an outline – identifying main and subordinate ideas – dialogue writing – enquiring about a product. Listening – listening to Technical Talks – Note Making – Speaking – participating in conversations – Short Group Discussions – phrases used during discussions – Language development – modal verbs – present/ past perfect tense – Vocabulary development – fixed and semi-fixed expressions

Total Periods: 45

TEXT BOOKS:

1. Butterfield, Jeff,"Soft Skills for Every one", Cengage Learning: New Delhi, (2017)
2. Richards C. Jack and David Bohleke,"Speak Now 3", Oxford Press,(2012)

REFERENCES:

1. Bailey, Stephen,"Academic Writing: A Practical guide for Students", New York: Rutledge, (2011)
2. Hughes, Glyn and Josephine Moate, "Practical English Classroom", Oxford University Press: Oxford, (2014)
3. Vargo, Mari,"Speak Now Level 4", Oxford University Press: Oxford, (2013)
4. Richards C. Jack,"Person to Person (Starter)". Oxford University Press: Oxford, (2006)
5. Bhatnagar, Nitin and Mamta Bhatnagar,"Communicative English for Engineers and Professionals", Pearson: New Delhi, (2010)

WEB RESOURCES:

1. Learn Engineering
   https://www.youtube.com/user/LearnEngineeringTeam/videos?view=0&sort=p&shelf_id=14
2. English Speaking Practice https://play.google.com/store/apps/details?id=com.talkenglish.practice
3. BBC Learning English http://www.bbc.co.uk/learningenglish/

COURSE OUTCOMES:

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

CO1. Listen and comprehend lectures and talks in their area of specialization successfully
CO2. Read technical texts and write area- specific texts effortlessly
CO3. Speak appropriately and effectively in varied formal and informal contexts
CO4. Write winning job applications and good abstracts
CO5. Write abstracts and technical articles

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1				2			3		3	3	2	2
CO2				2			3		2	3	3	2
CO3				1			1		1	3	3	1
CO4				2			2		2	2	3	3
CO5				3			3		3	3	3	3

HOD/MECH

19GE1202	**MATRICES AND ADVANCED CALCULUS**	**L-T-P**	**C**
		3-1-0	**4**

Programme: B.E. Mechanical Engineering

Objectives :

- To apply advanced matrix knowledge to Engineering problems
- To equip themselves familiar with the functions of several variables
- To familiarize with the applications of differential equations.
- To expose to the concept of Analytical function
- To familiarize with Complex integration

Prerequisite: Basic knowledge about Matrices, Differentiation and Integration and Vectors

MATRICES **9**

Characteristic equation – Eigen values and Eigen vectors of a symmetric and non symmetric matrix – Properties of Eigen values and Eigen vector – Cayley – Hamilton theorem and its applications

FUNCTIONS OF SEVERAL VARIABLES **9**

Function of two variables – Partial derivatives– Taylor's expansion – Maxima and Minima –Jacobians – Euler's theorem for homogeneous function

ORDINARY DIFFERENTIAL EQUATIONS **9**

Linear equations of second order with constant and variable coefficients – Homogeneous equation of Euler type – Legendre's equations – Methods of Variation parameter

MULTIPLE INTEGRALS **9**

Double integration in Cartesian and polar coordinates– Area as a double integral – Triple integration in Cartesian coordinates– Volume as a Triple Integral

VECTOR CALCULUS **9**

Gradient, divergence, curl – Solenoidal and irrotational fields – Vector identities (without proof) – Directional derivatives–Green's, Gauss divergence and Stoke's theorems (without proof)

Lecture: 45 Tutorial: 15 Total Periods: 60

TEXT BOOKS:

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publications, 42nd Edition, (2012)
2. Venkataraman M.K., "Engineering Mathematics – First Year", 2nd edition, National Publishing Co., Chennai, (2000)

REFERENCES:

1. Kreyszig E, "Advanced Engineering Mathematics", John Wiley & Sons. Singapore, 10th edition, (2012)
2. K.Ganesan, Sundarammal Kesavan, K.S.Ganapathy Subramanian & V.Srinivasan, "Calculus and Solid Geometry", Revised Edition, (2013)
3. Veerajan. T, "Engineering Mathematics I", Tata McGraw Hill Publishing Co, New Delhi, 5th edition, (2006)
4. Kandasamy P,"Engineering Mathematics", Vol.I, 4th revised edition, S.Chand &Co., New Delhi, (2000)

WEB RESOURCE:

https://nptel.ac.in/courses/111/106/111106051/

COURSE OUTCOMES:

The students will be able to

CO1. Understand the fundamental knowledge of Eigen values and Eigen vectors
CO2. Apply differentiation to solve maxima and minima problems
CO3. Apply various techniques in solving differential equations
CO4. Apply integration to compute multiple integrals, area and volume
CO5. Understand the basic concepts of gradient, divergences, curl of a vector point function

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1		2						2			
CO2	2								2			3
CO3		2										
CO4	1		2						1			2
CO5		2	1									

HOD/MECH

19GE1304	**ENGINEERING PHYSICS FOR MECHANICAL ENGINEERS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:

- To inculcate the knowledge on the modes of heat transfer
- To familiarize the basic concept of wave motions
- To introduce the fundamentalsof lasers and fiber optics
- To introduce the fundamentals of acoustics and ultrasonics
- To impart knowledge of crystal structures

Prerequisite: Basic theoretical concepts of Physics in higher secondary levels

THERMAL PHYSICS **9**

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints – bimetallic strips– Thermal conduction, convection and radiation –heat conductions in solids – thermal conductivity – Forbe's and Lee's disc method: theory and experiment – conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters

QUANTUM PHYSICS **9**

Black body radiation–Planck's theory (derivation)–Deduction of Wien's displacement law andRayleigh–Jeans' Law from Planck's theory–Compton effect: Theory and experimental verification– Properties of Matter waves–G.P Thomson experiment– Schrodinger's wave equation– Timeindependent and time dependent equations–Physical significance of wave function–Particle in a1-dimensional box– Electron microscope– Scanning electron microscope– Transmission electronmicroscope

LASER AND FIBRE OPTICS **9**

Lasers: Population inversion – Einstein's A and B coefficients derivation– types of lasers – Semiconductor lasers: Homojunction – Nd – YAG laser – Application of lasers in engineering and medicine. Fiber optics: principle, numerical aperture and acceptance angle – types of optical fibres (material, refractive index and mode) – fibre optic sensors: pressure and displacement

ACOUSTICS AND ULTRASONICS **9**

Velocity, frequency, wavelength, intensity, loudness (expression), timber, sound, reflection of sound, echo; Reverberation, reverberation time, Sabine's formula, remedies over reverberation – Absorption of sound, absorbent materials – Conditions for good acoustics of a building – Noise, its effects and remedies– Ultrasonics – Production of ultrasonics by Piezo-electric and magnetostriction – Detection of ultrasonics– Engineering applications of Ultrasonics (Non-destructive testing, cavitation, measurement of gauge)– Infrasound – Seismography (concept only)

CRYSTAL PHYSICS **9**

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, seven crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter – planar distances – coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures – crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation – growth of single crystals: solution and melt growth techniques

Total Periods: 45

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, (2015)
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, (2012)
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, (2012)
4. Dr.P.Mani, Dhanam Publication "Engineering Physics-I", Dhanam Publications, (2018)

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, (2015)
2. Charles kittel, "Introduction to solid state physics", 8th edition, Wiley India Pvt.Ltd. (2004)
3. Marikani A.,"Engineering Physics. PHI Learning Pvt., India, (2009)
4. Palanisamy P.K.,"Engineering Physics", SCITECH Publications, (2011)

WEB RESOURCE(S):

1. https://nptel.ac.in/courses/122107035/ - Thermal Physics
2. https://nptel.ac.in/courses/122106034/ - Quantum Physics

COURSE OUTCOMES:

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

CO1. Gain basic knowledge on heat transfer and its applications
CO2. Apply the concepts of wave motion in engineering field
CO3. Apply the fundamental knowledge on lasers and fiber optics in engineering applications
CO4. Gain knowledge about acoustics and ultrasonics
CO5. Understand the basic concept of crystal structures

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3						3			
CO2			1						1			
CO3	3		3									
CO4		3							3			
CO5	2								2			

HOD/MECH

19GE1404	**ENGINEERING CHEMISTRY FOR MECHANICAL ENGINEERS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques
- To understand the mechanism of corrosion, corrosion protection measures and different types of coatings
- To understand the types of fuel, calorific value calculations, manufacture of solid, liquid and gaseous fuels
- To make the students conversant with lubricants and nano materials
- To understand the principle and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells

Prerequisite: Basic theoretical concepts of Chemistry in higher secondary level

WATER AND ITS TREATMENT **9**

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate and calgon conditioning) external treatment – Ion exchange process – desalination of brackish water – Reverse Osmosis

CORROSION AND PROTECTIVE COATINGS **9**

Mechanisms of galvanic and concentration cell corrosion. Atmospheric corrosion, Pitting and crevice corrosion. Stress corrosion, corrosion fatigue, Fretting and cavitation. Corrosion protection by design, coatings – Electroplating of Cu, Ni and Cr. Surface conversion processes, Anodic and cathodic protection, corrosion inhibitors, Vapour phase inhibitors. Paints – Constituents and their functions, vitreous enamel coatings, super hydrophobic and self healing coatings

FUELS AND COMBUSTION **9**

Fuels: Introduction – classification of fuels – coal – analysis of coal (proximate and ultimate) – carbonization – manufacture of metallurgical coke (Otto Hoffmann method) – petroleum – manufacture of synthetic petrol (Bergius process) – knocking – octane number – cetane number – natural gas – compressed natural gas (CNG) – liquefied petroleum gases (LPG). Combustion of fuels: Introduction – calorific value – higher and lower calorific values – theoretical calculation of calorific value – ignition temperature – spontaneous ignition temperature – explosive range – flue gas analysis (ORSAT Method)

LUBRICANTS AND NANO MATERIALS **9**

Lubricants – Concept of tribology; Types of lubricants and Mechanism of lubrication, Physical and Chemical properties of lubricants, Additives of lubricants, Selection of lubricants, freezing points of lubricants

Basics – distinction betweenmolecules, nanoparticles and bulk materials; size – dependentproperties.Nanoparticles:nano cluster, nano rod, nanotube(CNT) and nanowire. Synthesis:precipitation, thermolysis, hydrothermal, solvothermal, electrode position, chemical vapourdeposition, laser ablation; Properties and applications

ENERGY SOURCES AND STORAGE DEVICES **9**

Nuclear fission – nuclear fusion – differences between nuclear fission and fusion – nuclear chain reactions – nuclear energy – light water nuclear power plant – solar energy conversion – solar cells –wind energy.

Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell

Total Periods: 45

TEXT BOOKS:

1. S.S. Dara and S.S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, (2015)
2. P.C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, (2015)
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, (2013)

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, (2014)
2. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, (2015)
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications",Cambridge University Press, Delhi, (2015)
4. Nirajan karak, "Nanomaterials and polymer nano composites", Elsevier, (2018)

WEB RESOURCE:

https://nptel.ac.in/courses/113104061/ - Corrosion fundamentals

COURSE OUTCOMES:

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

CO1. Identify water treatment techniques and better understanding of engineering processes for further learning
CO2. Acquire the basic electrochemical concepts for understanding corrosion processes and corrosion protection measures
CO3. Gain knowledge about the economic and environmental case for transitioning to next generation, or by profiling the advanced biofuel industry
CO4. Gain knowledge on lubricants and Nano materials
CO5. Understand the concept and operation of available and relevant energy storage systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2						1			2	2
CO2	2										1	1
CO3	2	2									1	1
CO4	2	2									1	2
CO5	2	2					1	2			2	1

HOD/MECH

19CS1503	PROBLEM SOLVING AND PYTHON PROGRAMMING	L-T-P 2-0-4	C 4

Programme: B.E. Mechanical Engineering

Objectives :

- To develop an understanding of algorithmic problem solving
- To read and write simple Python programs
- To develop Python programs with conditionals and loops
- To define Python functions and call them
- To use Python data structures – lists, tuples, dictionaries and work with files

Prerequisite: None

COMPUTER AND PROGRAMMING FUNDAMENTAL **3**

Introduction – Components of a computer – Problem Solving Techniques: Algorithms, Flowchart, Pseudo code – Program Control Structures – Programming Languages

DATA, EXPRESSIONS, STATEMENTS **3**

Need for Python for Mechanical Engineers – Modes of Python – values and data types: Variables - expressions – statements – Operators – precedence of operators – Input and Output – comments – Functions: function definition and use, flow of execution, parameters and arguments

CONTROL FLOW, FUNCTIONS **3**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional(if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, scope: local and global, composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays

LISTS, TUPLES, AND DICTIONARIES **3**

Compound data – Lists: list operations – list slices – list methods – list loop – mutability – aliasing – cloning lists – list Parameters – Lists as arrays – Tuples: tuple assignment – tuple as return value – Dictionaries: operations and methods – advanced list processing – list comprehension

FILES, MODULES, PACKAGES **3**

Files and exception: text files, reading and writing files, format operator; command line arguments, Errors: Syntax Errors, Runtime errors, Logical Errors – Exceptions – handling exceptions, modules, packages

Lab Experiments:

Simple Programs: **3**

1. Write a program that accepts two numbers from the user and print their sum
2. Write a program to calculate simple interest
3. Write a program to read two numbers and print their quotient and remainder
4. Write a program to find the distance between two points in a plane

Programs using Control Flow: **9**

5. Write a program that declares 3 integers, determines and prints the largest and smallest in the group
6. Write a program to find that given year is leap year or not
7. Write a program to find factorial of a given number
8. Write a program to find that given number is Armstrong or not

9. Write a program to print Fibonacci Series
10. Write a program that takes an integer and forms a new integer which has the number of digits at the ten's place and the least significant digit in the one's place

Program using functions: **9**

11. Write a program to find GCD of two numbers
12. Write a program to implement linear search
13. Write a program to implement binary search
14. Write a program to implement merge sort

Program using strings: **6**

15. Write a program to check whether a string is a palindrome or not using recursion
16. Write a program to detect if two strings are anagrams
17. Write a program to replace all occurrences of 'a' with $ in a string

Program using lists: **9**

18. Write a program to find the second largest number in a list
19. Write a program to merge two lists and sort it
20. Write a program to find all numbers in a range which are perfect squares and sum of all digits in the number is less than 10

Program using dictionaries: **6**

21. Write a program to create a dictionary with key as first character and value as words starting with that character read from a string entered

Program using files: **3**

22. Write a program to count the number of words and number of lines in a text file

Lecture: 30 Practical:45 Total Periods: 75

TEXT BOOK:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, (2016)

REFERENCES:

1. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , (2013)
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., (2016)
3. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., (2015)
4. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, (2013)
5. The Python Tutorial, https://docs.python.org/2.7/tutorial/

WEB RESOURCE:

The Python Tutorial, https://docs.python.org/2.7/tutorial/

COURSE OUTCOMES:

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

CO1. Develop algorithmic solutions to simple computational problems.
CO2. Read, write, execute by hand Python programs using conditionals and loops.
CO3. Develop Python programs step-wise by defining functions and calling them.
CO4. Represent compound data using Python lists, tuples, dictionaries and sets.
CO5. Read and write data from/to files in Python Programs and also able to handle Exceptions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	2		3	1						
CO2	3	2	2		3	1						
CO3	3	3	3	3		1						
CO4	3	3	3	3		1						
CO5	3		3									

HOD/MECH

19ME1502	**ENGINEERING GRAPHICS**	**L-T-P**	**C**
		1-0-4	**3**

Programme: B.E. Mechanical Engineering
Objective: To develop graphic skills in students
Prerequisite: Basic knowledge on geometry and Conics

PLANE CURVES **12**

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

PROJECTION OF POINTS AND LINES **12**

Principles of projection, projection of points in four quadrants – Projection of straight lines located in the first quadrant – inclined to both planes – Determination of true lengths and true inclinations by rotating line method and traces

PROJECTION OF SOLIDS **12**

Projection of simple solids like Prisms, Pyramids, Cylinder and Cone when the axis is inclined to one reference plane

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES **12**

Sectioning of above solids in simple vertical position by cutting planes inclined to HP and perpendicular to VP – Obtaining true shape of section

Development of lateral surfaces of simple and sectioned solids – Prisms, Pyramids, Cylinder and Cone

ISOMETRIC AND PERSPECTIVE PROJECTIONS **12**

Principles of isometric projection – isometric scale – isometric projections of truncated Prisms, Pyramids, Cylinder and Cone. Perspective projection of simple prism, pyramid and cylinder by Visual ray method

Total Periods: 60

TEXT BOOKS:

1. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited (2016)
2. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai (2015)

REFERENCES:

1. Kumar M.S., "Engineering Graphics", D.D. Publications, (2015)
2. Shah M.B. and Rana B.C., "Engineering Drawing", Pearson Education (2009)
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I & II combined), Subhas Stores, Bangalore, (2007)
4. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, (2008)
5. Parthasarathy N.S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, (2015)

WEB RESOURCES:

1. https://nptel.ac.in/courses/112104172/ - Introduction
2. https://nptel.ac.in/courses/112103019/ - Standards of drawing

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets
2. IS 9609 (Parts 0 and 1) – 2001: Technical products Documentation – Lettering
3. IS 10714 (Part 20) – 2001 and SP 46 – 2003: Lines for technical drawings
4. IS 11669 – 1986 and SP 46 – 2003: Dimensioning of Technical Drawings
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods

Special points applicable to end semester examination on Engineering Graphics:

1. There will be five questions in the end semester examination
2. All questions will carry equal marks of 20 each making a total of 100
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size
4. The end semester examination will be conducted in two sessions (FN and AN on the same day) for 50 percent of student (approx) at a time

COURSE OUTCOMES:

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

CO1. Construct plane curves
CO2. Draw the projections of points and lines
CO3. Draw the projections of simple solids
CO4. Draw the sectional views of solids and the applications of development of surfaces
CO5. Construct isometric and perspective projections

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3								2			3
CO2	3								2			3
CO3	3								2			3
CO4	3								2			3
CO5	3								2			3

HOD/MECH

19ME1311	**PHYSICS AND CHEMISTRY LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objectives:

- To make the students to acquire practical skills in handling basic measuring instruments.
- To introduce the different experiments to test the basic understanding of physics concepts applied in Optics, Laser and Ultrasonic.
- To acquire practical knowledge in Properties of matter and Thermal physics.
- To make the students to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis
- To develop and understanding of the range and uses of analytical methods in chemistry.

Prerequisite: Experiments in Physics and chemistry introduced at the higher secondary levels in schools

LIST OF EXPERIMENTS FOR PHYSICS LABORATORY(Any FIVE Experiments)

1. Determination of specific resistance of a given coil of wire – Carey Foster's Bridge.
2. Determination of band gap of a Semiconductor.
3. Determination of hysteresis losses in ferromagnetic material – B-H curve.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
6. Determination of Wavelength, and particle size using Laser
7. Determination of Numerical aperture and acceptance angle in an optical fiber.
8. Determination of Young's modulus of the material – Non Uniform bending method.
9. Determination of wavelength of spectral lines using grating – Spectrometer.
10. Determination of rigidity modulus – Torsion pendulum.

REFERENCES:

1. Physics Laboratory Manual, Department of Physics, Francis Xavier Engineering College, Tirunelveli.
2. Dr. G Senthilkumar, "Physics Laboratory Manual", VRB Publishers Pvt.Ltd., New Edition, (2017)

WEB RSOURCE:

https://nptel.ac.in/courses/115105110/ - Young's Modulus experiment

LIST OF EXPERIMENTS FOR CHEMISTRY LABORATORY

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.

2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Estimation of copper content of the given solution by EDTA method.
4. Determination of strength of given hydrochloric acid using pH meter.
5. Estimation of iron content of the given solution using potentiometer.
6. Conductometric titration of strong acid vs strong base.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Conductometric precipitation titration ($BaCl_2$ vs Na_2SO_4).
9. Estimation of sodium and potassium present in water using flame photometer.
10. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.

REFERENCES:

1. Vogel's,"Textbook of Quantitative Chemical Analysis", 8thedition, (2014)

WEB RESOURCE:

https://nptel.ac.in/content/storage2/courses/122101001/downloads/lec-38.pdf

Total Periods: 45

COURSE OUTCOMES:

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

CO1 Improve the adequate knowledge in basic measuring parameters.
CO2 Gain knowledge on the basics of Optics, Laser and Ultrasonic
CO3 Apply the principles of elasticity and heat transfer for Engineering applications.
CO4 Outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.
CO5 Understand in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1			2							
CO2	3	1			2							
CO3	3	1			2							
CO4	3	1			2							
CO5	3	1			2							

HOD/MECH

19GE2101	**TECHNICAL COMMUNICATON**	**L-T-P**	**C**
		2-0-0	**2**

Programme: B.E. Mechanical Engineering

Objectives:

- Widen strategies and skills to augment their ability to read and comprehend engineering and technology texts
- Foster their capability to write convincing job applications and effective reports
- Develop their speaking skills to make technical presentations, participate in group discussions
- Strengthen their listening skill which will help them comprehend technical lectures and talks in their areas of specialization
- Cultivate writing skills both technical and general

Prerequisite: Basic knowledge in English Language

READING AND STUDY SKILLS **6**

Listening – Listening to longer technical talks; Speaking – describing in detail the working process of any electronic/electrical machine; Reading – reading longer technical texts and taking down notes – Note Making strategies; Writing – interpreting charts, graphs; Vocabulary Development – Select Technical Vocabulary; Language Development – Active Voice and Passive Voice

INTRODUCTION TO TECHNICAL WRITING **6**

Listening – Listening to talks mostly of a scientific/technical nature and completing information; Speaking – Technical Presentations; Reading – Technical related topics; Writing – purpose statements – extended definitions – writing instructions – checklists – recommendations; Vocabulary Development – select technical vocabulary; Language Development – subject verb agreement, compound words

INTERMEDIATE WRITING **6**

Listening – Listening to mock Interviews; Speaking – answering Interview questions; Reading – longer texts both general and technical, practice in speed reading; Writing – Minutes of the Meeting – Writing opinion paragraph – Writing paragraphs with reasons; Language Development – If – Conditionals

REPORT WRITING I **6**

Listening- Listening to documentaries and making notes; Speaking –Making Technical Presentations; Reading – reading for detailed comprehension; Writing – Fire accident Report, Industrial Visit Report; Vocabulary Development – finding suitable synonyms – paraphrasing; Language Development –clauses

REPORT WRITING II **6**

Listening – Listening to Reports; Speaking – participating in a group discussion – Reading– reading and understanding technical articles; Writing – Writing Feasibility Reports, Survey Reports; Vocabulary Development – verbal analogies; Language Development – advanced use of articles, Prepositional phrases

Total Periods: 30

TEXT BOOKS:

1. Butterfield, Jeff. "Soft Skills for Every one", Cengage Learning: New Delhi, (2017)
2. Richards C. Jack and David Bohleke,"Speak Now 4", Oxford Press,(2014)

REFERENCES:

1. Redston, Chris & Gillies Cunningham,"Face 2 Face" (Pre-intermediate Student's Book & Worknbook) Cambridge University Press, New Delhi, (2005)
2. Booth-L. Diana, "Project Work", Oxford University Press, Oxford,(2014)
3. Grussendorf, Marion, "English for Presentations", Oxford University Press, Oxford,(2007)
4. Means, L. Thomas and Elaine Langlois, "English & Communication for Colleges", Cengage Learning, USA,(2007)
5. Raman, Meenakshi and Sharma, Sangeetha,"Technical Communication Principles and Practice", Oxford University Press, New Delhi, (2014)

WEB RESOURCE(S):

1. Learn Engineering
   https://www.youtube.com/user/LearnEngineeringTeam/videos?view=0&sort=p&shelf_id=14
2. Engineering Dictionary https://www.engineering-dictionary.com/
3. Interpretation of Charts https://www.youtube.com/watch?v=cTWXaLX2L6Y
4. IELS Listening Practice
   https://play.google.com/store/apps/details?id=mimosa.english.ieltpractice.listening&hl=en_IN

COURSE OUTCOMES:

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

CO1. Read advanced technical texts and write area- specific texts effortlessly
CO2. Listen and comprehend extensive technical lectures and talks in their area of specialization successfully
CO3. Successfully answer questions during Interviews
CO4. Write good reports
CO5. Communicate effectively – adapting to purpose, structure, audience and medium

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				2			3		1	2	2	3
CO2				2			2		3	3	2	2
CO3				1			1		3	3	2	2
CO4				3			2		2	2	3	2
CO5				2			2		3	3	2	2

HOD/MECH

19MA2202	**APPLICATION OF PDE AND TRANSFORM**	**L-T-P**	**C**
		3-1-0	**4**

Programme: B.E. Mechanical Engineering

Objectives :

- To expose to the concept of Analytical function
- To familiarize with Complex integration
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems
- To acquaint the student with PDE and Fourier series techniques in solving heat flow problems and improve the knowledge in Laplace Transforms

Prerequisite: Basic knowledge about Differentiation, Integration and complex analysis

ANALYTIC FUNCTIONS9

Definition of Analytic Function – Cauchy Riemann equations – Properties of analytic functions – Determination of harmonic conjugate – Milne-Thomson's method and bilinear transformation

COMPLEX INTEGRATION **9**

Cauchy's integral theorem (without proof) – Cauchy's integral formulae and its applications – Singularities – Poles and Residues – Cauchy's residue theorem

FOURIER SERIES **9**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis

PDE AND APPLICATIONS OF FOURIER SERIES **9**

Formation of PDE – Homogenous linear PDE – Method of separation of variables – Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction

LAPLACE TRANSFORMS **9**

Transforms of simple functions – Basic operational properties – Inverse transforms – Convolution theorem – Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients only

Lecture: 45 Tutorial: 15 Total Periods: 60

TEXT BOOK:

1. Grewal B.S, "Higher Engg Maths", Khanna Publications, 42nd Edition, (2012)

REFERENCES:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley & Sons. Singapore, 10th edition, (2012)
2. K.Ganesan, Sundarammal Kesavan, K.S.Ganapathy Subramanian & V.Srinivasan, "Advanced Calculus and Complex Analysis", Revised Edition, (2013)
3. Veerajan, T., "Engineering Mathematics I", Tata McGraw Hill Publishing Co., New Delhi, 5thedition,.
4. Kandasamy P,"Engineering Mathematics", Vol.I, 4threvised edition, S.Chand &Co., New Delhi, (2000)
5. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., Advanced Mathematics for Engineering students, Volume I, 2nd edition, S.Viswanathan Printers and Publishers, (1992)

WEB RESOURCE:

https://nptel.ac.in/courses/112108285/ - Cauchy Riemann equation

COURSE OUTCOMES:

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

CO1. Understand and apply the concept of analytic functions, bilinear transformations
CO2. Understand the concepts of Cauchy's theorem, Cauchy's integral formula
CO3. Solve differential equations using Fourier series analysis which plays a vital role in engineering applications
CO4. Solve one and two dimensional heat flow problems and one dimensional wave equations PDE using Fourier series techniques
CO5. Analyse Laplace transforms and inverse Laplace transforms of simple functions

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1		2						2			
CO2	1	2							1			2
CO3		1	3									
CO4	2	2	1									3
CO5	1								2			

HOD/MECH

19ME2503	BASIC CIVIL AND BUILDING ENGINEERING	L-T-P	C
		2-0-0	2

Programme: B.E. Mechanical Engineering
Objective : To provide an insight into the fundamentals of basic civil and engineering
Prerequisite: None

SCOPE OF CIVIL ENGINEERING **6**

Civil Engineering contributions to the welfare of the society – Specialized sub disciplines in civil Engineering – Structural, construction, Geotechnical, Environmental, Transportation and Water Resources Engineering

CIVIL ENGINEERING MATERIALS **6**

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel – Timber – modern materials

BUILDING COMPONENTS AND STRUCTURES **6**

Foundations: Types of foundations – Bearing capacity and settlement – requirement of good foundations, Civil Engineering Structures: Brick Masonry – Stone Masonry – Beams – Columns – Intels – Roofing – flooring – plastering

CONSTRUCTION TECHNIQUES **6**

Environmental impact of materials – responsible sourcing Eco Building (Green Building) Material used – Construction methods – Natural Buildings – Passive buildings – Intelligent(Smart) buildings – Meaning – Building automation – Energy efficient buildings for various zones – Case studies of residential , office buildings and other buildings in each zones

BUILDING DRAWINGS **6**

Types of drawing with appropriate scale & uses index map, key plan, village map, site plan, layout plan – Types of Projection adopted in Building Drawing – Scales for various types of Drawings – Symbols, Conventions and Abbreviations for – Electrical fittings, water supply,sanitary fittings, material for construction etc. – Concept plan and drawing of residential single and two storied buildings.

Total Periods: 30

TEXT BOOKS:

1. Shanmugam G and Palanisamy "Basic Civil and Mechanical Engineering", Tata McGraw Hill, New Delhi, (2016)
2. Varghese P.C. "Building construction", Prentice Hall of India Pvt. Ltd, New Delhi, (2007)

REFERENCES:

1. Ramamarutham S, "Basic Civil Engineering" Dhanpat Rai Publishing Company (P) Limited, (2004)
2. Arora S.P. and Bindra S.P., "Building Construction, Planning Techniques and Method of Construction", Dhanpat Rai and Sons, (1997)
3. Peurifoy R.L., Ledbetter, W.B. and Schexnayder, C., "Construction Planning, Equipment and Methods", 5th Edition, McGraw Hill, Singapore, (1995)
4. V.B.Sikka "Civil Engineering drawing", B.D.Kataria Sons, Ludhiana, (2009)

WEB RESOURCE:

https://nptel.ac.in/courses/105107156/

COURSE OUTCOMES:

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

CO1. Define the various scope of civil engineering

CO2. Select a suitable material for building engineering

CO3. Identify the surveying component

CO4. Select a suitable construction technique

CO5. Read and draw the building drawing

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2						3					1
CO2	3				3	1	2				2	
CO3	1				1		1					2
CO4					3	2	3					2
CO5		2			3	1						2

HOD/MECH

19ME2504	**ELECTRICAL DRIVES AND CONTROLS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the basic concepts of different types of electrical machines and their performance
- To study the different methods of starting and Braking of D.C motors and induction motors
- To study the conventional and solid-state drives

Prerequisite: Engineering Physics

INTRODUCTION TO ELECTRICAL MACHINES **9**

Ohm's Law – Kirchhoff's Laws – Introduction to D.C. and A.C. Circuits – Waveforms and RMS Value – Power and Power factor – Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, single phase and three phase induction Motor

ELECTRICAL DRIVES AND CHARACTERISTICS **9**

Basic Elements – Types of Electric Drives – Factors are influencing the Choice of Electrical Drives – Heating and Cooling Curves – Loading Conditions and Classes of Duty – Speed – Torque – Characteristics of various electrical drives

STARTING AND BRAKING METHODS FOR ELECTRICAL DRIVES **9**

Types of Starters – Typical Control Circuits for Shunt and Series Motors, Three Phase Squirrel Cage and Slip Ring Induction Motors – Braking of Electrical Motors – D.C. Motors: Shunt, Series And Compound – Single Phase and Three Phase Induction Motors

SPEED CONTROL OF D.C. DRIVES **9**

Speed Control of D.C. Series and Shunt Motors – Armature and Field Control, Ward – Leonard Control System – Using Controlled Rectifiers and D.C. Choppers – Applications

SPEED CONTROL OF A.C. DRIVES **9**

Voltage Control, Voltage Frequency (V/f) Control and Slip Power Recovery Scheme – Using Inverters and A.C. Voltage Regulators – Applications

Total Periods: 45

TEXT BOOKS:

1. Nagrath .I.J. & KothariD.P, "Electrical Machines", Tata McGraw-Hill, (1998)
2. Vedam Subrahmaniam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill, (2001)

REFERENCES:

1. PillainS.K "A First Course on Electric Drives", Wiley Eastern Limited, (1998)
2. Singh M.D., K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, (1998)
3. Partab H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, (1994)

WEB RESOURCE:

https://nptel.ac.in/courses/108/104/108104140/

COURSE OUTCOMES:

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

CO1.Explain different types of electrical machines and their performance
CO2.Understand the concepts of Drives and characteristics of Motors
CO3.Understand different methods of starting and braking of DC motors
CO4.Understand the conventional and solid state DC drives
CO5.Understand the conventional and solid state AC drives

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2	1						1	2		1
CO2	2	2	1						1	2		1
CO3	2	2	1						1	2		1
CO4	2	2	1						1	2		1
CO5	2	2	1						1	2		1

HOD/MECH

19ME2505	**ENGINEERING MECHANICS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering
Prerequisite: HSC Mathematics and Engineering Physics

STATICS OF PARTICLES **9**

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces – additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility

EQUILIBRIUM OF RIGID BODIES **9**

Free body diagram – Types of supports – Action and reaction forces – stable equilibrium –Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force – equilibrium of Rigid bodies in two dimensions

PROPERTIES OF SURFACES AND SOLIDS **9**

Centroids and centre of mass – Centroids of lines and areas – Rectangular, circular, triangular areas by integration – T section, I section, – Angle section, Hollow section by using standard formula – Theorems of Pappus – Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia

DYNAMICS OF PARTICLES **9**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's laws of motion – Work Energy Equation – Impulse and Momentum – Impact of elastic bodies

FRICTION **9**

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction

Total Periods: 45

TEXT BOOKS:

1. Beer, Johnston, Mazurek, Cornwells and Sanghi, "Vector Mechanics for Engineers: Statics, Dynamics", 10th Edition, Tata McGraw Hill Noida, Uttar Pradesh, (2013)
2. N.H. Dubey, "Engineering Mechanics Statics and Dynamics", 1st Edition, McGraw-Hill Education India Private Ltd., New Delhi, (2012)

REFERENCES:

1. R.C. Hibbeler, "Engineering Mechanics: Dynamics", 13th Edition, Prentice Hall, (2012)
2. J.L. Meriam and L.G. Kraige, "Engineering Mechanics: Dynamics", 7th Edition, Wiley India Private Limited, (2013)
3. Irving H. Shames, "Engineering Mechanics Statics and Dynamics", 4th Edition, Pearson India, (2011)

4. Rajasekaran S., Sankarasubramanian G. "Fundamentals of Engineering Mechanics", 3rd Edition Vikas Publishing House Pvt Limited, (2009)
5. www.nptel.iitm.ac.in/video.php?subjectId=122104015

WEB RESOURCES:

1. https://nptel.ac.in/courses/122104015/
2. https://nptel.ac.in/courses/112103109/

COURSE OUTCOMES:

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

CO1. Illustrate the vectorial and scalar representation of forces and moments
CO2. Assess the appropriate support system for the given force system due to various reactions
CO3. Calculate the centroid, centre of gravity for geometrical bodies and moment of inertia for two dimensional sections
CO4. Calculate dynamic forces exerted in rigid body
CO5. Analyse the mechanism of friction and various frictional forces involved in mechanical systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	3				1			1	2		2
CO2	2	3				1			1	2		2
CO3	2	3				1			1	2		2
CO4	2	3				1			1	2		2
CO5	2	3				1			1	2		2

HOD/MECH

\

19GE2M01	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**L-T-P**	**C**
		2-0-0	**0**

Programme: B.E. Mechanical Engineering

Objectives:
- To study the nature and facts about environment
- To find and implement scientific, technological, economic and political solutions to environmental problems
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management

Prerequisite: Basic theoretical concepts of biological science in higher secondary level

ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY **7**

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – ecological succession– Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) pond ecosystem (d) ocean ecosystem – Introduction to biodiversity definition: genetic, species and ecosystem diversity – value of biodiversity–India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity– endangered and endemic species of India –In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

ENVIRONMENTAL POLLUTION **6**

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution– solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies. Field study of local polluted site – Urban / Rural / Industrial / Agricultural

NATURAL RESOURCES **6**

Forest resources: Use and over-exploitation, deforestation - timber extraction– Water resources: Use and over- utilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Role of an individual in conservation of natural resources

SOCIAL ISSUES AND THE ENVIRONMENT **6**

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – role of non-governmental organization-environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – consumerism and waste products – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act

HUMAN POPULATION AND THE ENVIRONMENT **5**

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies

Total Periods: 30

TEXTBOOKS:

1. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, (2006)
2. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, (2004)

REFERENCES :

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi, (2007)
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) Pvt, Ltd, Hydrabad, (2015)
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, (2014)
4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press, (2005)

WEB RESOURCE:

https://nptel.ac.in/courses/103107084/

COURSE OUTCOMES:

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

CO1. Acquire knowledge about the different biodiversity species and their importance
CO2. Classify problems related to environmental degradation
CO3. Attain greater knowledge of how natural resources relate to the economy and environment at present and in the future
CO4. Identify a societal problem and to develop a plan of action to address the issues
CO5. Analyze the changes due to population explosion

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1							2	2				
CO2						3	3	1				
CO3								3				
CO4						3	3					
CO5						2		1				

HOD/MECH

19ME2511	**ENGINEERING PRACTICES LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objective: To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical

Prerequisite: None

CIVIL, MECHANICAL& ELECTRICAL

I. CARPENTRY

- Study of joints in roofs, doors, windows and furniture.
- Hands-on-practice: T joint, Dovetail joint, cross lap joint.

II. WELDING

- Preparation of Butt joints, lap joints and T joints by shielded metal arc welding.

III. SHEET METAL

- Forming and Bending
- Model Making-Tray, Funnel, dust pan.

IV.PLUMBING

- Study of pipeline joints, its locations and functions; valves, taps, couplings, unions, reducers, elbows in household fittings.
- Hands-on-exercise: Basic pipe connections, mixed pipe material connections, pipe connections with different joining components.

V. FITTING

- Preparation of square fitting and V fitting models.

VI. ELECTRICAL

- Residential house wiring using switches, fuse, indicator, lamp and energy meter.
- Fluorescent lamp wiring.
- Stair case wiring

Total Periods: 45

REFERENCES:

1. K.Jeyachandran, S.Natarajan & S, Balasubramanian, "A Primer on Engineering Practices Laboratory", Anuradha Publications, (2007)
2. T.Jeyapoovan, M.Saravanapandian & S.Pranitha, "Engineering Practices Lab Manual", Vikas Publishing House Pvt. Ltd, (2006)
3. H.S. Bawa, "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, (2007)
4. A.Rajendra Prasad & P.M.M.S. Sarma, "Workshop Practice", Sree Sai Publication, (2002).
5. P.Kannaiah & K.L.Narayana, "Manual on Workshop Practice", Scitech Publications, (1999)

WEB RESOURCE:

https://nptel.ac.in/courses/112107250/ - Sheet metal works

LIST OF EXPERIMENTS

1. Carpentry-Cross Lap joint , T Joint, Dovetail Joint
2. Welding of single V-Butt joint
3. Welding of Lap joint
4. Welding of T joint
5. Connection of two galvanized iron pipes
6. Connection of PVC pipes
7. Basic pipe connections involving the fitting like valves taps and bends.
8. Sheet Metal – Rectangular Tray
9. Sheet Metal-Funnel, Dust pan
10. Fitting-Square fitting, Vee fitting
11. House wiring, Staircase wiring, Lamp wiring

LIST OF EQUIPMENTS

(For a batch of 30 students)

CIVIL

1.	Assorted components for plumbing consisting of metallic pipes, Plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings	15 Sets
2.	Carpentry vice (fitted to work bench)	15 Nos.
3.	Standard woodworking tools	15 Sets
4.	Models of industrial trusses, door joints, furniture joints	5 Nos.
5.	**Power Tools:**	
	Demolition Hammer	2 Nos.
	Hand Drilling Machine	2 Nos.
	Wooden Cutter	2 Nos.

MECHANICAL

1.	Arc welding transformer with cables and holders	5 Nos.
2.	Welding booth with exhaust facility	5 Nos.
3.	Welding accessories like welding shield, chipping hammer, Wire brush, etc.,	5 Sets
4.	Power Tool: Angle Grinder	2 Nos.
5.	Fitting vice (fitted to work bench)	15 Nos.
6.	Standard working tools	15 sets

COURSE OUTCOMES:

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

CO1. Fabricate carpentry components
CO2. Use welding equipments to join the structures
CO3. Perform sheet metal works
CO4. Perform basic fitting operations and plumbing
CO5. Carry out basic home electrical works and appliances

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1		2						3			1
CO2	1		2						3			1
CO3	1		2						3			1
CO4	1		2						3			1
CO5	1		2						3			1

HOD/MECH

19ME2512	**ELECTRICAL MACHINES LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objectives:

- To understand the working of DC machines
- To study the different methods of starting D.C motors
- Find the performance of AC machines of any rating
- Have the knowledge of synchronization of alternators and voltage regulation of alternators

Prerequisite: None

LIST OF EXPERIMENTS

1. Verification of KVL and KCL
2. Load test on DC Shunt motor
3. Load test on DC Series motor
4. Speed control of DC Shunt motor
5. O.C. and load characteristics of DC shunt generator
6. Load test on single phase induction motor
7. Speed control of single phase slip ring Induction Motor
8. Regulation of an alternator by EMF & MMF methods
9. V curves & Inverted V curves of synchronous motors
10. Study of DC & AC Starters

Total Periods: 45

LIST OF EQUIPMENTS

1. Voltmeter – different ranges
2. Ammeter – different ranges
3. RPS
4. DC shunt motor
5. DC series motor
6. DC shunt motor – DC shunt generator set
7. Three phase alternator
8. Three phase synchronous motor
9. Three phase Squirrel cage Induction motor
10. Single phase Induction motor

WEB RESOURCE:

https://nptel.ac.in/courses/108105131/ - Induction motor

COURSE OUTCOMES:

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

CO1. Define the performance characteristics of DC machines
CO2. Pre-determine the performance characteristics of DC machines and transformers
CO3. Define the performance characteristics of AC machines
CO4. Familiarize the speed control techniques for DC motor and induction motor
CO5. Pre-determine the performance characteristics of synchronous motor and alternator

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2				1			2		2	1
CO2	3	2				1			2		2	1
CO3	3	2				1			2		2	1
CO4	3	2				1			2		2	1
CO5	3	2				1			2		2	1

HOD/MECH

19ME3201	**STATISTICS AND NUMERICAL ANALYSIS**	**L-T-P**	**C**
		3-1-0	**4**

Programme: B.E. Mechanical Engineering

Objectives:

- To apply the concept of testing of hypothesis to Engineering problems
- To equip themselves familiar with ANOVA
- To introduce the basic concepts of probability
- To have knowledge in simple integrals
- To improve their ability in solving partial and ordinary differential equations with initial and boundary conditions

Prerequisite: Basic knowledge about measures of central captaincy

TESTING OF HYPOTHESIS **9**

Sampling distributions – Statistical hypothesis – Tests based on t, Chi-square and F distributions for mean, variance and proportion – Contingency table (test for independent) – Goodness of fit

DESIGN OF EXPERIMENTS **9**

One way and two way classifications – Completely randomized design – Randomized block design – Latin square design

PROBABILITY AND STATISTICS **9**

Definitions of probability, sampling theorems, conditional probability; mean, median, mode andStandard deviation; random variables, binomial, poisson and normal distributions

INTERPOLATION AND NUMERICAL INTEGRATION **9**

Lagrange's formula– Newton's forward and backward difference interpolation – Numerical single integrations using Trapezoidal, Simpson's 1/3 rule and Simpson's 3/8 rule

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **9**

Single step methods: Taylor's series method – Euler's method –Fourth order Runge-Kutta method for solving first order equations – Multi step methods: Milne's method for solving first order equations

Lecture: 45 Tutorial: 15 Total Periods: 60

TEXT BOOKS:

1. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science", 10thEdition, Khanna Publishers, New Delhi, (2015)
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, (2015)

REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9thEdition, Cengage Learning, (2016)
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8thEdition, (2014)
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis", Pearson Education, Asia, New Delhi, (2006)
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, (2004)
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 8thEdition, Pearson Education, Asia, (2007)

WEB RESOURCE:

https://www.youtube.com/watch?v=sIRl1xWrViY - Design of Experiments – An Overview

COURSE OUTCOMES:

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

CO1. Apply the concept of testing of hypothesis for small and large samples in real life problems
CO2. Apply the basic concepts of classifications of design of experiments in the field of agriculture
CO3. Understand the fundamental knowledge of the concepts of probability and distributions which can describe real life phenomenon
CO4. Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations
CO5. Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering application

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1								3			2
CO2		1	2									
CO3			1									2
CO4		1										
CO5	2								1			

HOD/MECH

19ME3602	**MANUFACTURING TECHNOLOGY – I**	**L-T-P**	**C**
		3-0-2	**4**

Programme: B.E. Mechanical Engineering

Objective: To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components and powder metallurgy

Prerequisite: Engineering Practices Lab

METAL CASTING PROCESSES **9**

Type of patterns – Pattern Materials – Pattern allowances –Design of pattern – moulds and cores – Moulding sand Properties and testing – Cupola Furnaces; Principle of special casting processes: Shell – investment– Centrifugal Casting – Stir casting; Defects in Sand casting-solidification and cooling – riser and gating design - Computer aided casting simulation

JOINING PROCESSES **9**

Fusion welding processes: Gas welding – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding – Gas metal arc welding – Submerged arc welding; Resistance welding – Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects, adhesive bonding

METAL FORMING PROCESSES **9**

Hot working and cold working of metals – Open, impression and closed die forging. Rolling mills, Types of Rolling – Flat strip rolling – shape rolling operations – Principle of rod and wire drawing– Types of Extrusion – plastic deformation and yield criteria – load estimation for forging, rolling, extrusion and drawing

SHEET METAL PROCESSES **9**

Sheet metal characteristics – shearing, bending and drawing operations – load estimation for shearing, deep drawing, bending – Formability of sheet metal –special forming processes – Hydro forming – Rubber pad forming –Explosive forming, magnetic pulse forming, Super plastic forming – Micro forming

PLASTIC MANUFACTURING AND POWDER METALLURGY **9**

Working principles and typical applications – injection moulding – Compression moulding, Transfer Moulding,blow moulding –Rotational moulding –Thermoforming –Principles of powder metallurgy-blending of powders, compacting, presintering, sintering – Products of powder metallurgy

LIST OF EXPERIMENTS

PREPARATIONOFSANDMOULD

Mouldwithsolid,splitpatterns	**3**
Mouldwithloose-piecepattern	**3**
MouldwithGear pattern	**2**

WELDINGEXERCISES **1**

Demonstration on Horizontal,Verticalwelding	**3**
Hands on exercise: Vee joint, L-joint and Tee joint	

SHEETMETALWORK

Fabricationofsheetmetal tray andfunnel	**3**

Lecture: 45 Practical: 30Total Periods: 75

TEXT BOOKS:

1. Hajra Chouldhary S.K and Hajra Choudhury A.K., "Elements of workshop Technology", volume I, Media promoters and Publishers Private Limited, Mumbai, (2014)
2. KalpakjianS, "Manufacturing Engineering and Technology", Pearson Education IndiaEdition, (2013)

REFERENCES:

1. Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, (2012)
2. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-(2013)
3. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, (2012)
4. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., (2014)
5. William F. Hosford, Robert M.Caddell, "Metal Forming Mechanics an Mettallurgy", 4thEdition, Cambridge university press, (2011)
6. Henry.S.Valverg , "Applied Metal Forming", Cambridge University Press, (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/112107083/ - Sand Moulding

COURSE OUTCOMES:

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

CO1. Explain different metal casting processes, associated defects, merits and demerits
CO2. Compare different metal joining processes
CO3. Summarize various hot working and cold working methods of metals
CO4. Explain various sheet metal making processes
CO5. Distinguish various methods of manufacturing plastic components

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	1	3	2	3			3		1	1	3
CO2	2		3	3	3			3		1	2	3
CO3	2	1	1	3	3			3		1	2	3
CO4	2		3	3	3			3		1	1	3
CO5	2		1	3	3			3		1	2	3

HOD/MECH

19ME3603	**ENGINEERING THERMODYNAMICS**	**L-T-P**	**C**
		3-1-0	**4**

Programme: B.E. Mechanical Engineering

Objectives:
- To familiarize the students to understand the fundamentals of thermodynamics and to perform basic thermodynamic analysis on simple thermal systems
- To introduce the students on vapour and gas power cycles

Prerequisite: Engineering Chemistry

(Use of standard and approved steam tables, Mollier chart, compressibility chart permitted)

BASIC CONCEPTS AND FIRST LAW **9**

Basic concepts – concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work.P-V diagram. Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales. First law of thermodynamics –application to closed and open systems – steady and unsteady flow processes

SECOND LAW AND AVAILABILITY ANALYSIS **9**

Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle – Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for – pure substance, ideal gases –processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Available and non-available energy of a source and finite body. Energy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency

PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE **9**

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Ideal and actual Rankine cycles, Cycle Improvement Methods – Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles

IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS **9**

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties-.Compressibility factor-.Principle of Corresponding states. –Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heatcapacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, PhaseChange Processes. Simple Calculations

GAS MIXTURES AND PSYCHROMETRY **9**

Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometricproperties, Psychrometric charts. Property calculations of air vapour mixtures by using chart andexpressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

Lecture: 45 Tutorial: 15 Total Periods: 60

TEXT BOOKS:

1. R.K.Rajput, "A Text Book of Engineering Thermodynamics",5th Edition, (2017)
2. Yunus A Cengel & Michael A Boles "Thermodynamics", 8th Edition, (2015)
3. NagP.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, (2014)
4. Robert T. Balmer, "Modern Engineering Thermodynamics", Academic Press, (2011)

REFERENCES:

1. Natarajan E., "Engineering Thermodynamics", Anugraham Publication, (2015)
2. Rajput R.K., "Thermal Engineering", S. Chand Publishers, (2010)
3. Holman J.P., "Thermodynamics", Tata McGraw Hill, (2006)
4. Cengel, "Thermodynamics–An Engineering Approach",Tata McGraw Hill, New Delhi (2012)
5. Khurmi R.S., "Steam Tables", S.Chand publication, (2014)

WEB RESOURCE:

https://nptel.ac.in/courses/112105123/

COURSE OUTCOMES:

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

CO1. Apply the first law of thermodynamics for simple open and closed systems under steady and unsteady conditions

CO2. Apply second law of thermodynamics to open and closed systems and calculate entropy and availability

CO3. Apply Rankine cycle to steam power plant and compare few cycle improvement methods

CO4. Apply thermodynamic concepts to different air standard cycles and analyze the performance

CO5. Derive various thermodynamic relations and to calculate the properties of gas mixtures

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2									1
CO2	3	3	2									1
CO3	3	3	2				1					1
CO4	3	3	2									1
CO5	3	3	2				1					1

HOD/MECH

19ME3604	**FLUID MECHANICS AND MACHINERY**	**L-T-P**	**C**
		3-1-0	**4**

Programme: B.E. Mechanical Engineering
Objective: To understand the characteristics of fluids and working of hydraulic machines
Prerequisite: Engineering Physics

BASIC CONCEPTS AND PROPERTIES **9**

Units&Dimensions –Properties of fluids–Fluid statics–Manometry, - buoyancy, forces on submerged bodies, stability of floating bodies–Flow characteristics: Velocity and acceleration, velocity potential functions and stream functions, concepts of system and control volume –Application of control volume to continuity equation –energy equation, momentum equation Pascal's law, measurement of pressure, manometers, Hydrostatic law

FLOWTHROUGH PIPES **9**

Laminar flow though circular conduits and circular annuli – Boundary layer concepts – Boundary layer thickness –Hydraulic and energy gradient –Darcy, Weisbach equation – Friction factor and Moody diagram –Minor losses –Flow through pipes in series and in parallel – loss of energy in pipes – Equivalent pipes

DIMENSIONALANALYSIS **9**

Dimension and units – Buckingham's Π theorem – Discussion on dimensionless parameters – Models and similitude –Applications of dimensionless parameters

HYDRAULIC TURBINES **9**

Force exerted on moving plate vanes – Definition and classifications – Pelton, Francis, Propeller and Kaplan turbine: Working principles – Velocity triangle – Work done – specific speed – efficiencies – Performance curve for turbines

HYDRAULIC PUMPS **9**

Definition and classifications – Centrifugal and Reciprocating Pumps: Working principles – Indicator diagram – Specific speed – efficiency and performance curves – Cavitations in pumps

Lecture: 45 Tutorial: 15 Total Periods: 60

TEXT BOOKS:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi (2013)
2. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. (2010)

REFERENCES:

1. Bansal R.K., "A text book of Fluid Mechanics and Hydraulics Machines", Laxmi Publication, India, (2015)
2. Rajput R.K., "Fluid Mechanics and Hydraulic Machines", S.Chand & Company Ltd., New Delhi, (2013)
3. Kumar K.L., "Engineering Fluid Mechanics", S.Chand Publishing (P) Ltd., New Delhi, (2014)
4. White F.M., "Fluid Mechanics", Tata McGraw-Hill, New Delhi, (2010)
5. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", (2011)

WEB RESOURCE:

https://nptel.ac.in/courses/112105171/

COURSE OUTCOMES:

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

CO1. List the various fluid properties and to apply control volume analysis to fluid mechanics problems

CO2. Differentiate the various losses that occur in fluid flow through pipes and to estimate the head losses

CO3. Mathematically predict the nature of physical quantities

CO4. Describe the working principle and construct performance curves for hydraulic turbines

CO5. Construct the characteristic curves for hydraulic pumps

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3								2
CO2	3	3	3	3								2
CO3	3	3	3	3								2
CO4	3	3	3	3			2					2
CO5	3	3	3	3								2

HOD/MECH

19ME3605	**ENGINEERING MATERIALS AND METALLURGY**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

Prerequisite: Engineering Physics

ALLOYS AND PHASE DIAGRAMS **9**

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Stress strain diagram for mild steel, Cast iron ,plastic, glass and aluminium, Iron – carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application

HEAT TREATMENT **9**

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening

FERROUS AND NON-FERROUS METALS **9**

Effect of alloying additions on steel-α and β stabilisers– stainless and tool steels – HSLA, Maraging steels – Cast Iron – Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg–alloys, Ni–based super alloys and Titanium alloys

NON-METALLIC MATERIALS **9**

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes) – Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON –Composites-Classifications – Metal Matrix and FRP – Applications of Composites

MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS **9**

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

Total Periods: 45

TEXT BOOKS:

1. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition (2014)
2. Selvakumar N, "Engineering Metallurgy and Nanotechnology" Scitech, Publications (India) Pvt. Ltd., (2016)

REFERENCES:

1. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, (2010)
2. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., (2015)
3. U.C.Jindal,"Engineering Materials and Metallurgy", 1st Edition, Dorling Kindersley, (2012)
4. George E. Dieter, Jr, "Mechanical Metallurgy", CreateSpace Independent Publishing Platform, (2014)

WEB RESOURCE:

https://nptel.ac.in/courses/113106032/

COURSE OUTCOMES:

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

CO1. Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification
CO2. Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes
CO3. Clarify the effect of alloying elements on ferrous and non-ferrous metals
CO4. Summarize the properties and applications of non metallic materials
CO5. Explain the testing of mechanical properties

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3									2		2
CO2	3	2	2							2		2
CO3	3									2		2
CO4	3									2		2
CO5	3									2		2

HOD/MECH

19ME3611	FLUID MECHANICS AND MACHINERY LABORATORY	L-T-P 0-0-4	C 2

Programme: B.E. Mechanical Engineering
Objective: To supplement the principles learnt in fluid mechanics and machinery
Prerequisite: Engineering Physics

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rotameter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal Pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

Total Periods: 45

List of Equipment for a Batch of 30 Students

Sl.No.	NAME OF THE EQUIPMENT	QUANTITY
1	Orifice meter setup	1
2	Venturi meter setup	1
3	Rotameter setup	1
4	Pipe Flow analysis setup	1
5	Centrifugal pump	1
6	Reciprocating pump setup	1
7	Gear pump setup	1
8	Pelton wheel setup	1
9	Francis turbine setup	1
10	Kaplan turbine setup	1

COURSE OUTCOMES:

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

CO1. Perform test on Orifice, Venturi and Rota meter to determine the coefficient of discharge
CO2. Draw the characteristics of curve of Centrifugal and Gear pump
CO3. Analysis the performance of Reciprocating pump
CO4. Perform the test on impulse turbine (Pelton) and draw its characteristics curve
CO5. Draw the characteristics curve for reaction turbine like Francis and Kaplan turbine

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	1	3	3			1					1
CO2	1	1	3	3			1					1
CO3	1	1	3	3			1					1
CO4	1	1	3	3			1					1
CO5	1	1	3	3			1					1

HOD/MECH

19ME3612	COMPUTER AIDED DRAFTING LABORATORY	L-T-P	C
		0-0-4	2

Programme: B.E. Mechanical Engineering
Objective: To gain more knowledge in 2D & 3D drawings by using relevant software
Prerequisite: Engineering Graphics

Drawing Standards

Code of practice for Engineering Drawing, BIS specifications–Welding symbols, riveted joints, keys and fasteners – Selection of standard components like bolts, nuts, screws, keys etc. with the help of design data book

2-D Drawings

Limits, Fits – Tolerance of individual dimensions –Specification of Fits – Preparation of production drawings and reading of part and assembly drawings

Basic commands used in Drafting Packages

Drawing, Editing, Plotting, Layering Concepts, Hatching, Detailing, Assembly, Solids, Rendering, Shading, basic principles of GD&T(geometric dimensioning & tolerance), Preparation of Bill of materials

List of Exercises

- Drawing of curves like parabola, spiral, involute of square and circle
- Drawing of front view and top view of simple solids like bolt & Nut, welded joints
- Drawing sectional views of simple machine elements
- Drawing of Orthographic view from Isometric view
- Drawing of Isometric view from Orthographic view
- Drawing of simple 3D objects using Extrude and Revolve command
- Assembly drawing – Sleeve and Cotter joint
- Assembly drawing – Knuckle joint
- Assembly drawing – Flange Coupling
- Assembly drawing – Universal Coupling

NOTE:

1. Students may also be trained in manual drawing of some of the above assembly
2. Practical examination duration is Three hours. Students will carry out one exercise in assembly drawing and one exercise in simple objects.

SYSTEM REQUIREMENTS

(For a batch of 30 Students)

Hardware:

1. Intel i3 core due processor with 4GB ram with 500GB hard disk – 30 Nos.
2. Laser Printer – 1 No.

Software:

1. Drafting package – AutoCAD – Adequate license (Open source)

Total Periods:45

COURSE OUTCOMES:

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

CO1. Demonstrate the fundamentals of drafting techniques
CO2. Outline the basic shapes and modeling
CO3. Understand the drawing from different perspective
CO4. Convert Isometric to orthographic projections & from orthographic to isometric of simple objects
CO5. Assemble machine elements

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		3	2	3	3					3		3
CO2		3	3	3	3					3		3
CO3		3	3	3	3					3		3
CO4		3	3	3	3					3		3
CO5		3	3	3	3					3		3

HOD/MECH

9GE3M01	COMMUNICATION AND SOFT SKILLS	L-T-P	C
		0-0-2	0

Programme: B.E. Mechanical Engineering

Objectives:

- Provide Guidance and Practice to communicate in English.
- Provide support to read from different genres.
- Practice to write technical articles.
- Understand the Importance of Soft skills
- Improve Personality Traits

Prerequisite: The fundamental knowledge in English Language.

LISTENING SKILLS **6**

Conversational skills (formal and informal)– group discussion – making effective presentations using computers, listening/watching interviews conversations, documentaries – listening to lectures, discussions from TV/Radio/Podcast – Video tutorials

READING AND WRITING SKILLS **6**

Reading different genres of tests ranging from newspapers to creative writing; Writing abstracts – summaries – interpreting visuals – Attributes to technical Writing – Assembly Guidelines – White paper writing – Informal Usability Report – Release/launch notes.

WRITING STRATEGIES **6**

Introduction to Writing Strategies – different genres of writing – including instruction manuals, proposals, reports, posters and visual communication, technical descriptions, product recalls **–** Executive Summaries **–** Repair manuals **–** organizing ideas from Journal writings – Note-Making.

PERSONALITY TRAITS – AN OVERVIEW **6**

Definition – Types – Openness to experience – Conscientiousness – extraversion – Agreeableness – Neuroticism – Problem solving skills – examine ideas and develop theories and explanations.

SOFT SKILLS **6**

Motivation – self image – goal setting – managing changes – time management – stress management – leadership traits – team work – career and life planning.

Total Periods: 30

TEXT BOOKS:

1. Brooks, Margret,"Skills for Success. Listening and Speaking Level 4", Oxford University Press: Oxford, (2011)
2. Mitra, K. Barun,"Personality Development and Soft Skills", Oxford University Press: Oxford, (2016)

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar, "Communicative English for Engineers and Professionals", Pearson: New Delhi, (2010)
2. Hughes, Glyn and Josephine Moate,"Practical English Classroom", Oxford University Press: Oxford, (2014)
3. Personality Development (CD-ROM), Times Multimedia, Mumbai.

WEB RESOURCES:

1. Learn Engineering
   https://www.youtube.com/user/LearnEngineeringTeam/videos?view=0&sort=p&shelf_id=14
2. Group Discussion https://www.youtube.com/watch?v=hhjvTUv9L0g
3. Presentation Skills https://www.youtube.com/watch?v=wp4ho9raVjA&t=74s
4. IELS Listening Practice

   https://play.google.com/store/apps/details?id=mimosa.english.ieltpractice.listening&hl=en_IN

COURSE OUTCOMES:

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

CO1. Talk in English in real life situations
CO2. Make effective presentations
CO3. Participate in GD and contribute ideas with ease
CO4. Master soft skills required for the work place
CO5. Write letters and technical writing

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				1			1		3	3	1	2
CO2				1			1		3	3	1	2
CO3				1			1		3	3	1	2
CO4				1			1		3	3	1	2
CO5				1			1		3	3	1	2

HOD/MECH

19ME4601	MANUFACTURING TECHNOLOGY – II	L-T-P	C
		3-0-0	3

Programme: B.E. Mechanical Engineering

Objective : To understand the concept and basic mechanics of metal cutting, working of standard machine tools Computer Numerical Control (CNC) of machine tools and CNC Program

Prerequisite: Manufacturing Technology I

THEORY OF METAL CUTTING **9**

Mechanics of machining, orthogonal metal cutting, merchant's circle, forces in machining, Types of chip, single point and multi point cutting tools – tool geometry and materials, tool wear, tool life, cutting fluids and Machinability – economics of machining

TURNING MACHINES **9**

Basic machine tools – Centre lathe – various operations, taper turning methods, thread cutting procedure, Machining time and power estimation – Capstan and turret lathes – automats – single spindle, Swiss type, multi spindle – Turret Indexing mechanism, Bar feed mechanism

SHAPER, MILLING AND GEAR CUTTING MACHINES **9**

Shaper – crank and slotted link mechanism; Typical Drilling operations, Milling operations – Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes – finishing of gears

FINISHING PROCESSES **9**

Abrasive processes: grinding wheel – specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centre less grinding – broaching machines – push, pull, surface and continuous broaching machines, lapping, Honing, Polishing

CNC MACHINING **9**

Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining

Total Periods: 45

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II, Media Promoters, (2014)
2. Rao P.N "Manufacturing Technology – Metal Cutting and Machine Tools", 3rd Edition, Tata McGraw-Hill, New Delhi, (2013)

REFERENCES:

1. Dr.A.B. Chattopadhyay, "Machining and machine tools", Wiley publisher, (2017)
2. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., (2014)
3. Rao P.N.,"CAD/CAMPrinciplesandApplications",TataMcGrawHill, (2014)
4. Rajput R.K., "A Textbook of Manufacturing Technology", Laxmi puplication, NewDelhi, (2014)
5. ShrawatN.S.andNarangJ.S.,"CNCMachines",DhanpatRai &Co., (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/112105127/

COURSE OUTCOMES:

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

CO1. Explain the mechanism of material removal processes
CO2. Describe the operational features of the centre lathe and special purpose lathe
CO3. Familiarize the working principle of shaper, milling and gear cutting machine tools
CO4. Distinguish various finishing processes
CO5. Summarize numerical control of machine tools and write a part program

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1		2							3
CO2	3	1	1		2							3
CO3	3	1	1		2							3
CO4	3	1	1		2							3
CO5	3	1	2		2							3

HOD/MECH

19ME4602	STRENGTH OF MATERIALS	L-T-P	C
		3-0-2	4

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the stresses developed in bars, compounds bars, beams, shafts, columns, cylinders and spheres
- To understand the effect of component dimensions and shape on stresses and deformations are to be understood

Prerequisite: Engineering Mechanics

STRESS, STRAIN AND DEFORMATION OF SOLIDS **9**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress

TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM **9**

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending – bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution

TORSION **9**

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs

DEFLECTION OF BEAMS AND COLUMNS **9**

Double Integration method – Macaulay's method – Area moment Theorems for computation of slopes and deflections in beams – Conjugate beam and strain energy – Maxwell's reciprocal theorems – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns

THIN CYLINDERS AND SPHERES **9**

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theory – Application of theories of failure

Lecture: 45 Practical: 30 Total Periods: 75

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminum rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals – Brinell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Effect of hardening– Improvement in hardness and impact resistance of steels.
10. Tempering– Improvement Mechanical properties Comparison

(i) Unhardened specimen
(ii) Quenched Specimen and
(iii) Quenched and tempered specimen.
11. Microscopic Examination of
(i) Hardened samples and
(ii) Hardened and tempered samples.

TEXT BOOKS:

1. Ramamrutham S., "Strength of Materials", Dhanpatrai Publishing company, (2012)
2. Bansal R.K., "A Text book of strength of material", Laxmi publication, New Delhi, (2014)

REFERENCES:

1. Popov E.P., "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, (2010)
2. Beer F.P. and Johnston R., "Mechanics of Materials", McGraw-Hill Book Co, (2012)
3. Timoshenko Gere, "Mechanics of Materials", D.Van Nostrand company , New York, (2009)
4. Don H. Morris, William F. Riley and Leroy D. Sturges, "Mechanics of Materials", John Wiley and Sons Inc., (2008)
5. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, (2013)

WEB RESOURCE:

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

COURSE OUTCOMES:

At the end of the course, the students will be able to
CO1. Understand the basic concept of various stress, strains, elastic constant and principle planes.
CO2. Draw the SFD & BMD different beams with various types of applied loads and the effect of stresses
CO3. Calculate the torsion stress and deflections on the springs
CO4. Compute the slope and deflection in determinate beam and columns by various method.
CO5. Analyze the stress and deformation induced in thin cylinders , thick and spherical shells

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								2
CO2	3	3	2	2								2
CO3	3	3	2	2								2
CO4	3	3	2	2								2
CO5	3	3	2	2								2

HOD/MECH

19ME4603	**THERMAL ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :
- To apply the thermodynamic concepts on engines, nozzles, turbines, compressors, Refrigeration and air conditioning systems
- To perform simple analysis on work absorbing and work producing devices to calculate the performance

Prerequisite: Engineering Chemistry, Engineering Thermodynamics

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

GAS POWER CYCLES **9**

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency – Comparison of cycles

INTERNAL COMBUSTION ENGINE COMBUSTION AND PERFORMANCE **9**

IC engine – Classification, working, components and their functions. Ideal and actual: Valve and port timing diagrams, p-v diagrams – two stroke & four stroke, and SI & CI engines. Desirable properties and qualities of fuels, Air-fuel ratio. Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common Rail Direct lnjection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms

STEAM NOZZLE AND TURBINE **9**

Types and shapes of nozzles Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Meta stable flow. Turbines: Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing

AIR COMPRESSOR **9**

Classification and comparison, working principle, work of compression – with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of rotary compressors with reciprocating air compressors

REFRIGERATION AND AIR CONDITIONING SYSTEMS **9**

Refrigerants – Vapour compression refrigeration cycle – super heat, sub cooling – Performancecalculations – working principle of vapour absorption system, Ammonia –Water, Lithium bromide –water systems (Description only). Air conditioning system – Processes, Types and Working Principles – Concept of RSHF, GSHF, ESHF – Cooling Load calculations.

Total Periods: 45

TEXT BOOKS:

1. Mahesh M.Rathore, "Thermal Engineering", 1st edition, Tata Mc Graw Hill Publications, (2010)
2. Rajput R.K., "Thermal Engineering", S. Chand Publishers, (2017)

REFERENCES:

1. Ganesan V., "Internal Combustion Engines", Tata McGraw Hill Publishing Co., New York, (2012)
2. Nag.P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, (2013)
3. Ballaney P.L. "Thermal Engineering", Khanna publishers, 24th Edition, (2012)
4. Rudramoorthy R, "Thermal Engineering", Tata Mc Graw Hill , New Delhi, (2003)
5. Sarkar B.K. "Thermal Engineering", Tata Mc Graw Hill Publishers, (2007)
6. Khurmi R.S, Gupta J.K. "A Text Book on Thermal Engineering", S.Chand 15th Edition, (2018)

WEB RESOURCE:

https://nptel.ac.in/courses/112/106/112106133/

COURSE OUTCOMES:

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

CO1. Explain the functioning and features of IC engines, components and auxiliaries and to calculate the performance parameters of IC Engines

CO2. Understand the types and working of compressors and to solve problems in single stage and multi stage air

CO3. Calculate the velocity and design parameters in steam nozzles and to carry out performance analysis on steam turbines

CO4. Measure the COP of refrigeration system and understand the different types of refrigeration systems

CO5. Calculate the properties of air and cooling load needed for any application

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1		1						1
CO2	3	2	1	1		1						1
CO3	3	2	1	1		1						1
CO4	3	2	1	1		1						1
CO5	3	2	1	1		1						1

HOD/MECH

19ME4604	**KINEMATICS OF MACHINES**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :
- To impart knowledge on various types of Mechanisms
- To impart skills to analyse the position, velocity and acceleration of mechanisms
- To familiarize higher pairs like cams, gears and to understand the effects of friction in motion transmission

Prerequisite: Engineering Mechanics, Strength of Materials

BASICS OF MECHANISMS **9**

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Mechanical advantage – Transmission Angle – Description of some common mechanisms, Straight line generators, Universal Joint

KINEMATICS OF LINKAGE MECHANISMS **9**

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration

KINEMATICS OF CAM MECHANISMS **9**

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting

GEARS AND GEAR TRAINS **9**

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting. Gear trains – Speed ratio, train value – Epicyclic Gear Trains

FRICTION IN MACHINE ELEMENTS **9**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads –Bearings and lubrication – Friction clutches – Belt and rope drives

Total Periods: 45

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, (2014)
2. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, (2014)

REFERENCES:

1. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, (2014)
2. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, (2006)
3. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, (1999)
4. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, (2005)
5. Khurmi R.S., "Theory of Machines", 14th Edition, S Chand Publications, (2005)

WEB RESOURCE:

https://nptel.ac.in/courses/112104121/

COURSE OUTCOMES:

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

CO1. Discuss and interpret the basics of mechanisms
CO2. Calculate velocity and acceleration in simple mechanisms
CO3. Develop different types of CAM profiles
CO4. Solve problems on gears and gear trains
CO5. Examine friction in various machine elements

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2				1		3
CO2	3	3	3		2	2				1		3
CO3	3	3	3		2	2				1		3
CO4	3	3	3		2	2				1		3
CO5	3	3	3	2	3	3				1		3

HOD/MECH

19ME4505	**ELECTRONICS AND MICROPROCESSOR**	**L-T-P**	**C**
		3-0-2	**4**

Programme: B.E. Mechanical Engineering
Objective: To enable the students to understand the fundamental concepts of Semi Conductors, Transistors, Rectifiers, Digital Electronics and 8086 Microprocessors
Prerequisite: Engineering Physics

SEMICONDUCTOR DIODE AND APPLICATIONS **9**

Classification of solids based on energy band theory – Intrinsic and Extrinsic Semiconductors– PN junction diode – V-I Characteristics– Zener diode – characteristics, Zener Voltage regulation – Half wave and full wave rectifiers –Breakdown Mechanism in PN junction

TRANSISTORS AND POWER DEVICES **9**

Bipolar junction transistor – NPN/PNP Transistor, CB, CE, CC configuration and Characteristics – JFET– Drain and Transfer characteristics –SCR, Diac, Triac– Concept of feedback – Negative feedback Application in temperature and motor speed control

DIGITAL SYSTEMS **9**

Number system – Logic Gates(AND, OR, NOT, XOR,Universal) – Boolean algebra – Half and full adders- Flip flops – SR, JK, T, D,– Shift Registers – Counters – A/D and D/A conversion

8086 MICROPROCESSOR **9**

Introduction to 8086 – Microprocessor architecture –pin configuration – Addressing modes – Instruction set and assembler directives – Simple programs using arithmetic and logical operations

INTERFACING AND APPLICATIONS OF MICROPROCESSOR **9**

Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Interrupt controller –Programming and applications Case studies: Traffic Light control,Stepper motor control

LIST OF EXPERIMENTS

1.	V I Characteristics of PN Junction diode and zener diode	**2**
2.	Halfwave Rectifier & Full Wave Rectifier	**2**
3.	Characteristics of FET & SCR	**3**
4.	Verification of Logic Gates & Flip Flop's (JK&D)	**3**
5.	Design and implementation of 3-bit synchronous up/down counter	**3**
6.	Arithmetic operations using 8086 Microprocessor	**2**

Lecture: 45 **Practical: 30** **Total Periods: 75**

TEXT BOOKS:

1. Donald A Neaman, "Semiconductor Physics and Devices", 4th Edition, Tata Mc GrawHill Inc.,(2012)
2. Robert Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory", Pearson Prentice Hall, 10th edition, July (2008)
3. Ronald J Tucci, Neal S widmer, "Digital Systems Principles and Applications", 10th edition Pearson Publications,
4. A. Anand Kumar, "Fundamentals of digital circuits", 3rd Edition, Prentice Hall of India
5. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", 2nd Edition, Prentice Hall of India, (2007)
6. Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware",TMH, (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/108107029/

COURSE OUTCOMES:

At the end of the course, the students will be able to
CO1. Identify the various types of semiconductors and Applications
CO2. Explain the fundamental concepts of the transistors and power devices
CO3. Use digital electronics in the present contemporary world
CO4. Understand and execute programs based on 8086 microprocessor
CO5. Understand the Interfacing and Applications of 8086

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2							3
CO2	3	3	3	2	2							3
CO3	3	3	3	3	3							3
CO4	3	2	3		3	1	2					3
CO5	3	2	3		3	2	2					3

HOD/MECH

19ME4611	**MANUFACTURINGTECHNOLOGY LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objective: To Study and acquire knowledge on various basic machining operations in general, special purpose machines and its applications in real life manufacture of components in the industry

Prerequisite: Engineering Practices Laboratory, Manufacturing Technology I

LIST OF EXPERIMENTS

1. Machining Step turning Using lathe machine
2. Machining taper turning, knurling, threading Using lathe machine
3. Machining internal thread cutting using lathe machine
4. Machining Hexagonal head shaping in shaping machine
5. Contour milling using vertical milling machine
6. Spur gear cutting in milling machine
7. Helical Gear Cutting in milling machine
8. Gear generation in hobbing machine
9. Gear generation in gear shaping machine
10. Plain Surface grinding
11. Cylindrical grinding
12. Centre less grinding
13. Measurement of cutting forces in Milling / Turning Process

Total Periods: 45

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Turret and Capstan Lathes	1 No each
2	Centre lathe	7 No
3	Shaping machine	1 No
4	Horizontal Milling Machine	2 No
5	Vertical Milling Machine	1 No
6	Surface Grinding Machine	1 No.
7	Cylindrical Grinding Machine	1 No.
8	lathe Tool Dynamometer	1 No
9	Milling Tool Dynamometer	1 No
10	Gear Hobbing Machine	1 No
11	Tool Makers Microscope	1 No
12	CNC Lathe	1 No
13	Gear Shaping machine	1 No
14	Centerless grinding machine	1 No

COURSE OUTCOMES:

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

CO1. Perform different lathe operations in lathe machine
CO2. Use different machine tools for manufacturing gears
CO3. Use different machine tools for finishing operations
CO4. Manufacture component using shaping machine
CO5. Measure cutting force using dynamometer

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3					2	2	2	2
CO2				3	2				2	2	1	2
CO3				3					2	2	1	2
CO4				3					2	2	1	2
CO5		1		3					2	2	2	2

HOD/MECH

19ME4612	**THERMAL ENGINEERING LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering
Objective: To supplement the principles learnt in thermal engineering
Prerequisite: Thermal Engineering

LIST OF EXPERIMENTS

1. Valve Timing and Port Timing diagrams
2. Performance Test on 4 – stroke Diesel Engine
3. Heat Balance Test on 4 – stroke Diesel Engine
4. Morse Test on Multi-cylinder Petrol Engine
5. Retardation Test on a Diesel Engine
6. Determination of Flash Point and Fire Point of various fuels / lubricants
7. Performance Test on a Steam Generator
8. Performance Test on Steam Turbine
9. Performance test on a reciprocating air compressor
10. Determination of COP of a refrigeration system
11. Experiments on Psychrometric processes

Total Periods: 45

LIST OF EQUIPMENTS

- I.C Engine – 2 stroke and 4 stroke model
- 4-stroke Diesel Engine with mechanical loading
- 4-stroke Diesel Engine with hydraulic loading
- 4-stroke Diesel Engine with electrical loading
- Multi-cylinder Petrol Engine
- Apparatus for Flash and Fire Point
- Steam Boiler with turbine setup
- Single/two stage reciprocating air compressor
- Refrigeration test rig
- Air-conditioning test rig

COURSE OUTCOMES:

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

CO1. Draw the valve timing and port diagram and to evaluate the performance of IC engine with various type of loading
CO2. Determine the thermal properties of fuels and lubricants
CO3. Conduct test to evaluate the performance of steam generator and turbine
CO4. Conduct test to evaluate the performance of reciprocating air compressor
CO5. Determine the performance of refrigeration system and also explain the various psychrometric properties

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3					1			1
CO2	3	3	3	3					1			1
CO3	3	3	3	3					1			1
CO4	3	3	3	3					1			1
CO5	3	3	3	3					1			1

HOD/MECH

19GE4M01	**INTERPERSONAL SKILLS – LISTENINGAND SPEAKING**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objectives:

- Master themselves with English Language Skills required for undertaking academic listening and speaking skills
- Support them to practice formal and informal speaking activities
- Improve their listening skills to listen to native speakers
- Make technical Presentations
- Listen to on-line sources

Prerequisite: The fundamental knowledge in English Language.

LISTENING AS A KEY SKILL **6**

Importance of Listening – Preparing to listen to a lecture – Basics of Note taking – Listening to personal information – Listening to technical topics – Listening to process Information

LISTENING STRATEGY **6**

Appreciative Listening– Listening to Non-Technical Video Lecture by Native Speakers – focus on sounds and words; **Critical Listening**– Listening to Technical Video Lecture by Native speakers – identifying the key points; **Relationship Listening** – Listening to Conversations by native speakers

INTERMEDIATE SPEAKING **6**

Self-Introduction – Sharing of Ideas – Briefing Academic topics – One to one conversation about a product – Explaining a product/gadget – Answering questions – stressing syllables –intonation patterns – compare and contrast information – Pronunciation

ADVANCED SPEAKING **6**

Making Technical Presentation – Strategies – Extempore – Speaking about the Strengths & Weaknesses – Responding appropriately to Interview Questions – Group discussion

ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS AND PLACEMENTS **6**

International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Civil Service (Language related) – Verbal Ability

Total Periods: 30

TEXT BOOKS:

1. Brooks, Margret. “Skills for Success, Listening and Speaking, Level 4”, Oxford University Press, Oxford (2011)
2. Richards, C. Jack. & David Bholke,“Speak Now Level 3”, Oxford University Press, Oxford, (2010)

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar,“Communicative English for Engineers and Professionals”, Pearson, New Delhi, (2010)
2. Hughes, Glyn and Josephine Moate,“Practical English Classroom”, Oxford University Press, Oxford, (2014)
3. Vargo, Mari,“Speak Now Level 4”, Oxford University Press, Oxford, (2013)
4. Richards C. Jack,“Person to Person (Starter)”, Oxford University Press, Oxford, (2006)
5. Ladousse, Gillian Porter,“Role Play”, Oxford University Press, Oxford, (2014)

WEB RESOURCES:

1. Learn Engineering
   https://www.youtube.com/user/LearnEngineeringTeam/videos?view=0&sort=p&shelf_id=14
2. Group Discussion https://www.youtube.com/watch?v=hhjvTUv9L0g
3. Interview Skills https://www.youtube.com/watch?v=QgjkjsqAzvo
4. TED Talk https://www.youtube.com/user/TEDtalksDirector
5. IELS Listening Practic**e**

   https://play.google.com/store/apps/details?id=mimosa.english.ieltpractice.listening&hl=en_IN

COURSE OUTCOMES:

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

CO1. Listen and respond appropriately
CO2. Present TED Talks
CO3. Make Effective Technical Presentations
CO4. Take up National and International Examination with ease
CO5. Answer questions during interview process with a professional touch

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				1			1		3	3	1	2
CO2				1			1		3	3	1	2
CO3				1			1		3	3	1	2
CO4				1			1		3	3	1	2
CO5				1			1		3	3	1	2

HOD/MECH

19ME5501	**PROFESSIONAL ETHICS FOR ENGINEERS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective : To enable the students to create an awareness on Engineering Ethics and Human Values to instil Moral and Social Values and Loyalty and to appreciate the rights of others

Prerequisite: None

HUMAN VALUES **9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

ENGINEERING ETHICS **9**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

SAFETY, RESPONSIBILITIES AND RIGHTS **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

GLOBAL ISSUES **9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Total Periods: 45

TEXT BOOKS:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, (2004)
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, (2003)

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, (2004)
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, (2009)
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, (2001)
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, (2003)

5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd., New Delhi, (2013)
6. World Community Service Centre, "Value Education", Vethathiri publications, Erode, (2011)

WEB RESOURCE:

https://nptel.ac.in/courses/110105097/

COURSE OUTCOMES:

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

CO1. Apply the value of ethics with sustained lifelong learning to strengthen autonomous professional decision
CO2. Apply the moral issues, ethical dilemmas and corporate professionalism through identification of suitable professional body
CO3. Analyze the environment and lives of world community as a responsible engineer.
CO4. Evaluate the duties and responsibilities of employee/corporate.
CO5. Analyze ethical problems supported by established experiments around the world and provide solution as a professional expert

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2		3		1		2
CO2						2		3		1		2
CO3						3	2	3		1		2
CO4						3	2	3	2	1		2
CO5						3	3	3	3	1		2

		L-T-P	C
19ME5602	**HEAT AND MASS TRANSFER**	**3-0-0**	**3**

Programme: B.E. Mechanical Engineering

Objectives :
- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.

Prerequisite: Engineering Physics and Engineering Thermodynamics
(Use of standard HMT data book permitted)

CONDUCTION **9**

General Differential equation of Heat Conduction – Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction – plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids – Use of Heisler's charts.

CONVECTION **9**

Free and Forced Convection – Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS **9**

Nusselt's theory of condensation – Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method – NTU method.

RADIATION **9**

Black Body Radiation – Grey body radiation – Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

MASS TRANSFER **9**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Total Periods: 45

TEXT BOOKS:

1. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, (2010)
2. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition (2015)

REFERENCES:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7thEdition, (2014)
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, (2012)
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, (2002)

4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., (1994)
5. R.C.Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, (2009)
6. S.P. Venkateshan, "Heat Transfer", Ane Books, New Delhi, (2014)

WEB RESOURCE:

https://nptel.ac.in/courses/112101097/

COURSE OUTCOMES:

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

CO1. Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems

CO2. Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems

CO3. Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems

CO4. Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems

CO5. Apply diffusive and convective mass transfer equations and correlations to solve mass transfer problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1								1
CO2	3	3										1
CO3	3	3	2	1								1
CO4	3	3		1								1
CO5	3	3										1

HOD/MECH

19ME5603	**DYNAMICS OF MACHINES**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

Prerequisite: Engineering Mechanics, Kinematics of Machinery, Engineering Physics and Engineering Mathematics.

FORCEANALYSIS **9**

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses – Dynamics of Cam – follower mechanism.

BALANCING **9**

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines– Field balancing of discs and rotors.

FREE VIBRATION **9**

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

FORCEDVIBRATION **9**

Response of one degree freedom – two degrees of freedom - systems to periodic forcing – Harmonic disturbances –Disturbance caused by unbalance – Support motion –transmissibility- control techniques- vibration, tuned absorbers –vibration measurement.

BASICS OF NOISE AND MECHANISM FOR CONTROL **9**

Introduction to noise, amplitude, frequency, wavelength, and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise- Mechanism for control - Governors – Types – Centrifugal governors. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

Total Periods: 45

TEXT BOOKS:

1. F.B.Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, (2011)
2. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, (2014)
3. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, (2014)

REFERENCES:

1. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, (2014)
2. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3rdEdition Affiliated East-West Pvt. Ltd., New Delhi, (2006)
3. Khurmi, R.S., "Theory of Machines", 14thEdition, S Chand Publications, (2005)
4. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, (1992)
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, (2009)
6. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, (2002)

WEB RESOURCE:

https://nptel.ac.in/courses/112104114/

COURSE OUTCOMES:

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

CO1. Calculate static and dynamic forces of mechanisms.
CO2. Calculate the balancing masses and their locations of reciprocating and rotating masses.
CO3. Compute the frequency of free vibration.
CO4. Compute the frequency of forced vibration and damping coefficient.
CO5. Carryout the performance characteristics of the governor and infer the gyroscopic effect on automobiles, ships and airplanes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2				1		3
CO2	3	3	3		2	2				1		3
CO3	3	3	3		2	2				1		3
CO4	3	3	3		2	2				1		3
CO5	3	3	3	2	3	3				1		3

HOD/MECH

19ME5604	**DESIGN OF MACHINE ELEMENTS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

(Use of PSG Design Data Book is permitted)

Prerequisite: Manufacturing Technology I and II, Strength of Materials

STEADYANDVARIABLE STRESSESINMACHINE PARTS **9**

Introduction to the design process – factors influencing machine design, selection of materials based on mechanical properties – Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame – Factor of safety – theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

9

SHAFTSANDCOUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines – Rigid and flexible couplings.

TEMPORARY AND PERMANENT JOINTS **9**

Threaded fastners – Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures – theory of bonded joints.

ENERGY STORING ELEMENTS AND ENGINE COMPONENT **9**

Various types of springs, optimization of helical springs – rubber springs – Flywheels considering stresses in rims and arms for engines and punching machines – Connecting Rods and crank shafts.

BEARINGS **9**

Sliding contact and rolling contact bearings – Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs – Selection of Rolling Contact bearings.

Total Periods: 45

TEXT BOOKS:

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "MechanicalEngineering Design", 9th Edition, Tata McGraw-Hill, (2015)
2. Bhandari V.B., "Design of Machine Elements", Tata McGraw-Hill Book Co, (2016)

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), (2010)
2. Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, (2004)
3. P.C. Gope, "Machine Design – Fundamental and Application", PHI learning private ltd, New Delhi, (2012)
4. R.B. Patel, "Design of Machine Elements", MacMillan Publishers India P Ltd., Tech-Max

Educational resources, (2011)
5. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, (2017)
6. Sundararajamoorthy T. V. Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, (2015)
7. Design Data Hand Book", PSG College of Technology, Coimbatore, (2013)

WEB RESOURCE:

https://nptel.ac.in/courses/112105125/

COURSE OUTCOMES:

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

CO1. Design machine members subjected to static and variable loads
CO2. Design shafts and couplings for various applications
CO3. Analyze bolted and welded joints for various kinds of loads
CO4. Design helical, leaf springs and flywheels for various applications
CO5. Design and select sliding and rolling contact bearings

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3							2		3
CO2		3	3							2		3
CO3		3	3							2		3
CO4		3	3							2		3
CO5		3	3							2		3

HOD/MECH

19ME5605	**METROLOGY AND MEASUREMENTS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :

- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
- To familiar with different measurement equipments and use of this industry for quality inspection.

Prerequisite: Manufacturing Technology I and II, Fluid Mechanics and Machinery

BASICS OF METROLOGY **9**

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

LINEARANDANGULARMEASUREMENT **9**

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

FORM MEASUREMENT **9**

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

MEASUREMENT OF POWER, FLOW AND TEMPERATURE **9**

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

ADVANCES IN METROLOGY **9**

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

Total Periods: 45

TEXT BOOKS:

1. Jain R.K., "Engineering Metrology", Khanna Publishers, (2012)
2. Gupta I.C, "Engineering Metrology", Dhanpat rai Publications, (2013)

REFERENCES:

1. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, (2010)
2. Donald Peckman, "Industrial Instrumentation", Wiley Eastern, (2004)
3. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA, (1990)
4. Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, (2007)

5. Raghavendra, Krishnamurthy "Engineering Metrology & Measurements", Oxford University press, (2013)
6. Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, (2015)

WEB RESOURCE:

https://nptel.ac.in/courses/112106179/

COURSE OUTCOMES:

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

CO1. Describe the concepts of measurements to apply in various metrological instruments
CO2. Outline the principles of linear and angular measurement tools used for industrial applications
CO3. Explain the procedure for conducting computer aided inspection
CO4. Demonstrate the techniques of form measurement used for industrial components
CO5. Discuss various measuring techniques of mechanical properties in industrial applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		3							3		3
CO2	3	3	3							3		3
CO3	3		3		3					3		2
CO4	3	3	3							3		2
CO5	3	3	3							3		3

HOD/MECH

19ME5611	**CAD / CAM LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objectives:
- To gain practical experience in handling 3D modelling, assembling and drafting using modelling software systems.
- To study the features of CNC Machine Tool.
- To expose students to modern control systems (Fanuc, Siemens etc.,)
- To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

Prerequisite: Engineering Graphics

LIST OF EXPERIMENTS

1. 3D Geometric Modelling **30 Periods**

List of Experiments

1. Introduction of 3D Modelling software

Creation of 3D assembly model of following machine elements using 3D Modelling software

2. Flange Coupling
3. Plummer Block
4. Screw Jack
5. Lathe Tailstock
6. Universal Joint
7. Machine Vice
8. Safety Valves
9. Non-return valves
10. Connecting rod
11. Piston
12. Crankshaft

2. Manual Part Programming. **15Periods**

(i) Part Programming – CNC Machining Centre
- a) Linear Cutting.
- b) Circular cutting.
- c) Cutter Radius Compensation.
- d) Canned Cycle Operations.

(ii) Part Programming CNC Turning Centre

a) Straight, Taper and Radius Turning.
b) Thread Cutting.
c) Rough and Finish Turning Cycle.
d) Drilling and Tapping Cycle.

3. Computer Aided Part Programming

a) CL Data and Post process generation using CAM packages.
b) Application of CAPP in Machining and Turning Centre.

Total Periods:45

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No.	Description of Equipment	Qty
HARD' ARE		
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
5.	CNC Lathe	1
6.	CNC milling machine	1
SOFTWARE		
7.	Any High end integrated modeling and manufacturing CAD/ CAM software	15 licenses
8.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC / Sinumeric and Heidenhain controller)	15 licenses
9.	Licensed operating system	Adequate
10.	Support for CAPP	Adequate

COURSE OUTCOMES:

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

CO1. Interpret the fundamentals of the Computer Aided Design which will equip them to pursue higher studies

CO2. Illustrate any solid part modelling by using modelling software package

CO3. Identify the different modeling, transformation and assembling tools in computer aided modeling problems

CO4. Interpret the fundamentals of the G-codes and M-codes for CNC program

CO5. Write the part programming of CNC milling and lathe

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	2	3	3					3		
CO2		3	3	3	3					3		
CO3		3	3	3	3					3		
CO4		3	3	3	3					3		
CO5		3	3	3	3					3		

HOD/MECH

19ME5612	**HEAT AND MASS TRANSFER LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objectives:
- To study the heat transfer phenomena to estimate the relevant coefficient.
- To study the performance of refrigeration systems

Prerequisite: Engineering Physics, Engineering Thermodynamics

List of Exercises

HEATTRANSFER

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.

Total Periods: 45

LIST OF EQUIPMENTS

S.No.

	NAME OF THE EQUIPMENT	**Qty.**
1	Guarded plate apparatus	1 No.
2	Lagged pipe apparatus	1 No.
3	Natural convection-vertical cylinder apparatus	1 No.
4	Forced convection inside tube apparatus	1 No.
5	Composite wall apparatus	1 No.
6	Thermal conductivity of insulating powder apparatus	1 No.
7	Pin-fin apparatus	1 No.
8	Stefan-Boltzmann apparatus	1 No.
9	Emissivity measurement apparatus	1 No.
10	Parallel/counter flow heat exchanger apparatus	1 No.

COURSE OUTCOMES:

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

CO1. Analyse and interpret heat transfer parameters by conducting experiments on conduction experimental setups.

CO2. Analyse and interpret heat transfer parameters by conducting experiments on natural and forced convection apparatus.

CO3. Analyse and interpret heat transfer parameters by conducting experiments on radiation apparatus.

CO4. Analyse and interpret heat transfer parameters by conducting experiments on heat exchanger test setups.

CO5. Analyse and interpret heat transfer parameters by conducting experiments on a fluidized Bed Cooling Tower.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								1
CO2	3	3	3	3								1
CO3	3	3	3	3								1
CO4	3	3	3	3								1
CO5	3	3	3	3								1

HOD/MECH

19ME5613 METROLOGY AND DYNAMICS LABORATORY L-T-P C
0-0-4 2

Programme: B.E. Mechanical Engineering

Objectives:
- Demonstrating the calibration of simple linear measuring instruments used in manufacturing industries
- Demonstrating the important linear and angular measurements carried out in manufacturing industries
- Demonstrating the measurement of prismatic components using contact and non-contact methods and surface metrology
- Applying the principles of kinematics involved in various mechanisms
- Applying the principles of Dynamics involved in various Experiments

Prerequisite: Nil

PART A – METROLOGY

LIST OF EXPERIMENTS

1. Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks.
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge.
3. Measurement of linear dimensions using Comparators.
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method (floating carriage micrometer)
6. Measurement of gear parameters – disc micrometers, gear tooth vernier caliper
8. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
9. Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components
10. Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector and Video measurement system
11. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
12. Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests.
13. Measurement of force, torque and temperature.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Name of the Equipment	Qty.
1	Micrometer	5
2	Vernier Caliper	5
3	Vernier Height Gauge	2
4	Vernier depth Gauge	2
5	Slip Gauge Set	1
6	Gear Tooth Vernier	1
7	Sine Bar	1
8	Floating Carriage Micrometer	1
9	Profile Projector / Tool Makers Microscope	1
10	Parallel / counter flow heat exchanger apparatus	1
11	Mechanical / Electrical / Pneumatic Comparator	1
12	Autocollimator	1

Sl. No.	Name of the Equipment	Qty.
13	Temperature Measuring Setup	1
14	Force Measuring Setup	1
15	Torque Measuring Setup	1
16	Coordinate measuring machine	1
17	Surface finish measuring equipment	1
18	Bore gauge	1
19	Telescope gauge	1

PART B – DYNAMICS

LIST OF EXPERIMENTS

1. 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.
2. Motorized gyroscope – Study of gyroscopic effect and couple.
3. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
4. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
5. 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.
7. a)Determination of torsional natural frequency of single and Double Rotor systems - Undamped and Damped Natural frequencies.
   b)Vibration Absorber – Tuned vibration absorber.
8. Vibration of Equivalent Spring mass system – undamped and damped vibration.
9. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
10. a) Balancing of rotating masses. b) Balancing of reciprocating masses.
11. 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 ratio using vibrating table.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Name of the Equipment	Qty.
1	Cam follower setup.	1
2	Motorised gyroscope.	1
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1
4	Whirling of shaft apparatus.	1
5	Dynamic balancing machine.	1
6	Two rotor vibration setup.	1
7	Spring mass vibration system.	1
8	Torsional Vibration of single rotor system setup.	1
9	Gear Models	1
10	Kinematic Models to study various mechanisms.	1
11	Turn table apparatus.	1
12	Transverse vibration setup of a) cantilever b) Free-Free beam c) Simply supported beam	1

COURSE OUTCOMES:

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

CO1. Select a suitable measuring instrument for measurement of linear and angular dimensions and use the same for carrying out measurements.

CO2. Calibrate simple linear measuring instruments like Vernier caliper, micrometer, Vernier height gauge, etc. using gauge blocks.

CO3. Use advanced measuring equipments coordinate measuring machines, roundness tester, measuring microscope, surface finish measuring equipment to carryout measurements.

CO4. Apply the measurement of various kinematic parameters.

CO5. Apply the vibration parameters in various experiments.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	2	3								
CO2		2	2	3								
CO3		2	2	3								
CO4		2	2	3								
CO5		2	2	3	2							

HOD/MECH

19GE5M01	**INTERPERSONAL SKILLS ESSENTIAL**	**L-T-P**	**C**
		0-0-4	**0**

Programme: B.E. Mechanical Engineering

Objectives:

1. Recognize the characteristics of competent communication in dyadic interactions.
2. Demonstrate the ability to assess the appropriateness and effectiveness of interpersonal strategies used in various interpersonal situations.
3. Demonstrate skill in selecting and using a variety of communication strategies and responses based on situational contexts, goals, and human needs.
4. Recognize the ethical dimensions of interpersonal skills.

Prerequisite: The fundamental knowledge in English Language

VERBAL COMMUNICATION **6**

Introducing Interpersonal Communication – Considering Self – Perceiving Others – Determine project topic and questions for Improving – Interpersonal Communication – Oral Presenting of innovative ideas – Assignment analysis.

DECISION-MAKING **6**

Introduction – Objectives and Expectations – Classifying Decisions – valuating Alternatives: Plus-Minus– Implication **–** Project Direction – Writing down decision statements –Understanding Culture –Evaluating Alternatives: Paired Comparison –Supportive Listening Skills Demonstration **-** Team Decision Making – Communicating Verbally–Conflict Analysis – Visual idea Presentation.

PROBLEM-SOLVING **6**

Identifying problems – Writing problem statement, Analyzing the situation – Gathering information related to the problem stated – Identifying solution criteria – Choosing the best solution – Implementing a solution – writing solution content – Measuring solution success – Report preparation.

CRITICAL THINKING AND INFORMATION ANALYSIS **6**

Critical thinking Introduction – Developing reasoning and logical skills – Discussing forecasting techniques – Writing Quantitative analysis – Discussing mind mapping.

NEGOTIATION SKILLS **6**

Understanding the hidden complexities and dynamics of negotiation – Internalising the roles played by relationships, trust and rapport – Strategically preparing for any negotiation scenario – writing implementation and compliance statements.

Total Periods: 30

TEXT BOOKS:

1. Brooks, Margret. “Skills for Success, Listening and Speaking, Level 4”, Oxford University Press, Oxford (2011)
2. Richards, C. Jack. & David Bholke, “Speak Now Level 3”, Oxford University Press, Oxford, (2010)

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar, "Communicative English for Engineers and Professionals", Pearson, New Delhi, (2010)
2. Hughes, Glyn and Josephine Moate, "Practical English Classroom", Oxford University Press, Oxford, (2014)
3. Vargo, Mari, "Speak Now Level 4", Oxford University Press, Oxford, (2013)
4. Richards C. Jack, "Person to Person (Starter)", Oxford University Press, Oxford, (2006)
5. Ladousse, Gillian Porter, "Role Play", Oxford University Press, Oxford, (2014)

WEB RESOURCES:

1. Interpersonal Communication https://www.youtube.com/watch?v=L8NhxVXopaU
2. Decision Making https://www.youtube.com/watch?v=pPIhAm_WGbQ
3. Problem Solving https://www.youtube.com/watch?v=DCjC_cG4vF4
4. Critical Thinking https://www.youtube.com/watch?v=J0yEAE5owWw
5. Negotiation Skills https://www.youtube.com/watch?v=DZntD2KEJs0

COURSE OUTCOMES:

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

CO1. Listen and respond appropriately
CO2. Present TED Talks
CO3. Make Effective Technical Presentations
CO4. Take up National and International Examination with ease
CO5. Answer questions during interview process with a professional touch

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	2	2		3	3	2	2	2	2	2
CO2		1	3	2							3	
CO3		1	2			3			2	2		
CO4		1	2						3	3	1	1
CO5		1	2							3	2	

HOD/MECH

19ME6601	**DESIGN OF TRANSMISSION SYSTEMS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues

(Use of PSG Design Data Book permitted)

Prerequisite: Engineering Mechanics, Strength of Materials for Mechanical Engineers, and Design of Machine Elements.

DESIGN OF FLEXIBLE ELEMENTS **9**

Design of Flat belts and pulleys – Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

SPUR GEARS AND PARALLEL AXIS HELICAL GEARS **9**

Speed ratios and number of teeth-Force analysis – Tooth stresses – Dynamic effects – Fatigue strength – Factor of safety – Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane – Equivalent number of teeth– forces for helical gears.

BEVEL, WORM AND CROSS HELICAL GEARS **9**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits – terminology. Thermal capacity, materials – forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology –helix angles – Estimating the size of the pair of cross helical gears.

GEARBOXES **9**

Geometric progression – Standard step ratio – Ray diagram, kinematics layout – Design of sliding mesh gear box – Design of multi speed gear box for machine tool applications – Constant mesh gear box – Speed reducer unit – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

CAMS, CLUTCHES AND BRAKES **9**

Cam Design: Types – pressure angle and under cutting base circle determination – forces and surface stresses. Design of plate clutches –axial clutches – cone clutches – internal expanding rim clutches – Electromagnetic clutches. Band and Block brakes – external shoe brakes – Internal expanding shoe brake.

Total Periods: 45

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, (2016)
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "MechanicalEngineering Design", 8th Edition, Tata McGraw-Hill, (2008)

REFERENCES:

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, (2003)
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, (2003)
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, (2000)
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, (2005)
5. Sundararajamoorthy T. V, Shanmugam.N, "Machine Design", Anuradha Publications, Chennai, (2003)

WEB RESOURCE:

https://nptel.ac.in/courses/112106137/

COURSE OUTCOMES:

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

CO1. Gain basic concepts of various power transmission systems and Selection and design of flat belt, V belt drives & Pulleys, Wire rope and chain drives.
CO2. Understand power transmission between parallel shafts and design spur & helical gears.
CO3. Visualize transmission between intersecting shafts and design the bevel, worm gears and cross helical gears.
CO4. Prepare kinematic layout and structural arrangement of the gear boxes.
CO5. Differentiate between clutches, brakes & cam and design the same.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3							3		3
CO2		3	3							3		3
CO3		3	3							3		3
CO4		3	3							3		3
CO5		3	3							3		3

HOD/MECH

19ME6611	**COMPUTER AIDED ENGINEERING LABORATORY**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objectives:
- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

Prerequisite: Computer aided drafting

List of Exercises
Analysis (Simple Treatment only)

1. Static Analysis of 2-D beam problems
2. Static Analysis of Plane stress problems
3. Static Analysis of Axisymmetric problems
4. Structural Analysis of Trusses
5. Stress analysis of a plate with a circular hole
6. Stress analysis of a bicycle frame
7. Mode frequency analysis of a 2D plate
8. Harmonic analysis of a 2D component
9. Conductive Heat Transfer Analysis of 2D components
10. Convective Heat Transfer Analysis of 2D components
11. Thermal stress analysis of a Shell
12. Thermal stress analysis of a Plate

List of Exercises
Simulation

1. Simulation of matrix operations using MAT Lab
2. Plotting of one and two variable using MAT Lab
3. Simulation of spring mass system using MAT Lab
4. Simulation of Hydraulic/Pneumatic cylinder using MAT Lab

SYSTEM REQUIREMENTS
(For a batch of 30 Students)

Hardware:

1. Intel i3 core due processor with 4GB ram with 500GB hard disk – 30 Nos.
2. Laser Printer – 1 No.

Software:

1. FEMAP /equivalent – 30 licenses

Total Periods:45

COURSE OUTCOMES:

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

CO1. Interpret the fundamentals of the Computer Aided Design which will equip them to pursue higher studies
CO2. Know the Indian Standards on drawing practices and standard components
CO3. Identify the different modeling, transformation and assembling tools in computeraided modeling of structural problems
CO4. Illustrate any solid part modelling by using modelling software package
CO5. Assemble the part model by using modeling software package

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3	3					3		
CO2	3			3	3					3		
CO3	3			3	3					3		
CO4	3			3	3					3		
CO5	3			3	3					3		

HOD/MECH

19ME6912	**DESIGN AND FABRICATION PROJECT**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objective: To give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.

Prerequisite: Engineering Materials and Metallurgy, Design of Machine Elements, Design of Transmission System, Manufacturing Technology I and II

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Total Periods: 45

COURSE OUTCOMES:

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

CO1. Remember the basic principles of mechanical engineering in design of component
CO2. Understand the manufacturing process for fabrication of designed component
CO3. Apply the ethical principles in drafting of project report
CO4. Analyze the functionality of the fabricated component
CO5. Evaluate the communication of individual and team on technical information

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3											
CO3								3				
CO4			3									
CO5									3	3	3	

HOD/MECH

19GE6M01	PROFESSIONAL COMMUNICATION – ADVANCED READING AND WRITING	L-T-P 0-0-4	C 0

Programme: B.E. Mechanical Engineering

Objectives:

- Strengthen Reading skills.
- Identify prewriting skills.
- Enhance writing skills with specific reference to Technical Writing.
- Improve Critical Thinking.
- Write project proposals with ease.

Prerequisite: The fundamental knowledge in English Language

ADVANCED READING **6**

Strategies of effective Reading – Newspaper Reading – Reading Abstracts - Uses of glosses and footnotes – Introduction to various types of Magazines/Journals - Reading short Technical Paragraphs – Reading Technical Articles.

READING TO COMPREHEND **6**

Read for details – Read to state Reasons – Read to write Opinion statements – Speed reading Techniques – Read analytical paragraphs.

WRITING STRATEGIES **6**

Introduction to Writing Strategies – Different genres of writing – Organizing ideas from Journal writings – Note- Making.

ADVANCED WRITING **6**

Writing Abstracts – Writing Literature Survey – Organization of Ideas – Writing Proposals.

PROOF READING **6**

Punctuation – Checking for redundancy – Subject-verb agreement – Reading out aloud – Checking for spelling errors – Common errors in English.

Total Periods: 30

TEXT BOOKS:

1. Brooks, Margret. “Skills for Success, Listening and Speaking, Level 4”, Oxford University Press, Oxford (2011)
2. Richards, C. Jack. & David Bholke, “Speak Now Level 3”, Oxford University Press, Oxford, (2010)

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar, "Communicative English for Engineers and Professionals", Pearson, New Delhi, (2010)
2. Hughes, Glyn and Josephine Moate, "Practical English Classroom", Oxford University Press, Oxford, (2014)
3. Vargo, Mari, "Speak Now Level 4", Oxford University Press, Oxford, (2013)
4. Richards C. Jack, "Person to Person (Starter)", Oxford University Press, Oxford, (2006)
5. Ladousse, Gillian Porter, "Role Play", Oxford University Press, Oxford, (2014)

WEB RESOURCES:

1. Google news https://news.google.com
2. Speed Reading https://www.youtube.com/watch?v=y7ghLmcMsMY
3. Writing Strategies https://www.youtube.com/watch?v=8j27mMyGWfM
4. Business Proposal https://www.youtube.com/watch?v=mozVzcNZMG0
5. Proof Reading https://www.youtube.com/watch?v=XuNjIR0a3kc

COURSE OUTCOMES:

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

CO1. Listen and respond appropriately
CO2. Present TED Talks
CO3. Make Effective Technical Presentations
CO4. Take up National and International Examination with ease
CO5. Answer questions during interview process with a professional touch

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				2			3		3	3	2	2
CO2				2			3		2	3	3	2
CO3				1			1		1	3	3	1
CO4				2			2		2	2	3	3
CO5				3			3		3	3	3	3

HOD/MECH

19ME7601	**POWER PLANT ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To understand the various components, operations and applications of different types of power plants, energy tarrifs and economy of power generation and emission
Prerequisite: Engineering Thermodynamics, Thermal Engineering

COAL BASED THERMAL POWER PLANTS **10**

Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems

DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS **10**

Types of diesel plants, components , Selection of Engine type, applications – Gas turbine power plant – Fuels – Gas turbine material – open and closed cycles- reheating – Regeneration and intercooling – combined cycle power plants – Integrated Gasifier based Combined Cycle systems- Waste Disposal Options for Coal Power Plants

NUCLEAR POWER PLANTS **7**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium – Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants- Waste Disposal Options for Nuclear Power Plants

POWER FROM RENEWABLE ENERGY **10**

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Pumped Storage – Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, OTEC, Biogas and Fuel Cell power systems

ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS **8**

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies- Clean energy – Carbon dioxide mitigation technologies- CCS

Total Periods: 45

TEXT BOOKS:

1. Nag. P.K., “Power Plant Engineering”, 3rd Edition, Tata McGraw – Hill Publishing Company Ltd., (2008)
2. Arora S.C and Domkundwar S, “A Course in Power Plant Engineering”, Dhanpat Rai (2013)
3. Morse F.P., “Power Plant Engineering”, Affiliated East West Press Ltd., (2003)

REFERENCES:

1. EI-Wakil M.M , “Power Plant Technology”, Tata McGraw-Hill, (2003)
2. K.K.Ramalingam , “Power Plant Engineering”, Scitech Publications, (2002)
3. G.R,Nagpal, “Power Plant Engineering”, Khanna Publishers, (2018)
4. G.D.Rai, “Introduction to Power Plant technology”, Khanna Publishers, (2018)

WEB RESOURCE:

https://nptel.ac.in/courses/112/107/112107291/

COURSE OUTCOMES:

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

CO1 Understand the various systems and sub-systems in coal based thermal power plants
CO2 Acquire the knowledge on the layout and working of diesel and gas turbine power plants
CO3 Gain understanding on basics of nuclear engineering and layouts of various nuclear reactors
CO4 Develop understanding on the different types of renewable sources of energy
CO5 Identify novel combustion technologies that mitigate combustion driven emission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		3			3	3	3					
CO2		3			3	3	3					
CO3		3			3	3	3					
CO4		3			3	3	3					
CO5		3			3	3	3					

HOD/MECH

19ME7602 **MECHATRONICS** **L-T-P C**
3-0-0 3

Programme: B.E. Mechanical Engineering

Objective: To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Prerequisite: Electrical Drives and Controls, Electronics and Microprocessor, Metrology and Measurements

INTRODUCTION **9**

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers**:** Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.

HYDRAULIC AND PNEUMATIC SYSTEMS **9**

Elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc.- Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits – switching circuits - sequential circuits - cascade methods.

AUTOMATION USING ELECTRONIC SYSTEMS **9**

practical case studied on hydraulic circuit design and performance analysis - Servo valves, electro hydraulic valves, proportional valves and their applications - hydro pneumatic circuits - use of microprocessors for sequencing - signal processing - servo systems - programming of microprocessors using 8086 instruction – circuit design case study and performance analysis.

PROGRAMMABLE LOGIC CONTROLLER **9**

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC – manufacturing applications using PLC.

ACTUATORS AND MECHATRONIC SYSTEM DESIGN **9**

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Total Periods: 45

TEXT BOOKS:

1. Bolton, “Mechatronics”, Prentice Hall, (2008)
2. Anthony Esposito, “Fluid Power with applications”, Prentice Hall international, 2009.
3. Kuo .B.C, “Automatic control systems”, Prentice Hall India, New Delhi, 2007.

REFERENCES:

1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, (1993)
2. Clarence W, de Silva, “Mechatronics” CRC Press, First Indian Re-print, (2013)

3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company, (2007)
4. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition, (2007)
5. Mujumdar.S.R, "Pneumatic System", Tata McGraw Hill 2006.

WEB RESOURCE:

https://nptel.ac.in/courses/112/103/112103174/

COURSE OUTCOMES:

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

CO1. Learn the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems.
CO2. Select Sensor & Transducer Mechatronics system.
CO3. Discuss the design of different pneumatic and Hydraulic circuits and systems.
CO4. Develop simple automated system using Electro-Pneumatic elements.
CO5. Select and program programmable logic controllers for simple manufacturing automation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	3	3		3		2			2	2	2	3
CO 2	3	3		3		2			2	2	2	3
CO 3	3		3	2			2		2	2	2	3
CO 4	3	2	2	3	2		2		2	2	2	3
CO 5	3	3	3	3	3	2			2	2	2	3

HOD/MECH

19ME7911	**TECHNICAL SEMINAR**	**L-T-P**	**C**
		0-0-2	**1**

Programme: B.E. Mechanical Engineering

Objectives:
- To encourage the students to study advanced engineering developments
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Prerequisite: All Courses

METHOD OF EVALUATION:

During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of about 8 to 10 minutes. In a session of two periods per week, 15 students are expected to present the seminar. Each student is expected to present at least twice during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

Total Periods: 30

COU SE OUTCOMES:

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

CO1. Review, prepare and present technological developments
CO2. Face the interviewer
CO3. Make effective presentations
CO4. Speak appropriately and effectively in varied formal and informal contexts
CO5. Answer questions during interview process with a professional touch

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1						3				2		2
CO2										3		3
CO3										3		3
CO4							2			3		3
CO5										3		3

HOD/MECH

19ME7912	**COMPREHENSION**	**L-T-P**	**C**
		0-0-4	**2**

Programme: B.E. Mechanical Engineering

Objective: To encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester of B.E. Degree Course through periodic exercise

Prerequisite: All Courses

METHOD OF EVALUATION:

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics

Total Periods: 30

COURSE OUTCOMES:

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

CO1. Recollect the knowledge acquired during the earlier semesters
CO2. Apply fundamental principle of mechanical engineering concepts to solve reallife problems.
CO3. Present technical topics and discuss about them.
CO4. Analyze and interpret experimental data with relevance.
CO5. Simplify the decision-making skills

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3			3						3
CO2	3	3	3									3
CO3	2								2			3
CO4	3		2	2								3
CO5	3							2				3

HOD/MECH

19ME7M13 **APTITUDE SKILLS** **L-T-P** **C**
0-0-2 **0**

Programme: B.E. Mechanical Engineering
Objectives: To enhance the problem solving skills, to improve the basic mathematical skills and to help students who are preparing for any type of competitive examinations.
Prerequisite:

BASICS OF QUANTITATIVE ABILITIES **8**
Problems on Number System - Problems on HCF and LCM- Problems on Average - Problems on Ratio and Proportion - Problems on Percentage.

ARITHMETIC QUANTITATIVE ABILITIES **8**
Problems on Ages - Problems on Profit and Loss - Problems on Simple and Compound Interest- Problems on Time and Distance

LOGICAL REASONING **8**
Number Series - Alpha Numerical, Letter & Symbol Series - Numerical and Alphabet Puzzles - Seating Arrangement

VERBAL REASONING **6**
Para – Jumble, Text Completion

Total Periods: 30

REFERENCES:
1. Abhijit Guha, "Quantitative Aptitude for Competitive Examinations", 4th Edition, McGraw Hill
2. Dr. R S Aggarwal, "A Modern Approach to Verbal and Non Verbal Reasoning", Revised Edition, S Chand Publications.
3. Arun Sharma, "How to prepare for Logical Reasoning for CAT & other Management Exams", Fifth Edition, Mc Graw Hill Publications.
4. Jaikishan and Premkishan, "How to Crack Test of Reasoning in all Competitive Examinations", Revised Edition, Arihant Publications.

COURSE OUTCOMES:
At the end of the course, the students will be able to
CO1. Understand the basic concepts of quantitative ability
CO2. Understand the basic concepts of logical and verbal reasoning

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2										2	2
CO2	2										2	2

HOD/MECH

19ME8911 **PROJECT WORK** **L-T-P** **C**
0-0-20 **10**

Programme: B.E. Mechanical Engineering

Objectives:
- To develop skills to formulate a technical project.
- To develop skills to formulate a technical project.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Prerequisite: All Courses

METHOD OF EVALUATION:

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Total Periods: 300

COURSE OUTCOMES:

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

CO1. Formulate a real world problem, identify the requirement and develop the design solutions.
CO2. Identify technical ideas, strategies and methodologies.
CO3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
CO4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
CO5. Prepare technical report and oral presentations.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		3	2			2	1					
CO2	2	2	1	3		2					2	2
CO3			3	2	2			2			2	2
CO4		1		2	3	1	2	2				
CO5									3	3		2

HOD/MECH

PROFESSIONAL ELECTIVES

SEMESTER V

19ME5701	**APPLIED HYDRAULICS AND PNEUMATICS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

Prerequisite: Engineering Physics

FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS **9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

HYDRAULIC ACTUATORS AND CONTROL COMPONENTS **9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems

HYDRAULIC CIRCUITS AND SYSTEMS **9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS **9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

TROUBLE SHOOTING AND APPLICATIONS **9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

Total Periods: 45

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education (2005)
2. Majumdar S.R., "Oil Hydraulics Systems-Principles and Maintenance", Tata McGraw-Hill, (2001)

REFERENCES:

1. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, (1982)
2. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, (1987)

3. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, (1995)
4. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, (1989)
5. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, (2006)

WEB RESOURCE:

https://nptel.ac.in/courses/112106175/

COURSE OUTCOMES:

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

CO1. Explain the Fluid power and operation of different types of pumps.
CO2. Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
CO3. Explain the different types of Hydraulic circuits and systems
CO4. Explain the working of different pneumatic circuits and systems
CO5. Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										2
CO2	1	3										2
CO3	1	2			1							2
CO4	1	2	2		1		1					2
CO5	1	1	3		1		1					2

HOD/MECH

19ME5702	**DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design.

Prerequisite: Strength of Materials for Mechanical Engineering, Design of Machine Elements, and Design of Transmission System

LOCATING AND CLAMPING PRINCIPLES **9**

Objectives of tool design – Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used

JIGS AND FIXTURES **9**

Design and development of jigs and fixtures for given component – Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems – Quick change fixtures

PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES **9**

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

BENDING AND DRAWING DIES **9**

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads – ironing – Design and development of bending, forming, drawing reverse re-drawing and combination dies – Blank development for axi-symmetric, rectangular and elliptic parts – Single and double action dies

FORMING TECHNIQUES AND EVALUATION **9**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

Total Periods: 45

Note: (Use of PSG Design Data Book is permitted in the University examination)

TEXT BOOKS:

1. Joshi, P.H. “Jigs and Fixtures”, Tata McGraw Hill Publishing Co., Ltd., New Delhi, (2004)
2. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, (2017)

REFERENCES:

1. Venkataraman K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, (2005)
2. Kempster., "Jigs and Fixture Design", Hoddes and Stoughton, (1974)
3. Joshi P.H., "Press Tools – Design and Construction", Wheels publishing, (1996)
4. Hoffman, "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, (2004)
5. ASTME Fundamentals of Tool Design Prentice Hall of India.
6. Design Data Hand Book, PSG College of Technology, Coimbatore.

WEB RESOURCE:

https://www.youtube.com/watch?v=vOo2MCYPsm4

COURSE OUTCOMES:

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

CO1. Understand the selection of proper location and clamping of components.
CO2. Understand the design and development of jigs and fixtures for the given component.
CO3. Understand the press working terminologies and design of various elements of dies.
CO4. Understand the design and development of bending, forming and drawing dies.
CO5. Understand the forming techniques and aids used for forming analysis.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3						3		3
CO2		3		3						3		3
CO3		3		3						3		3
CO4		3		3						3		3
CO5		3		3						3		3

HOD/MECH

19ME5703	**ADDITIVE MANUFACTURING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

Prerequisite: Manufacturing Technology I and II, CAD / CAM and Unconventional Machining Process

INTRODUCTION **10**

Overview – History – Need– Classification – Additive Manufacturing Technology in product development– Materials for Additive Manufacturing Technology – Tooling – Applications

CAD & REVERSE ENGINEERING **10**

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS **10**

Classification – Liquid based system – Stereolithography Apparatus (SLA) – Principle, process ,advantages and applications – Solid based system –Fused Deposition Modeling – Principle, process, advantages and applications, Laminated Object Manufacturing

POWDER BASED ADDITIVE MANUFACTURING SYSTEMS **10**

Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Three Dimensional Printing – Principle, process, advantages and applications– Laser Engineered Net Shaping (LENS), Electron Beam Melting.

MEDICAL AND BIO-ADDITIVE MANUFACTURING **5**

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies

Total Periods: 45

TEXT BOOKS:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", World Scientific Publishers, (2010)
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, (2003)

REFERENCES:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, (2007)
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, (2006)
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, (2000)
4. Ian Gibson, David Rosen and Brent Stucker, "Additive Manufacturing Technologies: 3D printing, Rapid prototyping and Direct Digital Manufacturing", Springer, (2014)
5. Andreas Gebhardt "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing"Hanser Gardner Publication (2011)

6. Tom Page "Design for Additive Manufacturing"LAP Lambert Academic Publishing, (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/112104265/

COURSE OUTCOMES:

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

CO1. Understand the basic concepts of additive manufacturing and its applications
CO2. Know the software's for additive manufacturing technology
CO3. Learn liquid and solid based additive manufacturing and its applications
CO4. Learn power based additive manufacturing and its applications
CO5. Examine the possibilities and limitations in medical and bio additive manufacturing

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2					3							
CO3	3											
CO4	3											
CO5												3

HOD/MECH

19ME5704	**POLYMER TECHNOLOGY**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To impart knowledge on mixing devices, extrusion moulding.
- To know the importance of Injection moulding and special moulding techniques.
- To understand the basic concepts in mould design

Prerequisite: Manufacturing Technology II

MIXING DEVICES **9**

Additives and Mixing process, different types of mixing devices – twin drum tumblers, ribbon blenders, Z-blade Mixer, high speed mixer, ball mill, two roll mill, Banbury mixer, internal mixing and screw mixing – twin screw compounding machines-differences between mixing conditions for rubbers and plastics

CALENDERING AND EXTRUSION **9**

Processing methods based on extruder (granule production, profile production, film blowing, blow moulding, extrusion stretch blow moulding) – extrusion coating process (sheet coating and wire covering) – rubber extrusion-hot feed and cold feed extrusion of rubber – calendaring of rubber compounds and PVC pastes – equipment and processes

INJECTION MOULDING **9**

Injection moulding machines and its components – moulds, multi cavity moulds, mould clamping devices, mould clamping force, injection blow moulding, reaction injection moulding.

OTHER MOULDING TECHNIQUES **9**

Thermoforming – vacuum forming, Pressure forming and matched mould forming – Rotation moulding – Compression moulding – Transfer moulding

BASIC CONCEPTS IN MOULD DESIGN **9**

Types of moulds – Feed system – ejector system – ejection techniques – mould cooling – CAD / CAM applications

Total Periods: 45

TEXT BOOKS:

1. D.H. Morton-Jones, Polymer Processing, Springer verlaggmbh (2014)
2. Myer Kutz, "Applied Plastics Engineering Handbook: Processing and Materials", Elsevier, UK, (2016)

REFERENCES:

1. Sinha R., "Outlines of Polymer Technology: Manufacture of Polymers", PHI, New Delhi, (2004)
2. Crawford R.J. Plastics Engineering, Butterworth - Heinemann, 3rd Edition, (2005)
3. Fried helm Hansen, Plastics Extrusion Technology, 2nd Edition, Hanser Publishers, (1997)
4. Peter Powell, A. Jan IngenHouz, Engineering with Polymers, Stanley Thomas Publishers Ltd., 2nd Edition. (1998)
5. Richard G.Griskey, Polymer Process Engineering, Chapman and Hall, (1995)
6. Tim A. Osswald Georg Menges "Material Science of Polymers for Engineers", Hanser Publications, (2012)

7. Michael L. Berins, "Plastic Engineering Handbook of the Society of the Plastics Industry", Kluwer Academic Publishers, Netherland, (1991)
8. Charles A. Harper, "Handbook of Plastic Processes", John Wiley, NJ, (2006)

WEB RESOURCE:

https://nptel.ac.in/courses/113105028/

COURSE OUTCOMES:

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

CO1. Remember various basic processing methods employed for Plastics.
CO2. Understand the principles of calendaring and extrusion processes
CO3. Apply the principles of injection moulding in manufacturing of components
CO4. Apply the other moulding techniques in production of components
CO5. Apply the basic concepts in design of mould system and evaluate the applications of CAD / CAM

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					2			1			2
CO2	1					2			1			2
CO3	1					2			1			2
CO4	1					2			1			2
CO5	1					2			1			2

HOD/MECH

19ME5705	**ADVANCED I.C. ENGINES**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the underlying principles of operation of different IC Engines and components.
- To provide knowledge on pollutant formation, control, alternate fuel etc.

Prerequisite: Thermal Engineering and Automobile Engineering

SPARK IGNITION ENGINES **9**

Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection – Stages of combustion – Normal and Abnormal combustion – Knock – Factors affecting knock – Combustion chambers.

9

COMPRESSION IGNITION ENGINES

Diesel Fuel Injection Systems – Stages of combustion – Knocking – Factors affecting knock – Directand Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure andspray penetration – Air motion – Introduction to Turbocharging.

POLLUTANT FORMATION AND CONTROL **9**

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

9

ALTERNATE FUELS

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel – Properties, Suitability, Merits and Demerits – Engine Modifications.

9

RECENT TRENDS

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometryturbochargers – Common Rail Direct Injection Systems – Hybrid Electric Vehicles – NOx Adsorbers – Onboard Diagnostics.

Total Periods: 45

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering Vol.2", Standard Publishers, New Delhi, (2014)
2. Ganesan V., "Internal Combustion Engines", Tata McGraw Hill, (2012)

REFERENCES:

1. Heinz Heisler, "Advanced Engine Technology", SAE International Publications, USA, (2005)
2. John B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill, (1988)
3. Gupta H.N., "Fundamentals of Internal Combustion Engines", Prentice Hall of India, (2006)
4. Ultrich Adler, "Automotive Electric/Electronic Systems", Published by Robert Bosh GmbH, (1995)
5. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons (2007)
6. Duffy Smith, "Auto Fuel Systems", The Good Heart Willcox Company, Inc., (1987)
7. Eric Chowenitz, "Automobile Electronics", SAE Publications, (1995)

WEB RESOURCE:

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/102104057/lec29.pdf

COURSE OUTCOMES:

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

CO1. Understand the basic fundamentals of SI engines
CO2. Understand the basic fundamentals of CI engines
CO3. Describe the various forms of pollutants and various emission control methods in IC Engines
CO4. Familiarize the various forms of alternative fuel
CO5. Know the recent technologies implemented in Automobiles

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3				2	2					3
CO2	3	3				2	2					3
CO3	3	3				2	3					3
CO4	3	3				2	3					3
CO5	3	3				2	3					3

HOD/MECH

19ME5706	**ALTERNATIVE FUELS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To know about the types of alternative fuels and energy sources for IC engines
Engineering Chemistry, Thermal Engineering
Prerequisite: Thermal Engineering, IC Engines, and Automobile Engineering

ALCOHOLS AS FUELS **9**

Introduction to alternative fuels – Need for alternative fuels – Availability of different alternative fuels for SI and CI engines. Alcohols as fuels. Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Blending, dual fuel operation, surface ignition and oxygenated additives. Performance emission and combustion characteristics in CI and SI engines.

VEGETABLE OIL AS FUEL **9**

Various vegetable oils and their important properties. Different methods of using vegetable oils engines – Blending, preheating Transesterification and emulsification of Vegetable oils – Performance in engines – Performance, Emission and Combustion Characteristics in diesel engines.

HYDROGEN AS ENGINE FUEL **9**

Production methods of hydrogen. Combustive properties of hydrogen. Problems associated with hydrogen as fuel and solutions. Different methods of using hydrogen in SI and CI engines. Performance, emission and combustion analysis in engines. Hydrogen storage - safety aspects of hydrogen.

BIOGAS, NATURAL GAS AND LPG AS FUELS **9**

Production methods of Biogas, Natural gas and LPG. Properties studies. CO_2 and H2S scrubbing in Biogas., Modification required to use in SI and CI Engines- Performance and emission characteristics of Biogas, NG and LPG in SI and CI engines.

ELECTRIC, HYBRID AND FUEL CELL VEHICLES **9**

Layout of Electric vehicle and Hybrid vehicles – Advantages and drawbacks of electric and hybrid vehicles. System components, Electronic control system – Different configurations of Hybrid vehicles. Power split device. High energy and power density batteries – Basics of Fuel cell vehicles.

Total Periods: 45

TEXT BOOKS:

1. Ayhan Demirbas, "Biodiesel A Realistic Fuel Alternative for Diesel Engines", Springer-Verlag London Limited, (2008)
2. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, (2013)

REFERENCES:

1. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, "The Biodiesel Handbook", AOCS Press Champaign, Illinois (2005)
2. Richard L Bechtold P.E., "Alternative Fuels Guide book", Society of Automotive Engineers, ISBN 0-76-80-0052-1, (1997)
3. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels
4. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.)

WEB RESOURCE:

https://nptel.ac.in/courses/103102015/

COURSE OUTCOMES:

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

CO1. Understand the various alternative fuels available
CO2. Know the different methods of vegetable oils
CO3. Describe the production methods of hydrogen fuel in IC Engines
CO4. Understand the production methods of biogas, natural gas etc.
CO5. Know the recent types of vehicle in Automobiles

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2				3	3					1
CO2	3	2				3	3					1
CO3	3	2				3	3					1
CO4	3	2				3	3					1
CO5	3	2				3	3					1

HOD/MECH

PROFESSIONAL ELECTIVES

SEMESTER VI

19ME6701	**MECHANICAL VIBRATIONS AND CONTROL**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives :
- To understand the Fundamentals of Vibration and its practical applications
- To understand the working principle and operations of various vibration measuring instruments
- To understand the various Vibration control strategies

Prerequisite: Dynamics of Machinery

FUNDAMENTALS OF VIBRATION **10**

Introduction – Sources of Vibration – Mathematical Models – Displacement, velocity and Acceleration – Review of Single Degree Freedom Systems – Vibration isolation Vibrometers and accelerometers – Response To Arbitrary and non-harmonic Excitations – Transient Vibration – Impulse loads – Critical Speed of Shaft – Rotor systems.

TWO DEGREE OF FREEDOM SYSTEM **7**

Introduction – Free Vibration Of Undamped And Damped – Forced Vibration With Harmonic Excitation System – Coordinate Couplings and Principal Coordinates

MULTI-DEGREES OF FREEDOM SYSTEM AND CONTINUOUS SYSTEM **9**

Multi Degree Freedom System – Influence Coefficients and stiffness coefficients – Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors – Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method – Geared Systems – Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method – Continuous System: Vibration of String, Shafts and Beams

VIBRATION CONTROL **9**

Specification of Vibration Limits –Vibration severity standards – Vibration as condition Monitoring tool – Vibration Isolation methods – Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber – Damped Vibration absorbers – Static and Dynamic Balancing – Balancing machines – Field balancing – Vibration Control by Design Modification – Active Vibration Control

EXPERIMENTAL METHODS IN VIBRATION ANALYSIS **10**

Vibration Analysis overview – Experimental Methods in Vibration Analysis – Vibration Measuring Instruments – Selection of Sensors – Accelerometer Mountings – Vibration Exciters – Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments – System Identification from Frequency Response – Testing for resonance and mode shapes

Total Periods: 45

TEXT BOOKS:

1. Rao S S, "Mechanical Vibrations", 5th Edition, Prentice Hall, (2011)
2. Grover G K, "Mechanical Vibrations", Nem Chand and Brothers, Roorkee, (2009)

REFERENCES:

1. Thomson W, "Theory of Vibration with Applications", CRC Press, (1996)
2. Ashok Kumar Mallik, "Principles of Vibration control", Affiliated East-West Press (P) Ltd., New Delhi Press, (1990)
3. Lewis H Bell, "Industrial Noise Control Fundamentals and Applications", Marcel Dekkev Incl., New York, (1982)

4. Seto, “Mechanical Vibrations”, Schaum's Outline Series, McGraw Hill Book Company, New Delhi, (1990)
5. Ambekar A G, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., (2006)

WEB RESOURCE:

https://nptel.ac.in/courses/112107087/

COURSE OUTCOMES:

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

CO1. Develop mathematical models of dynamical systems with single degree of freedom to determine their response to harmonic, transient and impulse loads.
CO2. Develop mathematical models of dynamical systems with multiple degrees of freedom to calculate natural frequencies and mode shapes.
CO3. Determine the natural frequencies and mode shapes of continuous systems such as strings in transverse vibrations, bars in longitudinal vibrations, and circular shafts in torsional vibrations using analytical and numerical methods.
CO4. Evaluate the severity of vibration and choose a suitable vibration isolation system, perform static and dynamic balancing and design suitable vibration absorber systems
CO5. Know the vibration limits and able to select and analyse by various vibration measuring instruments

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3	3						2		3
CO2	2		3	3						2		3
CO3	2		3	3						2		3
CO4	1		1	2		2	2			2		3
CO5	1		1	2		2	2			2		3

HOD/MECH

19ME6702	**FINITE ELEMENT ANALYSIS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To introduce the concepts of Mathematical Modeling of Engineering Problems and to appreciate the use of FEM to a range of Engineering Problems

Prerequisite: Engineering Mechanics, Strength of Materials for Mechanical Engineers, and Engineering Mathematics I

INTRODUCTION **9**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems – Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method

ONE-DIMENSIONAL PROBLEMS **9**

One Dimensional Second Order Equations – Discretization – Element types – Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors – Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams.

TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS **9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts – Quadrilateral elements – Higher Order Elements.

TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS **9**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

ISOPARAMETRIC FORMULATION **9**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Total Periods: 45

TEXT BOOKS:

1. Seshu P., “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd. New Delhi, (2013)
2. Reddy J.N., “An Introduction to the Finite Element Method”, McGraw-Hill Edition, (2010)

REFERENCES:

1. Bhavikatti S.S., “Finite Element Analysis”, New Age International Publishers, (2015)
2. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, (1990)
3. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., (2002)

4. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, (2004)
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, (2002)

WEB RESOURCE:

https://nptel.ac.in/courses/112/104/112104116/

COURSE OUTCOMES:

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

CO1. Select the various approximation techniques to solve differential equations of physical phenomenon.
CO2. Exercise the one dimensional elements to solve solid mechanics and heat transfer problems.
CO3. Apply the two dimensional elements to solve the scalar variable problems.
CO4. Apply the axisymmetric, plate and shell elements to solve structural engineering problems.
CO5. Apply the finite element method to solve problems on isoparametric element and dynamics problem.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2		1								2
CO3	3	2		1								2
CO4	3	2		1								2
CO5	3	2		1								2

HOD/MECH

19ME6703	**MECHANICAL BEHAVIOUR OF MATERIALS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: The students having studied the basics of material structures and properties and strength of materials shall be introduced to dislocation theories of plasticity behavior, various strengthening mechanisms and fracture mechanics. It will expose students to failure mechanisms due to fatigue and creep as well as their testing methods.

Prerequisite: Engineering Physics, and Engineering Materials and Metallurgy

BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES **9**

Elastic behavior of materials – Hooke's law, plastic behaviour: dislocation theory – Burger's vectors and dislocation loops, dislocations in the FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, dislocation climb, intersections of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning.

STRENGTHENING MECHANISMS **9**

Cold working, grain size strengthening. Solid solution strengthening. martensitic strengthening, precipitation strengthening, dispersion strengthening, fibre strengthening, examples of above strengthening mechanisms from ferrous and non-ferrous systems, simple problems. Yield point phenomenon, strain aging and dynamic strain aging

FRACTURE AND FRACTURE MECHANICS **9**

Types of fracture, basic mechanism of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT. Fracture mechanics – introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of KIC, introduction to COD, J integral.

FATIGUE BEHAVIOUR AND TESTING 9

Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, HCF/LCF, thermomechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.

CREEP BEHAVIOUR AND TESTING **9**

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametetric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby.

Total Periods: 45

TEXT BOOKS:

1. A.K.Bhargava, C.P.Sharma, "Mechanical behaviour and testing of materials" 1st Edition, Kindle Edition, (2011)
2. Dieter, G.E., "Mechanical Metallurgy", McGraw-Hill, SI Edition, (1995)
3. Davis. H.E., Troxell G.E., Hauck.G.E.W., "The Testing of Engineering Materials", McGraw-Hill, (1982)
4. Thomas H. Courtney, "Mechanical Behavior of Materials", 2nd edition, McGraw Hill, (2000)

REFERENCES:

1. Metals Hand book, Vol.10, "Failure Analysis and Prevention", 10th Edition, Jaico, (1999)
2. Thomas H. Courtney, "Mechanical Behavior of Materials", 2nd edition, McGraw Hill, (2000)
3. Hayden, H. W. W. G. G. Moffatt, J. Moffatt and J. Wulff, The Structure and Properties of Materials, Vol.III, Mechanical Behavior, John Wiley & Sons, New York, (1965)
4. Honey combe R. W. K., "Plastic Deformation of Materials", Edward Arnold Publishers, (1984)
5. Wulff, The Structure and Properties of Materials, Vol. III "Mechanical Behavior of Materials", John Wiley and Sons, New York, USA, (1983)
6. Suryanarayana, A. V. K., "Testing of Metallic Materials", Prentice Hall India, New Delhi, (1979)

WEB RESOURCE:

https://nptel.ac.in/courses/112/103/112103278/

COURSE OUTCOMES:

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

CO1. Ability to understand the mechanism involved in elastic and plastic behaviour of metals.
CO2. Ability to apply their knowledge of strengthening mechanism in ferrous and non ferrous sytems.
CO3. Ability to understand about the fundamental of fracture mechanics
CO4. Able to apply their knowledge in real time fatigue failures
CO5. Ability to evaluate and justify the safe use of materials for engineering application in high temperature.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	2		1				1		2
CO2	1	3		2		1				1		2
CO3	1	3		2		1				1		2
CO4	1	3		2		1				1		2
CO5	1	3		2		1				1		2

HOD/MECH

19ME6704 DESIGN FOR MANUFACTURING AND ASSEMBLY L-T-P C
3-0-0 3

Programme: B.E. Mechanical Engineering

Objectives :
- To know the concept of design for manufacturing, assembly and environment.
- To know the computer application in design for manufacturing and assembly.

Prerequisite: Manufacturing Technology I and II, Design of Machine Elements, Design of Transmission Systems, Unconventional Machining Process

INTRODUCTION **5**

General design principles for manufacturability – strength and mechanical factors, mechanisms selection, evaluation method, Process capability – Feature tolerances – Geometric tolerances – Assembly limits – Datum features – Tolerance stacks.

FACTORS INFLUENCING FORM DESIGN **13**

Working principle, Material, Manufacture, Design- Possible solutions – Materials choice – Influence of materials on form design – form design of welded members, forgings and castings.

COMPONENT DESIGN – MACHINING CONSIDERATION **8**

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 clamp ability – Design for accessibility – Design for assembly, Product design for manual assembly – Product design for automatic assembly – Robotic assembly.

COMPONENT DESIGN – CASTING CONSIDERATION **10**

Redesign of castings based on Parting line considerations – Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design – Modifying the design – group technology – Computer Applications for DFMA

DESIGN FOR THE ENVIRONMENT **9**

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method –AT&T's environmentally responsible product assessment – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

Total Periods: 45

TEXT BOOKS:

1. Dickson, John. R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, (1995)
2. Kevien Otto and Kristin Wood, "Product Design", Pearson Publication,4th Impression (2009)

REFERENCES:

1. Boothroyd, G, "Design for Assembly Automation and Product Design", New York, (1980)
2. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Marcel Dekker, (1994)
3. Dekker. Marcel Bralla, "Design for Manufacture handbook", McGraw hill, (1999)
4. Fixel, J. "Design for the Environment", McGraw Hill., (1996)

WEB RESOURCE:

https://nptel.ac.in/courses/107103012/

COURSE OUTCOMES:

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

CO1: Describe the general design principles for manufacturability

CO2: Understand the factors that influence form design

CO3: Familiarize the design features to facilitate machining

CO4: Describe the design factors that influencing the redesign of casting

CO5: Know the techniques to reduce environmental impact of a product

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	3			2		1				3
CO2	3	3	3	2		2						3
CO3	3	3	3	2		2						3
CO4	3	3	3	2		2						3
CO5	3	2	3	3	3	2	3	2		2		3

HOD/MECH

19ME6705	**PRODUCT DESIGN AND DEVELOPMENT**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To provide the basic concepts of product design, product features and its architecture and how to incorporate them suitably in product.

Prerequisite: Nil

INTRODUCTION **9**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

CONCEPT GENERATION AND SELECTION **9**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

PRODUCT ARCHITECTURE **9**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

INDUSTRIAL DESIGN **9**

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT **9**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

Total Periods: 45

TEXT BOOKS:

1. Karl T., Ulrich and D. Steven, and Eppinger, Product Design and Development, McGraw Hill, (2009)
2. Dieter G. E., Engineering Design, McGraw – Hill International, (2009)

REFERENCES:

1. Chitale A. K., Gupta R. C., " Product Design and Manufacturing", 6th Edition, PHI Publication, (2011)
2. Stephen R. Rosenthal, "Effective Product Design and Development", Business & Economics (1992)

3. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
4. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
5. Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.

WEB RESOURCE:

https://nptel.ac.in/courses/112104230/

COURSE OUTCOMES:

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

CO1. Understand the need for Integrated Product and Process Design
CO2. Illustrate the structured approaches in concept generation
CO3. Apply the principles of product architecture in component standardization
CO4. Develop integrated environment for industrial design
CO5. Examine the economic aspects of product development

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3						3	3
CO2			3	3	3						3	3
CO3				3	3							3
CO4						3	3					
CO5											3	3

HOD/MECH

19ME6706	**SUPPLY CHAIN MANAGEMENT AND LOGISTICS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To teach the basic principles of supply chains and associated logistics management.
Prerequisite: Nil

INTRODUCTION **9**

Role of Logistics and Supply chain Management: Scope and Importance – Evolution of SupplyChain – Decision Phases in Supply Chain – Competitive and Supply chain Strategies – Driversof Supply Chain Performance and Obstacles.

SUPPLY CHAIN NETWORK DESIGN **9**

Role of Distribution in Supply Chain – Factors influencing Distribution network design –Designoptions for Distribution Network Distribution Network in Practice – Role of network Design inSupply Chain – Framework for network Decisions

LOGISTICS IN SUPPLY CHAIN **9**

Role of transportation in supply chain – factors affecting transportations decision – Designoption for transportation network – Tailored transportation – Routing and scheduling intransportation

SOURCING AND COORDINATION IN SUPPLY CHAIN **9**

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration – sourcing planning and analysis – supply chain co-ordination – Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain

SUPPLY CHAIN AND INFORMATION TECHNOLOGY **9**

The role IT in supply chain – The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain

Total Periods: 45

TEXT BOOKS:

1. Sunil Chopra, Peter meindl and Kalra, “Supply Chain Management, Strategy, Planningand operation”, Pearson Education, (2010)
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management,PHI, (2010)

REFERENCES:

1. Jeremy F.Shapiro, “Modeling the supply chain”, Thomson Duxbury, (2002)
2. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI (2002)
3. James B.Ayers, “Handbook of Supply chain management”, St.Lucle press, (2000)

WEB RESOURCE:

https://nptel.ac.in/courses/110108056/

COURSE OUTCOMES:

At the end of the course, the students will be able to
CO1. Recall the basics of supply chain management, its drivers and obstacles
CO2. Outline the role of network design in supply chain
CO3. Apply the mathematical knowledge for logistics
CO4. Analyze the different sources and build strategic partnership
CO5. Identify the role of information and communication technology in supply chain

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3	3						3	3
CO2					3							3
CO3			3	3								
CO4					3	3					3	3
CO5										3	3	3

HOD/MECH

19ME6707	**COMPOSITE MATERIALS AND ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:

- To understand the fundamentals of composite material strength and its mechanical behavior Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

Prerequisite: Engineering Physics, Mechanics of Materials, and Strength of Materials

INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING **12**

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes

FLAT PLATE LAMINATE CONSTITUTE EQUATIONS **10**

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

LAMINA STRENGTH ANALYSIS **5**

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

THERMAL ANALYSIS **8**

Assumption of Constant C.T.E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

ANALYSIS OF LAMINATED FLAT PLATES **10**

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. BucklingAnalysis. Free Vibrations – Natural Frequencies

Total Periods: 45

TEXT BOOKS:

1. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press Edition (2007)
2. Gibson, R.F., "Principles of Composite Material Mechanics", McGraw-Hill, CRC press in progress (1994)
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press Edition (2007)

REFERENCES:

1. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998
2. Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, (1993)
3. Robert M. Jones, "Mechanics of Composite Materials", McGraw Hill, (1998)
4. Halpin J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., (1984)
5. Agarwal B.D. and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, (1990)

WEB RESOURCE:

https://nptel.ac.in/courses/112104168/

COURSE OUTCOMES:

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

CO1. Understand the concept of fiber preparation and identify manufacturing methods
CO2. Learn the flat plate laminate constitute equations
CO3. Understand the lamina strength analysis
CO4. Know the thermal analysis of composites
CO5. Analyze the bending, buckling and vibrational properties of composites

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2					1					2
CO2	2	2					1					2
CO3	3	3					1					2
CO4	3	3					1					2
CO5	3	3					1					2

HOD/MECH

19ME6708	**MODERN MACHINING PROCESSES**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To learn about various modern machining processes, the various process parameters and their influence on performance and their applications
Prerequisite: Manufacturing Technology I and II

INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES **9**

Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR – Applications

THERMAL AND ELECTRICAL ENERGY BASED PROCESSES **9**

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipments-Process Parameters-Surface Finish and MRR – electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing — Applications. Laser Beam machining and drilling, (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types – Beam control techniques – Applications.

CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES **9**

Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant – techniques of applying maskants – Process Parameters – Surface finish and MRR – Applications. Principles of ECM – equipments-Surface Roughness and MRR Electrical circuit – Process Parameters – ECG and ECH – Applications.

ADVANCED NANO FINISHING PROCESSES **9**

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES **9**

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

Total Periods: 45

TEXT BOOKS:

1. Vijay K. Jain, "Advanced Machining Processes", Allied Publishers Pvt. Ltd., New Delhi, (2014)
2. Mishra P.K., "Non-Conventional Machining", The Institution of Engineers,India, (2015)

REFERENCES:

1. Benedict G.F., "Non traditional Manufacturing Processes", Marcel Dekker Inc., New York, (2014)
2. Pandey P.C. and Shan H.S., "Modern Machining Processes", Tata McGraw-Hill, New Delhi (2015)

3. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, (2010)
4. Paul De Garmo, Black J.T. and Ronald A. Kohser., "Material and Processes in Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/112/103/112103202/

COURSE OUTCOMES:

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

CO1. Explain the need for unconventional machining processes and its classification and summarize the various mechanical energy based processes.
CO2. Compare various thermal energy and electrical energy based unconventional machining processes.
CO3. Summarize various chemical and electro-chemical energy based unconventional machining processes.
CO4. Summarize the various nano abrasives based unconventional machining processes.
CO5. Discuss various recent trends based unconventional machining processes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	2	1					1		3
CO2	1	3	3	2	1					1		3
CO3	1	3	3	3	1					1		3
CO4	1	3		3	1					1		3
CO5	1	3		3	1					1		3

HOD/MECH

19ME6709	**COMPUTER INTEGRATED MANUFACTURING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

Prerequisite: Manufacturing Technology I & II

INTRODUCTION **9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control – Introduction to CAD/CAM – Concurrent Engineering – CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING **9**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning – Control Systems – Shop Floor Control – Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) – Simple Problems.

CELLULAR MANUFACTURING **9**

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) **9**

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

INDUSTRIAL ROBOTICS **9**

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability – Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Total Periods: 45

TEXT BOOKS:

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, (2008)
2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, (2000)

REFERENCES:

1. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, (1995)
2. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India.
3. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, (2000)

WEB RESOURCES:

- http://www.nptel.ac.in/courses/112102011/
- http://nptel.ac.in/courses/110106044/
- http://nptel.ac.in/courses/112107143/36
- http://nptel.ac.in/courses/112103174/35

COURSE OUTCOMES:

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

CO1. Explain the basic concepts of CAD, CAM and computer integrated manufacturing systems
CO2. Summarize the production planning and control and computerized process planning
CO3. Differentiate the different coding systems used in group technology
CO4. Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
CO5. Classification of robots used in industrial applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3		2		3	3	3			3	2	3
CO2	3		2		3	3	3			3	2	3
CO3	3	2	2		3	3	3			3	2	3
CO4	3	2	2		3	3	3			3	2	3
CO5	3	2	2		3	3	3			3	2	3

HOD/MECH

19ME6710	**AIR BREATHING ENGINES**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To establish fundamental approach and application of jet engine components also analysis of flow phenomenon and estimation of thrust developed by jet engine.

Prerequisite: Thermal Engineering, IC Engine, Gas Dynamics and Jet Propulsion

PRINCIPLES OF AIR BREATHING ENGINES **12**

Operating principles of piston engines – thermal efficiency calculations – classification of piston engines – illustration of working of gas turbine engines – factors affecting thrust – methods of thrust augmentation – performance parameters of jet engines.

JET ENGINE INTAKES AND EXHAUST NOZZLES **12**

Ram effect, Internal flow and Stall in subsonic inlets – relation between minimum area ratio and eternal deceleration ratio – diffuser performance – modes of operation – supersonic inlets – starting problem on supersonic inlets – shock swallowing by area variation – real flow through nozzles and nozzle efficiency – losses in nozzles – ejector and variable area nozzles – interaction of nozzle flow with adjacent surfaces – thrust reversal.

JET ENGINE COMBUSTION CHAMBERS **12**

Chemistry of combustion, Combustion equations, Combustion process, classification of combustion chambers – combustion chamber performance – effect of operating variables on performance – flame stabilization, Cooling process, Materials, Aircraft fuels, HHV, LHV, Orsat apparatus

JET ENGINE COMPRESSORS AND TURBINES **12**

Euler's turbo machinery equation, Principle operation of centrifugal compressor, Principle operation of axial flow compressor – performance parameters of axial flow compressors – Principle of operation of axial flow turbines – limitations of radial flow turbines performance parameters of axial flow turbine – turbine blade cooling methods – matching of compressor and turbine.

RAMJET AND SCRAMJET PROPULSION **12**

Operating principle of ramjet engine – various components of ramjet engines – Combustion in ramjet engine – ramjet engine and its performance characteristics – integral ram rockets – salient features of scramjet engine and its applications for hypersonic vehicles.

Total Periods: 60

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Pearson education (2009)
2. James Award, "Aerospace propulsion system", Wiley publication, (2005)

REFERENCES:

1. Cohen H, Rogers G.F.C. and Saravanamuttoo H.I.H. "Gas Turbine Theory", Pearson Education Canada; 6th edition, (2008)
2. Mathur M.L. and Sharma R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition (2014)
3. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, (1985)
4. Longman, "Rolls Royce Jet Engine", Rolls Royce; 4th revised edition, (1986)

WEB RESOURCE:

https://nptel.ac.in/courses/101108068/

COURSE OUTCOMES:

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

CO1. Understand the working of Piston engines and Gas turbine engines and to estimate the performance of gas turbine engine.

CO2. Describe the principal design parameters and constraints that set the performance of Intakes and Nozzles.

CO3. Apply ideal and actual cycle analysis to a gas turbine combustion chamber to relate thrust and fuel burn to component performance parameters

CO4. Understand the working of multistage compressor and turbine, and to estimate the performance of a compressor or turbine stage.

CO5. Understand the working of Ram jet engine & Scramjet Engine and to estimate the performance of Ram jet engine.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								1
CO2	3	3	2	2								1
CO3	3	3	2	2			1					1
CO4	3	3	2	2			1					1
CO5	3	3	2	2			1					1

HOD/MECH

19ME6711	**REFRIGERATION AND AIR CONDITIONING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems

Prerequisite: Thermal Engineering

INTRODUCTION TO REFRIGERATION **9**

Basic Definitions, Heat pump and Refrigerating Machine, Best Refrigeration Cycle: The Carnot Principle, Gas as a Refrigerant in Reversed Carnot Cycle, Limitations of Reversed Carnot Cycle, Reversed Brayton or Bell Coleman Cycle, Application to Aircraft Refrigeration, Simple Numerical problems.

VAPOUR COMPRESSION REFRIGERATION SYSTEM **9**

Vapour compression cycle: p-h and T-s diagrams – deviations from theoretical cycle – subcooling and super heating – effects of condenser and evaporator pressure on COP – multipressure system – low temperature refrigeration – Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

OTHER REFRIGERATION SYSTEMS **9**

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration – Ejector refrigeration systems – Thermoelectric refrigeration- Air refrigeration – Magnetic – Vortex and Pulse tube refrigeration systems.

REFRIGERANTS AND SYSTEM COMPONENTS **9**

Refrigerants: Primary and Secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants, Selection of a Refrigerant, Ozone Depletion Potential and Global Warming Potential of CFC Refrigerants. Thermodynamic requirements, Comparison between different refrigerants, Substitutes for CFC refrigerants, Secondary Refrigerants.

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

AIR-CONDITIONING **9**

Basic Processes in Conditioning of Air, Psychrometric Processes in Air-Conditioning Equipment, Simple Air-Conditioning/system and State and Mass Rate of Supply Air, Summer Air Conditioning, Winter Air Conditioning. **Loading Calculation and Applied Psychometrics:** Preliminary Considerations, Internal Hear Gains, System Heat Gains, Break-up of Ventilation Load and Effective Sensible Heat Factor, Cooling Load Estimate. Psychrometric Calculations for Cooling, Selection of Air-Conditioning Apparatus for Cooling and Dehumidification, Building Requirements and Energy Conservation in Air Conditioned Buildings.

Total Periods: 45

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, (2010)

REFERENCES:

1. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, (2009)
2. Stoecker, W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, (1986)
3. ASHRAE Hand book, Fundamentals, (2010)
4. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, (2001)

WEB RESOURCE:

https://nptel.ac.in/courses/112/105/112105129/

COURSE OUTCOMES:

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

CO1. Illustrate the principles, nomenclature and applications of refrigeration systems.
CO2. Explain vapour compression refrigeration system and identify methods for performance improvement
CO3. Study the working principles of air, vapour absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems
CO4. Identify suitable refrigerant and equipment's for various refrigerating systems
CO5. Compute and Interpret cooling and heating loads in an air-conditioning system

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	1	1								2
CO2	3	3	1	1								2
CO3	3	3	1	1								2
CO4	3	3	1	1								2
CO5	3	3	1	1								2

HOD/MECH

19ME6712	**GAS DYNAMICS AND JET PROPULSION**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the basic difference between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.

(Use of Standard Gas Tables permitted)

Prerequisite: Engineering Thermodynamics, and Thermal Engineering

BASIC CONCEPTS AND ISENTROPIC FLOWS **9**

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers

FLOW THROUGH CONSTANT AREA DUCTS **9**

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties

NORMAL AND OBLIQUE SHOCK **9**

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications

JET PROPULSION **9**

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operation principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines – Scramjet engines

SPACE PROPULSION **9**

Types of rocket engines – Propellants – feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights

Total Periods: 45

TEXT BOOKS:

1. Anderson J.D., "Modern Compressible Flow", 3rd Edition, McGraw Hill, (2012)
2. Yahya S.M., "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, (2010)

REFERENCES:

1. Hill P., Peterson C., "Mechanics and Thermodynamics of Propulsion", Addison – Wesley Publishing company, (2012)
2. Zucrow N.J., "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, (2010)
3. Sutton G.P., "Rocket Propulsion Elements", John Wiley, (2012)
4. Ganesan V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, (2011)
5. Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd.,(1980)

WEB RESOURCE:

https://nptel.ac.in/courses/112106166/

COURSE OUTCOMES:

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

CO1. Understand the basic concept of isentropic flow through variable area ducts

CO2. Understand the variation of flow properties through constant area ducts with heat transfer and Friction

CO3. Understand the variation of flow parameters across the normal and oblique shocks

CO4. Understand the principle of different jet engine and numerical analysis of jet engine

CO5. Understand the principle of different rocket engine and numerical analysis of rocket engine

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									1
CO2	3	3	2									1
CO3	3	3	2									1
CO4	3	3				2	1					1
CO5	3	3				2	1					1

HOD/MECH

19ME6713	DESIGN OF HEAT EXCHANGER	L-T-P	C
		3-0-0	3

Programme: B.E. Mechanical Engineering

Objectives :
- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

Prerequisite: Heat and Mass Transfer, Design of Machine Elements

INTRODUCTION **9**

Types of heat exchangers, shell and tube heat exchangers – regenerators and recuperators – Temperature distribution and its implications – Parts description, Classification as per TubularExchanger Manufacturers Association (TEMA)

PROCESS DESIGN OF HEAT EXCHANGERS **9**

Heat transfer correlations, Overall heat transfer coefficient, analysis of heat exchangers – LMTD and effectiveness method. Sizing of finned tube heat exchangers, U tube heat exchangers, Design of shell and tube heat exchangers, fouling factors, pressure drop calculations.

STRESS ANALYSIS

Stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses – types offailures, buckling of tubes, flow induced vibration.

COMPACT AND PLATE HEAT EXCHANGER **9**

Types – Merits and Demerits – Design of compact heat exchangers, plate heat exchangers,performance influencing parameters, limitations

CONDENSERS AND COOLING TOWERS **9**

Design of surface and evaporative condensers – cooling tower – performance characteristics

Total Periods: 45

TEXT BOOKS:

1. Sadik Kakac and Hongtan Liu, “Heat Exchangers Selection”, Rating and Thermal Design, CRC Press, (2002)
2. Shah,R. K., Dušan P. Sekulic, “Fundamentals of heat exchanger design”, John Wiley & Sons, (2003)

REFERENCES:

1. Robert W. Serth, “Process heat transfer principles and applications”, Academic press, Elesevier, (2007)
2. Sarit Kumar Das, “Process heat transfer”, Alpha Science International, (2005)
3. John E. Hessel greaves, “Compact heat exchangers: selection, design, and operation”, Elsevier science Ltd, (2001)
4. Kuppan. T., “Heat exchanger design hand book”, New York: Marcel Dekker, (2000)
5. Eric M. Smith, “Advances in thermal design of heat exchangers: a numerical approach: directsizing, step-wise rating, and transients”, John Wiley & Sons, (1999)

WEB RESOURCE:

https://nptel.ac.in/courses/112105248/

COURSE OUTCOMES:

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

CO1. Understand the basics of heat exchangers
CO2. Apply the mathematical knowledge for thermal analysis
CO3. Apply the mathematical knowledge for stress analysis
CO4. Design the compact heat exchangers and plate heat exchangers
CO5. Design the surface and evaporative condensers and cooling tower

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	3	3	3	2								2
CO3	3	3	3	2								2
CO4	3	3	3	2								2
CO5	3	3	3	2								2

HOD/MECH

19ME6714	**RENEWABLE SOURCES OF ENERGY**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To identify the new methodologies /technologies for effective utilization of renewable energy sources
Prerequisite: Nil

INTRODUCTION **9**

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil Nadu, India and around the World – Potentials – Achievements / Applications – Economics of renewable energy systems.

SOLAR ENERGY **9**

Solar Radiation – Measurements of Solar Radiation – Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation – Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

WIND ENERGY **9**

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects

BIO - ENERGY **9**

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration – Biomass Applications

OTHER RENEWABLE ENERGY SOURCES **9**

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage – Fuel Cell Systems – Hybrid Systems

Total Periods: 45

TEXT BOOKS:

1. Rai G.D., “Non-Conventional Energy Sources”, Khanna Publisher, New Delhi, (2011)
2. Twidell, J.W. & Weir A, “ Renewable Energy Sources”, EFN Spon Ltd. UK, (2006)

REFERENCES:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., (2012)
2. Chetan Singh Solanki, Solar Photovoltaics, “Fundamentals, Technologies and Applications”, PHI Learning Private Limited, New Delhi, (2015)
3. David M. Mousdale “Introduction to Biofuels”, CRC Press, Taylor & Francis Group, USA (2017)
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Narosa Publishing House, New Delhi, (2002)
5. Freris L.L., “Wind Energy Conversion systems”, Prentice Hall, UK, (2002)

WEB RESOURCE:

https://nptel.ac.in/courses/121106014/

COURSE OUTCOMES:

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

CO1. Define the renewable energy scenario all over the world
CO2. Explain the basics of solar energy and its applications
CO3. Apply the principles of energy estimation in wind energy
CO4. Explain about biogas digesters and cogeneration plant
CO5. Compare different renewable energy sources and construct a hybrid system

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	3	2				3
CO2						3	3	2				3
CO3						3	3	2				3
CO4						3	3	2				3
CO5						3	3	2				3

HOD/MECH

19ME6715	**PRINCIPLES OF MANAGEMENT**	**L-T-P**	**C**
		3-0-0	**3**

Programme : B.E. Mechanical Engineering

Objective: To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization

Prerequisite : Nil

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS **9**

Definition of Management – Science or Art – Manager Vs Entrepreneur - Types of managers – Managerial roles and skills – Evolution of Management: Scientific, Human Relations, System, Contingency and Information Technology approaches – Types of Business organization: Sole proprietorship, Partnership, Company, Public and Private sector Enterprises - Organization culture and Environment – Current trends and issues in Management

PLANNING **9**

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Planning – Planning Tools and Techniques – Decision making: steps and process.

ORGANIZING **9**

Nature and purpose – Formal and informal Organization – Organization chart – Organization structure: Types – Line and Staff Authority – Departmentalization – Delegation of authority – Centralization and Decentralization – Job Design – Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and Management.

DIRECTING **9**

Foundations of individual and group behaviour – Motivation: theories &Techniques – Job satisfaction – Job enrichment – Leadership:Types &Theories – Communication: Process, Types &Barriers – Effective communication – Communication and IT.

CONTROLLING **9**

System and process of controlling – Budgets, Budgetary and Non-Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – Reporting.

Total Periods: 45

TEXT BOOKS:

1. Stephen P. Robbins & Mary Coulter, “Management”, Prentice Hall (India) Pvt. Ltd., 10th Edition, (2009)
2. JAF Stoner, Freeman R.E and Daniel R. Gilbert “Management”, 6th Edition, Pearson Education, (2004)

REFERENCES:

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, “Fundamentals of Management”, 7th Edition, Pearson Education, (2012)
2. Robert Kreitner & Mamata Mohapatra, “Management”, Biztantra, (2008)
3. Harold Koontz & Heinz Weihrich, “Essentials of Management”, Tata McGraw Hill, (2006)
4. Tripathy PC & Reddy PN, “Principles of Management”, Tata McGraw Hill, (2010)

WEB RESOURCE:

https://nptel.ac.in/courses/122108038/

COURSE OUTCOMES:

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

CO1. Define management and choose required organization culture
CO2. Outline the planning process and strategic management in decision making
CO3. Plan the human resource according to the organization purpose
CO4. Make use of motivational theories for human job satisfaction
CO5. Analyze productivity management using budgetary and non – budgetary techniques

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2		3				3
CO2						2		3				3
CO3						2	1	3				3
CO4						2	1	3				3
CO5						2	1	3				3

HOD/MECH

PROFESSIONAL ELECTIVES

SEMESTER VII

19ME7701	**DESIGN OF PRESSURE VESSELS & PIPING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To apply the Mathematical knowledge gained in the design of pressure vessels and piping
- To carry out the stress analysis in pressure vessels and piping

Prerequisite: Engineering Mechanics, Strength of Materials

INTRODUCTION **9**

Methods for determining stresses – Terminology and Ligament Efficiency – Applications

STRESSES IN PRESSURE VESSELS **9**

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels

DESIGN OF VESSELS **9**

Design of Tall cylindrical 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 – Pressure Vessel Design.

BUCKLING AND FRACTURE ANALYSIS IN VESSELS **9**

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

PIPING **9**

Introduction – Flow diagram – piping layout and piping stress Analysis – Introduction to pipe stress analysis software CAESAR II

Total Periods: 45

TEXT BOOK:

1. John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publishers and Distributors, (1987)

REFERENCES:

1. Henry H. Bedner, “Pressure Vessels, Design Hand Book”, CBS publishers and Distributors, (1987)
2. Stanley, M. Wales, “Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering”, (1988)
3. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, (1997)
4. Sam Kannapan, “Introduction to Pipe Stress Analysis”, John Wiley and Sons, (1985)

WEB RESOURCE:

https://nptel.ac.in/courses/112/105/112105124/

COURSE OUTCOMES:

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

CO1. Apply the terminology for the design of pressure vessels
CO2. Apply the mathematical fundamentals for the design of pressure vessels
CO3. design the pressure vessels and determination of stress concentration
CO4. Analyse the stresses in the pressure vessels
CO5. Apply the mathematical fundamentals for the design of pipes and design the piping.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2		1				1		2	2	2
CO2	2	2		1				1		2	2	2
CO3	2	2	2	1				1		2	2	2
CO4	2	2		1				1		2	2	2
CO5	2	2	2	1				1		2	2	2

HOD/MECH

19ME7702	**DESIGN AND ANALYSIS OF EXPERIMENTS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To impart a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.
Prerequisite: Statistics and Numerical Methods

INTRODUCTION **9**
Basic principles, guidelines for designing experiments, Basic statistical concepts, inferences about the differences in mean, randomized, paired comparison designs, Analysis of variances.

RANDOMIZED BLOCKS, LATIN SQUARES AND RELATED DESIGNS **9**
Completely randomized, Latin square, Graceo-Latin square and crossover designs.

FACTORIAL DESIGN **9**
Advantages of factorial design, description, calculation of direct and interaction effects. 2k factorial designs. Blocking and confounding -principle and use of confounded designs.

FRACTIONAL FACTORIAL DESIGN **9**
Two, three and mixed level fractional factorial designs - applications.

RESPONSE SURFACE DESIGN **9**
Fitting regression model. Response surfaces- first and second order designs.

Total Periods: 45

TEXT BOOKS:
1. C.F.Jeff Wu & Michael Hamada, "Experiments-Panning, Analysis, and Parameter Design Optimization", 2nd Edition, John Wiley & Sons. Inc. (2009)
2. D.C.Montgomery, "Design and Analysis of Experiments", 7th Edition, John Wiley & Sons. Inc. (2013)
3. R.L.Mason, R.F.Gunst & J.L.Hess, "Statistical Design and Analysis of Experiments with Applications to Engineering and Science", 2nd Edition, John Wiley & Sons. Inc. (2003)

REFERENCES:
1. T.B. Barker, "Quality by Experimental Design", 3rd Edition, CRC Press, ISBN 0-8247-2309-0, (2005)
2. Geoffrey Gordon, "System Simulation", 2nd Edition (revised), PHI, (2011)
3. Clewer, A.G. and D.H. Scarisbrick "Practical Statistics and Experimental Design for Plant and Crop Science" John Wiley and Sons, LTD. New York, (2001)
4. Morris,T.R. "Experimental Design and Analysis in Animal Sciences", CABI Publishing, New York (1999)

WEB RESOURCE:
https://nptel.ac.in/courses/110/105/110105087/

COURSE OUTCOMES:

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

CO1. Demonstrate the fundamental concepts applied with mathematical knowledge, methodologies to bring knowledge of characterize, analyze and solve a wide range of problems between the purpose of a model and the appropriate level of complexity and accuracy.

CO2. Plan, design and conduct experimental investigations efficiently and effectively; choose an appropriate experiment to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.

CO3. Analyze the nature of variable, statistical inference, influence parameter selection, factorial concepts, Conduct Design of experiments; interpret the direct and interaction effects by using RSM.

CO4. Analyze and apply the knowledge of DOE project practice with software like Matlab, ANOVA, and SYSTAT.

CO5. Analysis and application of RMS technique under various optimum operation conditions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	3	3	3	2		2						3
CO 2	3	3	3	3		2				2		3
CO 3	3	3	3	3		2				2		3
CO 4	3	3	3	3		2				2		3
CO 5	3	3	3	3		2				2		3

HOD/MECH

19ME7703	**REVERSE ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective:
- Understand the basic engineering systems, terminologies related to re-engineering, forward engineering, and reverse engineering.
- Disassemble products and specify the interactions between its subsystems, theirfunctionality and understanding engineering systems.
- Understand Reverse engineering of Systems.
- Understand tools and techniques of Reverse engineering systems.
- Understand legal aspects and copyright law to adopt reverse engineering

Prerequisite:
- Material Science
- Engineering Metallurgy
- Metrology & measurements
- Manufacturing processes.

Introduction to Reverse Engineering and Methodologies **9**

Introduction-Reverse Engineering – The Generic Process - Forward Engineering Design - Design Thought and Process - Design Steps - System Reverse Engineering – Reverse Engineering Methodology – Reverse Engineering Steps - System level Design - Examples.

Product Development and Mechanical Reverse Engineering **9**

Product Development - Product Functions - Engineering Specifications - Product Architecture – Mechanical Reverse Engineering - dissection - function analysis - event analysis – system assemblage - product layout - case studies - energy meter - forming pump.

Tools and Techniques for Reverse Engineering **9**

Contact & non-contact methods - destructive methods - Point Capture Devices - Stereoscopic Imaging Systems - Internal Measurement Systems - X-ray Tomography - Post processing the Captured Data - Handling Data Points - Curve and Surface Creation

Reverse Engineering Hardware and Software **9**

Contact 3D Scanner- Coordinate measuring machines (CMMs)- reconstruction of CAD models from measured data- automating reverse engineering (RE) - Non-Contact 3D Scanners- - digital imaging and computer vision-computer-aided reverse engineering-Computed Tomography (CT)

Reverse Engineering in Automotive and Medical sectors **9**

Legal Aspects of Reverse Engineering: Copyright Law, Reverse Engineering, Recent Case Law Barriers to Adopting Reverse Engineering

Total Periods: **45**

References

1. Product Design: Techniques in Reverse Engineering and New Product Development by K.Otto and K. Wood Prentice Hall, 2001.
2. Reverse Engineering: An Industrial Perspective by Raja and Fernandes. Springer-Verlag 2008

3. RE as necessary phase by rapid product development by Sokovic and Kopac. Journal of Materials Processing Technology 2005

COURSE OUTCOMES:

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

CO1. Identify and explain the steps involved in reverse engineering of a given component.
CO2. Apply mechanical reverse engineering for product development
CO3. describe product development processing for reverse engineering
CO4. select and apply tools & techniques for reverse engineering
CO5. describe the methods and devices for reverse engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	1											
CO 2			3	2					2			
CO 3									2			
CO 4					3							
CO 5	1				2							

HOD/MECH

19ME7704	**FLEXIBLE MANUFACTURING SYSTEMS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective : To understand the concepts and applications of flexible manufacturing systems.
Prerequisite: Manufacturing Technology I and II, Unconventional Machining Process, Computer Integrated Manufacturing

PLANNING, SCHEDULING AND CONTROL OF FMS **9**

Introduction to FMS – development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility – single product, single batch, n – batch scheduling problem – knowledge based scheduling system

COMPUTER CONTROL AND SOFTWARE FOR FMS **9**

Introduction – composition of FMS – hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends.

FMS SIMULATION AND DATA BASE **9**

Application of simulation – model of FMS – simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database.

GROUP TECHNOLOGY AND JUSTIFICATION OF FMS **9**

Introduction – matrix formulation – mathematical programming formulation – graph formulation – knowledge based system for group technology – economic justification of FMS – application of possibility distributions in FMS systems justification.

APPLICATIONS OF FMS AND FACTORY OF THE FUTURE **9**

FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.

Total Periods: 45

TEXT BOOKS:

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt., New Delhi, (1996)
2. H K Shivanand, M M Benal, V Koti, "Flexible Manufacturing Systems", New Age International publishers (2006)
3. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., (1991)

REFERENCES:

1. Kalpakjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishsing Co., (1995)
2. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., (1994)
3. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: Recent development", Elsevier Science, (1995)
4. Taiichi Ohno, "Toyota Production System: Beyond large-scale Production", Productivity Press (India) Pvt. Ltd. (1992)

WEB RESOURCE:

https://nptel.ac.in/courses/110107116/

COURSE OUTCOMES:

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

CO1. Remember the principles of flexible manufacturing systems
CO2. Understand the concepts and applications of computers in flexible manufacturing systems
CO3. Apply the modern tools in database management of FMS
CO4. Analyze the performance of group technology in FMS
CO5. Evaluate the application of FMS and understand the future factory of FMS

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3											
CO3	3				3							
CO4	3											
CO5	3											3

HOD/MECH

19ME7705	**RAPID PROTOTYPING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To Introduce the concept of Prototyping, types and its application in manufacturing and product development
Prerequisite: Knowledge in CAD

INTRODUCTION **9**

Product definition – Engineering Design Process – Product Prototyping and its Impact – Prototype Design and Innovation – Impact on Cost, Quality and Time – Process requirements for Rapid Prototyping – Product Prototyping and Product Development – Prototyping – Virtual and Rapid Prototyping in Product Development

PRODUCT PROTOTYPING **9**

Need for Prototyping – Issues in Prototyping – Conducting Prototyping – Design Procedure – Prototype Planning and Management – Product and Prototype Cost Estimation – Fundamentals of Cost Concepts – Prototype Cost Estimation – Cost Complexities – Prototype Design Methods – Prototype Design tools – Morphological Analysis – Functional Efficiency Technique – Paper Prototyping – Selecting a Prototype – Learning from Nature

VIRTUAL PROTOTYPING, MATERIALS SELECTION & RAPID PROTOTYPING **9**

Using Commercial Software for Virtual Prototyping – Prototyping Materials – Material Selection Methods – Rapid Prototyping Overview – Rapid Prototyping Cycle – Rapid Prototyping Procedure – STL files – Converting STL File from Various CAD Files – Controlling Part Accuracy in STL Format – Slicing the STL File – Case Studies in Design for Assembly.

TYPES OF RAPID PROTOTYPING PROCESS **9**

Types of RP Process – Stereolithography – Fused Deposition Modeling – Selective Laser Sintering – 3D Printing Process – Poly Jet Process Laminated Object Manufacturing – Electron Beam Melting Process – History – Operation – Advantages and Disadvantages – Applications – Relation to Other RP Technologies – (applies to all the process) – Direct Laser Deposition.

APPLICATIONS OF RAPID PROTOTYPING **9**

Investment Casting – Sand Casting – Permanent Mould Casting – Direct RP Tooling – Silicone Rubber Tooling – Investment Cast Tooling – Powder Metallurgy Tooling – Desktop Machining – Case Studies on Current Applications of RP – Novel Application of RP Systems – Future Trends of RP Systems.

Total Periods: 45

TEXT BOOKS:

1. Chua C.K, Leong K.F, and Lim C.S., "Rapid Prototyping : Principles and Applications", World Scientific (2010)
2. Cooper, G.K, "Rapid Prototyping Technology Selection and Application", Marcel Dekker Inc, USA, (2001)
3. Liou W.F., "Rapid Prototyping and Engineering Applications: A toolbox for prototype development", CRC Press, Taylor & Francis Group LLC, USA, (2008)

REFERENCES:

1. Kai., C.C, Lim, C.S. and Leong, F.K., "Rapid Prototyping: Principles and Applications in Manufacturing", Wiley Publication, (2008)
2. Rafiq Noorani "Rapid Prototyping: Principles and Applications", (2006)
3. Wiley Julia A McDonald, Chris J Ryall, David I Wimpenny, "Rapid Prototyping case book", Wiley, (2001)

WEB RESOURCES:

- https://nptel.ac.in/courses/112/104/112104265/
- https://www.coursera.org/learn/3d-printing-applications

COURSE OUTCOMES:

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

CO1. Synthesis the right manufacturing technique for manufacture of protoypes.
CO2. Develop an understanding on various additive manufacturing techniques for manufacture of critical and complex geometry products.
CO3. Orient the input files and produce a product using the available rapid prototyping systems in cost effective way
CO4. Integrate and develop complex geometrical shapes with highest degree of accuracy and surface finish.
CO5. Develop knowledge on the novel application of RP Technologies for future projected product manufacturing.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1											
CO2	1	2									1	1
CO3			3		3					2	2	
CO4	1	1		3	2	1	2				1	2
CO5	1	3							2	1		2

HOD/MECH

19ME7706	**WELDING TECHNOLOGY**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives: The main learning objective of this course is to prepare the students for:

- Explaining the ferrous welding metallurgy and its applications.
- Explaining the welding metallurgy of alloy steels and nonferrous metals and its applications.
- Understanding the basics of welding and to know about the various types of welding processes
- Identifying the causes and remedies of various welding defects; applying welding standards and codes.
- Applying design consideration principles of assembly in the design of assembled products.

Prerequisite: Manufacturing Technology I

PHYSICAL METALLURGY OF WELDING **9**

Welding of ferrous materials: Iron-Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat – affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

WELDING OF ALLOY STEELS AND NON-FERROUS METALS **9**

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

WORKING PRINCIPLES OF WELDING PROCESSES **9**

Gas And Arc Welding Processes, Resistance Welding Processes, Solid State Welding Processes, Thermit Welding, Atomic Hydrogen Welding, Electron Beam Welding, Laser Beam Welding, Friction Stir Welding, Welding Automation in Aerospace, Nuclear.

DEFECTS, WELDABILITY AND STANDARDS **9**

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes

DESIGN CONSIDERATIONS OF WELDING **9**

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.

Total Periods: 45

TEXT BOOKS:

1. Baldev Raj, Shankar V, Bhaduri A K, "Welding Technology for Engineers", Narosa Publications, (2011)
2. R.S.Parmar, "Welding Engineering and Technology", Khanna Publishers, (2013)

REFERENCES:

1. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, "Manufacturing and Design: Understanding the Principles of How Things Are Made", Elsevier, (2014)
2. Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, (2008)
3. Nadkarni S.V. "Modern Arc Welding Technology", Oxford IBH Publishers, (2014)
4. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, (2013)

WEB RESOURCE:

https://nptel.ac.in/courses/112/107/112107090/

COURSE OUTCOMES:

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

CO1. Explain the ferrous welding metallurgy and its applications.
CO2. Explain the welding metallurgy of alloy steels and nonferrous metals and its applications.
CO3. Explain the construction and working principles of various welding processes.
CO4. Identify the causes and remedies of various welding defects; apply welding standards and codes.
CO5. Apply design consideration principles of welding in the design of welded products.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2							2	2	3	3	3
CO2	2		2					2	2	3	3	3
CO3	2				2			2	2	3	3	3
CO4	2	2	2	3			2	2	2	3	3	3
CO5	2	3	3	3			2	2	2	3	3	3

HOD/MECH

19ME7707	**INTRODUCTION TO NANO TECHNOLOGY**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: Make the students to understand about the nanomaterials, synthesis and its characterization.
Prerequisite: Nil

BASICS AND SCALE OF NANOTECHNOLOGY **9**

Introduction –Scientific revolutions –Time and length scale in structures –Definition of a nanosystem –Dimensionality and size dependent phenomena –Surface to volume ratio – Fraction of surface atoms –Surface energy and surface stress – surface defects – Properties at nanoscale (optical, mechanical, electronic and magnetic).

DIFFERENT CLASSES OF NANOMATERIALS **9**

Classification based on dimensionality – Quantum Dots, Wells and Wires – Carbon – based nano materials (buckyballs, nanotubes, graphene)–Metal based nano materials (nanogold, nanosilver and metal oxides) – Nanocomposites – Nanopolymers –Nanoglasses –Nano ceramics – Biological nanomaterials.

SYNTHESIS OF NANOMATERIALS **9**

Classification of synthesis: Top down and bottom up nanofabrication. Chemical Methods: Metal Nanocrystals by Reduction – Solvothermal Synthesis – Photochemical Synthesis – Sonochemical Routes – Chemical Vapor Deposition (CVD) –Metal Oxide – Chemical Vapor Deposition (MOCVD).Physical Methods:Ball Milling –Electro deposition – Spray Pyrolysis – Flame Pyrolysis – DC/RF Magnetron Sputtering – Molecular Beam Epitaxy (MBE)

FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES **9**

Nanofabrication: Photolithography and its limitation – Electron-beam lithography (EBL) – Nanoimprint –Softlithography patterning. Characterization:Field Emission Scanning Electron Microscopy (FESEM) –Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) –Scanning Tunneling Microscope (STM) – Surface enhanced Raman spectroscopy (SERS) – X-ray Photoelectron Spectroscopy (XPS) – Auger electron spectroscopy (AES) –Rutherford backscattering spectroscopy (RBS).

APPLICATIONS **9**

Solar energy conversion and catalysis – Molecular electronics and printed electronics – Nanoelectronics – Polymers with aspecial architecture – Liquid crystalline systems – Linear and nonlinear optical and electro-optical properties, Applicationsin displays and other devices – Nanomaterials for data storage – Photonics, Plasmonics – Chemical and biosensors – Nanomedicine and Nanobiotechnology –Nanotoxicology challenges.

Total Periods: 45

TEXT BOOKS:

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, (2007)
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, (2002)
3. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., (2012)

REFERENCES:

1. Charles P. Poole Jr., Frank J. Ownes, 'Introduction to Nanotechnology", Wiley Interscience, (2003)
2. Dupas C., Houdy P., Lahmani M., "Nanoscience: Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, (2007)
3. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, (2003)
4. Nabok A., "Organic and Inorganic Nanostructures", Artech House, (2005)

WEB RESOURCE:

https://nptel.ac.in/courses/118/104/118104008/

COURSE OUTCOMES:

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

CO1. Understand the basics in nano sciences and scales using in this technology.
CO2. Explain what are all the materials and composites of materials including for the nanotechnologies like metals, glasses, polymers
CO3. Clarify the various reactions in chemical methods to synthesis the nanomaterials
CO4. Explain the making of nanostructures and fabricating methodologies
CO5. Summarize the applications of nanotechnologies in various field and platforms

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1							1			2		1
CO2										2		2
CO3				1						1		2
CO4										2		2
CO5										2		2

HOD/MECH

19ME7708	**COMPUTATIONAL FLUID DYNAMICS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To introduce numerical modelling and its role in the field of fluid flow and heat transfer and to enable the students to understand the various discretization methods, solution procedures and turbulence modelling.

Prerequisite: Fluid Mechanics and Machinery, Finite Element Analysis

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS **9**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD – Elliptic, Parabolic and Hyperbolic equations.

FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION **9**

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

FINITE VOLUME METHOD FOR CONVECTION DIFFUSION **9**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

FLOW FIELD ANALYSIS **9**

Finite volume methods – 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 – PISO Algorithms.

TURBULENCE MODELS AND MESH GENERATION **9**

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

Total Periods: 45

TEXT BOOKS:

1. Ghoshdastidar, P.S., “Computer Simulation of flow and heat transfer”, Tata McGraw Hill Publishing Company Ltd., (2017)
2. Versteeg, H.K., and Malalasekera, W., “An Introduction to Computational Fluid Dynamics: The finite volume Method”, Pearson Education Ltd. Second Edition, (2007)

REFERENCES:

1. Anil W. Date “Introduction to Computational Fluid Dynamics”, Cambridge University Press, (2005)
2. Chung, T.J. “Computational Fluid Dynamics”, Cambridge University, Press, (2002)
3. Ghoshdastidar P.S., “Heat Transfer”, Oxford University Press, (2005)
4. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, (2014)

5. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, (2004)

WEB RESOURCE:

https://nptel.ac.in/courses/112/105/112105045/

COURSE OUTCOMES:

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

CO1. Derive the governing equations and boundary conditions for Fluid dynamics
CO2. Analyze Finite difference and Finite volume methods for Diffusion
CO3. Analyze Finite volume method for Convective diffusion
CO4. Analyze Flow field problems
CO5. Explain and solve the Turbulence models and Mesh generation techniques

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2										
CO2				3	1							
CO3	2	2	2	2	1							
CO4				2	2							
CO5	3	2	1									

HOD/MECH

19ME7709	**AUTOMOBILE ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the construction and working principle of various parts of an automobile
- To have the practice for assembling and dismantling of engine parts and transmission system

Prerequisite: Thermal Engineering, Internal Combustion Engines

VEHICLE STRUCTURE AND ENGINES **9**

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components – functions and materials, variable valve timing (VVT).

ENGINE AUXILIARY SYSTEMS **9**

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

TRANSMISSION SYSTEMS **9**

Clutch– types and construction, gear boxes– manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

STEERING, BRAKES AND SUSPENSION SYSTEMS **9**

Steering geometry and types of steering gear box– Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

ALTERNATIVE ENERGY SOURCES **9**

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles– Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels – Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

Total Periods: 45

TEXT BOOKS:

1. Jain K.K. and Asthana R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, (2002)
2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13thEdition (2014)

REFERENCES:

1. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, (2012)
2. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, (1998)
3. Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, (1999)

4. Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA , (1978)
5. Newton ,Steeds and Garet, "Motor Vehicles", Butterworth Publishers, (1989)

WEB RESOURCE:

https://nptel.ac.in/courses/107/106/107106088/

COURSE OUTCOMES:

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

CO1. Recognize the various parts of the automobile and their functions and materials
CO2. Discuss the engine auxiliary systems and engine emission control
CO3. Distinguish the working of different types of transmission systems
CO4. Explain the Steering, Brakes and Suspension Systems
CO5. Predict possible alternate sources of energy for IC Engines

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	1	1	1			1					1
CO2	3	1	1	1			1					1
CO3	3	1	1	1			1					1
CO4	3	1	1	1			1					1
CO5	3	1	1	1			1					1

HOD/MECH

19ME7710 ENERGY CONSERVATION AND WASTE HEAT RECOVERY L-T-P C
3-0-0 3

Programme: B.E. Mechanical Engineering
Objective: To impart knowledge on the various methods of Energy Conservation, Energy policies and Waste heat recovery from thermal systems.
Prerequisite: Thermal Engineering, Heat and Mass Transfer

INTRODUCTION 9

Energy Scenario – world and India. Energy Resources availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries – an overview. Energy conservation and energy efficiency – needs and advantages, Energy strategy for the future, Energy Conservation Act.

ENERGY POLICIES 9

National energy policy in the last plan periods, Energy use and Energy supply, Overview of renewable energy policy and the Five Year Plan programmes, Basic concept of Input – Output analysis, Concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy – Carbon Trading – Renewable Energy Certification – CDM

WASTE HEAT RECOVERY IN THERMAL UTILITIES AND SYSTEMS 9

Election criteria for waste heat recovery technologies – recuperators – Regenerators – Economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems, identifying opportunities for energy savings – steam systems, Cogeneration and HVAC systems.

ENERGY CONSERVATION AND AUDITING 9

Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution. Energy auditing – types, methodologies, barriers. Energy audit instruments; Duties and responsibilities of energy managers and auditors – Energy audit questionnaire.

UNIT V ENERGY MANAGEMENT 9

Organizational background desired for energy management persuasion, motivation, publicity role, industrial energy management systems. Energy monitoring and targeting – Elements, data, information analysis and techniques – Energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS). Economics of various energy conservation schemes – Energy policy and energy labeling

Total Periods: 45

TEXT BOOKS:

1. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press
2. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press

REFERENCES:

1. Steve Doty, Wayne C. Turner "Energy Management Handbook", 7th Edition, the Fairmont Press, Inc., (2013)
2. F Kreith, D.Y.Goswami, "Energy management and conservation handbook", CRC Press, (2017)

3. "Industrial Energy Conservation Manuals", MIT Press, Mass, (2007)
4. YP Abbi and Shashank Jain. "Handbook on Energy Audit and Environment Management", TERI Publications, (2006)
5. R Loulou, P R Shukla and A Kanudia, "Energy and Environment Policies for a sustainable Future", Allied Publishers Limited, New Delhi, (1997)
6. Guide book for "National Certification Examination for Energy Managers and Energy Auditors" (Could be downloaded from www.energymanagertraining.com)

WEB RESOURCES:

- www.classcentral.com
- https://nptel.ac.in/courses

COURSE OUTCOMES:

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

CO1. Realize the present energy scenario and the need for energy conservation and various energy conservation measures.
CO2. Familiarize with various energy policies (National and International) & standards.
CO3. Comprehend the concepts of waste heat recovery system and perform energy analysis.
CO4. Conduct energy audit and optimize energy requirements.
CO5. Recognize the economics of energy conservation schemes in industrial energy management systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1								1	1			2
CO2								1	1			2
CO3					2		2		1			2
CO4								1	1			2
CO5								1	1			2

HOD/MECH

19ME7711	**TURBO MACHINERY**	**L-T-P**	**C**
		2-2-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To understand the various systems, principles, operations and applications of different types of turbo machinery components.
Prerequisite: Fluid Mechanics and Machinery, Thermal Engineering

PRINCIPLES **9**

Definition of turbo machines, parts of a turbo machine, comparison with positive displacement machine, classification, dimensionless parameters and their physical significance, Euler's turbine equation, components of energy transfer

COMPRESSORS, FANS AND BLOWERS **9**

Axial flow compressor - classification, expression for pressure ratio developed per stage - work done factor. Centrifugal compressor - classification, expression for overall pressure ratio, blade angles, slip factor, diffuser, surging

Fans Types- stage and design parameters-flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise.

AXIAL AND CENTRIFUGAL PUMPS **9**

Axial flow pumps: expression for degree of reaction; velocity triangles for different values of degree of reaction. Centrifugal pumps: definition - manometric head, suction head, delivery head, pressure rise, efficiency, slip, priming, cavitations, and NPSH.

STEAM TURBINES **9**

Classification - single stage impulse turbine, condition for maximum blade efficiency, stage efficiency. Compounding - need for compounding, method of compounding. Impulse staging - maximum utilization factor for multistage turbine with equiangular blades, effect of blades and nozzle losses. Reaction turbine maximum blade efficiency.

HYDRAULIC TURBINES **9**

Classification - Pelton, Francis and Kaplan turbines - velocity triangles, design parameters – work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of turbines.

Total Periods: 45

TEXT BOOKS:

1. Yahya, S.H., “Turbines, Compressor and Fans”, Tata McGraw Hill Publishing Company, (2005)
2. Seppo A. Korpela, “Principles of Turbo Machinery”, John Wiley & Sons, (2011)
3. Venkanna B.K., “Fundamentals of Turbo Machinery”, PHI Learning, (2009)
4. Dixon D.L., “Turbo Machinery”, Pergamaon Press, (2007)
5. Earl Logan, “Handbook of Turbo Machinery”, CRC Press, (2003)
6. Lewis R.I., “Turbo Machinery - Performance Analysis”, Elsevier Science & Technology Books, (1996)

REFERENCES:

1. Stepanoff A.J., "Turbo Blowers", John Wiley and Sons, 1970.
2. Brunoeck, "Fans", Pergamon Press, 1973.
3. Austin H. Church, "Centrifugal Pumps and Blowers", John Wiley and Sons, 1980.

WEB RESOURCE

https://nptel.ac.in/courses/101/101/101101058/

COURSE OUTCOMES:

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

CO1 Explain the working principle of turbo machines with suitable energy equations
CO2 Create fluid-dynamic design of a turbo machine for the required practical situations
CO3 Compare the performance of different turbo machines
CO4 Construct the inlet and outlet velocity triangles of turbo machines
CO5 Plot and interpret the performance curves of turbo machines

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1			3	2								
CO2			3	2								
CO3			3	2								
CO4			3	2								
CO5			3	2								

HOD/MECH

19ME7712	**ADVANCED THERMODYNAMICS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To enhance the understanding of thermodynamics principles and their relevance to the problems of humankind; provide the student with experience in applying thermodynamic principles to predict physical phenomena and to solve engineering problems.

Prerequisite: Engineering Thermodynamics

REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES **9**

Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Entropy generation, Irreversibility – Gay Stodal equation.

IDEAL AND REAL GASES **9**

Equation of state, Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius, Clapeyro equation. Throttling, Joule. Thompson coefficient. Non-reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixtures.

COMBUSTION **9**

Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat of reaction, Adiabatic flame temperature, Enthalpies, Equilibrium. Chemical equilibrium of ideal gas, The Vant Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

POWER CYCLES **9**

Review binary vapour cycle, co-generation and combined cycles, Second law analysts of cycles. Refrigeration cycles. Thermodynamics of irreversible processes. Introduction Phenomenological laws, Onsaga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

DIRECT ENERGY CONVERSION INTRODUCTION **9**

Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.

Total Periods: 45

TEXT BOOK:

1. Holman. J.P. "Thermodynamics", 4th edition, McGraw Hill, (2011)

REFERENCES:

1. Sonnatag & Van Wylen. "Fundamentals of Thermodynamics", John Wiley & Sons, (1997)
2. P.K. Nag, "Basic and Applied Thermodynamics", Tata McGraw-Hill Publishing Co. Ltd. (2010)
3. Yonus A Cengel and Michale A Boles, "Thermodynamics: An Engineering Approach", McGraw Hill (2002)
4. A. Bejan, "Advanced Engineering Thermodynamics", John Wiley & Sons. (2006)

WEB RESOURCE:

https://nptel.ac.in/courses/103/103/103103162/

COURSE OUTCOMES:

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

CO1. Understanding of Thermodynamic Laws and Corollaries
CO2. concept and behaviour of Ideal and Real gases
CO3. Gaining knowledge of Combustion Reactions
CO4. Attainment of principles of power cycles, laws and relations
CO5. Getting hold of knowledge about direct energy conversion

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	1	1								1
CO2	3	3	1	1								1
CO3	3	3	1	1								1
CO4	3	3	1	1								1
CO5	3	3	1	1								1

HOD/MECH

19ME7713 **FUEL CELL TECHNOLOGY** **L-T-P C**
3-0-0 3

Programme: B.E. Mechanical Engineering

Objective:
- To enable students to describe the performance characteristics of fuel cell power plant and its components.
- To outline the performance, design characteristics and operating issues for various fuel cells.
- To impart sufficient knowledge to students about the working of fuel cell industry or R&D organization.

Prerequisite: Nil

INTRODUCTION TO FUEL CELLS **9**

Introduction – working and types of fuel cell – low, medium and high temperature fuel cell,liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells– thermodynamics and electrochemical kinetics of fuel cells.

FUEL CELLS FOR AUTOMOTIVE APPLICATIONS **9**

Fuel cells for automotive applications – technology advances in fuel cell vehicle systems –onboard hydrogen storage – liquid hydrogen and compressed hydrogen – metal hydrides, fuelcell control system – alkaline fuel cell – road map to market.

FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE **9**

Fuel cell performance characteristics – current/voltage, voltage efficiency and power density,ohmic resistance, kinetic performance, mass transfer effects – membrane electrode assemblycomponents, fuel cell stack, bi-polar plate, humidifiers and cooling plates.

FUELING **9**

Hydrogen storage technology – pressure cylinders, liquid hydrogen, metal hydrides, carbonfibers – reformer technology – steam reforming, partial oxidation, auto thermal reforming – COremoval, fuel cell technology based on removal like bio-mass.

FUEL CYCLE ANALYSIS **9**

Introduction to fuel cycle analysis – application to fuel cell and other competing technologieslike battery powered vehicles, SI engine fuelled by natural gas and hydrogen and hybrid electricvehicle.

Total Periods: 45

TEXT BOOK:

1. Andrew L. Dicks and David A. J. Rand, “Fuel Cell Explained”, John Wiley & Sons. Inc., (2018)
2. Revankar shrip, “Fuel Cells: Principles, Design and Analysis”, Auerbach publications, (2014)

REFERENCES:

1. Dushyant Shekhawat, “Fuel Cells:Technologies for fuel processing”, North Holland Publishing Co., (2011)
2. Ohayre, “Fuel Cell Fundamentals”, John Wiley & Sons Inc., (2016)
3. F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, (2013)
4. Kevin Huang, “Solid Oxide Fuel Cell Technology: Principles, Performance and Operations”, Woodhead Publishing Ltd., (2009)

WEB RESOURCES:

- https://nptel.ac.in/courses/121/106/121106014/
- https://nptel.ac.in/courses/103/102/103102015/

COURSE OUTCOMES:

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

CO1. Describe the fundamentals of fuel cell
CO2. Deduce the performance of fuel cell systems
CO3. Demonstrate the construction and operation of fuel cell stack and fuel cell system
CO4. Illustrate the modelling techniques for fuel cell systems
CO5. Interpret the different methods of fuel processing for fuel cells

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		2	3						3	3	3	2
CO2	2	3			3				3	3	3	3
CO3		2	2								3	3
CO4		2	3								3	3
CO5	2		3						3	3	3	3

HOD/MECH

19ME7714	**MAINTENANCE ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
- To explain the different maintenance categories like Preventive maintenance condition monitoring and repair of machine elements.
- To illustrate some of the simple instruments used for condition monitoring in industry.

Prerequisite: Manufacturing Technology I & II, Unconventional machining processes, Metrology and measurements.

PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING **9**

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability –Maintenance organization – Maintenance economics.

MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE **9**

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repairs cycle - Principles and methods of lubrication – TPM.

CONDITION MONITORING **9**

Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

REPAIR METHODS FOR BASIC MACHINE ELEMENTS **10**

Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location

REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT **8**

Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.

Total Periods: 45

TEXT BOOKS:

1. Srivastava S.K., "Industrial Maintenance Management", S. Chand and Co., (1981)
2. Venkataraman .K "Maintancence Engineering and Management", PHI Learning, Pvt. Ltd., (2007)

REFERENCES:

1. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand and Co., (1995)
2. White E.N., "Maintenance Planning", I Documentation, Gower Press, (1979)
3. Garg M.R., "Industrial Maintenance", S. Chand & Co., (1986)
4. Higgins L.R., "Maintenance Engineering Hand book", 5th Edition, McGraw Hill, (1988)
5. Armstrong, "Condition Monitoring", BSIRSA, (1988)
6. Davies, "Handbook of Condition Monitoring", Chapman & Hall, (1996)

7. "Advances in Plant Engineering and Management", Seminar Proceedings -IIPE, (1996)

WEB RESOURCE:

https://nptel.ac.in/courses/112/107/112107143/

COURSE OUTCOMES:

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

CO1. Aware of the industrial maintenance.
CO2. Find knowledge in maintenance engineering approaches can be found employed in almost all fields of industries.
CO3. Know the different maintenance categories like Preventive maintenance condition monitoring and repair of machine elements.
CO4. Get knowledge about the simple instruments used for condition monitoring in industry.
CO5. Understand the safety norms and concepts of industries.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2		2	2	2			2	2	2	
CO2	3	2		2	2	2			2	2	2	
CO3	3	2		2	2	2			2	2	2	
CO4	3	2		2	2	2			2	2	2	
CO5	3	2		2	2	2			2	2	2	

HOD/MECH

19ME7715 **TOTAL QUALITY MANAGEMENT** **L-T-P C**
3-0-0 3

Programme:
B.E. Mechanical Engineering

Objectives:
- To learn concepts, dimension quality and philosophies of TQM
- To study the TQM principles and its strategies
- To learn the seven tools of statistical quality and management
- To impart knowledge on TQM tools for continuous improvement
- To introduce international quality management systems

Prerequisite:
Nil

INTRODUCTION **9**
Definition of Quality – Dimensions of Quality – Quality Planning – Quality costs – AnalysisTechniques for Quality Costs – Basic concepts of Total Quality Management – Historical Review – Quality Statements – Strategic Planning, Deming Philosophy – Crosby philosophy – ContinuousProcess Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen – Obstacles to TQM Implementation

TQM PRINCIPLES **9**
Principles of TQM, Leadership Concepts, Role of Senior Management, Quality Council, Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, CustomerRetention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward,
Performance Appraisal, Benefits – Supplier Partnership – Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures

STATISTICAL PROCESS CONTROL (SPC) **9**
The seven tools of quality – Statistical Fundamentals – Measures of central Tendency and Dispersion,Population and Sample, Normal Curve, Control Charts for variables X bar and R chart and attributesP, nP, C, and u charts, Industrial Examples, Process capability, Concept of six sigma – New sevenManagement tools

TQM TOOLS **9**
Benchmarking, Quality Function Deployment (QFD) – House of Quality, QFD Process, and Benefits – Taguchi Quality Loss Function – Total Productive Maintenance (TPM), FMEA – Stages of FMEA,Case studies

QUALITY SYSTEMS **9**
Need for ISO 9000 and Other Quality Systems – Elements, Implementation of Quality System,Documentation, Quality Auditing, ISO 9000:2015, ISO 9001:2015 and ISO 9004:2018, TS 16949, ISO 14000, ISO 50001 – Concept, Requirements and Benefits

Total Periods:45

TEXT BOOKS:
1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, (2013)

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, (2012)
2. N.Gupta and B.Valarmathi, "Total Quality Management", Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, (2009)
3. Dr.S.Kumar, "Total Quality Management", Laxmi Publications Ltd. New Delhi, (2006)
4. P.N.Muherjee, "Total Quality Management", Prentice Hall of India, New Delhi, (2006)

WEB RESOURCES:

- https://nptel.ac.in/courses/110/104/110104080/
- https://nptel.ac.in/courses/110/104/110104085/

COURSE OUTCOMES:

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

CO1. Use the concepts, dimension of quality and philosophies of TQM
CO2. Apply the principles of TQM and its strategies in industries
CO3. Apply the statistical quality tools and seven management tools
CO4. Choose the suitable TQM tools for continuous improvement
CO5. Use the concept of QMS, EMS and EnMS in industries

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1					2		3				
CO2						2		3			2	
CO3	2	3	1		2							
CO4	1	2	2									
CO5						1	2	2				

HOD/MECH

19ME7716	**PROCESS PLANNING AND COST ESTIMATION**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To give an understanding of the fundamentals of Process Planning and estimation of appropriate costs of processes and products and applying these to manage competitive manufacturing systems and organisations.

Prerequisite: Manufacturing Technology – I, Manufacturing Technology – II

PROCESS PLANNING **9**

Defining process planning Aims and Objectives –Computer Aided Process Planning – Retrieval / Variance CAPP and Generative CAPP –Drawing interpretation –Material selection process and methods –Factors to be considered in selecting: Processes; Process Sequencing; Operation Sequencing; Equipment & Tool Selection; Case Study in Process Planning.

FUNDAMENTAL OF ESTIMATING AND ELEMENTS OF COST **9**

Concept and Purpose of Estimating, Functions of Estimating Department, Concept of Costing, Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Elements of Cost – Introduction, Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost).

OVERHEADS AND DEPRECIATION **9**

Overheads , Allocation or Distribution of Overhead Cost , Depreciation and Methods to Calculate it, Interest on Capital, Idleness Costs, Repair and Maintenance Cost

ESTIMATION OF CASTING, FORGING & WELDING COSTS **9**

Estimation of cost for Casting processes, Welding processes and Forging processes.

ESTIMATION OF MACHINING TIME AND COST **9**

Estimation of Machining Time and Cost – Lathe operations, Drilling, Milling, Shaping, Planning, and Grinding operations

Total Periods: 45

TEXT BOOKS:

1. Adithan, M, Process Planning and Cost Estimation, New Age International Publishers, (2007)
2. Peter Scallan, Process planning, The Design/Manufacture Interface, Butterworth Heinemann, (2003)

REFERENCES:

1. Chitale A. K., and Gupta R. C., "Product Design and manufacturing", Prentice Hall of India, New Delhi, (1997)
2. Gideon Halevi, "Process and operation planning", Kluwer academic publishers (Printed ebook), (2003)
3. Narang G.B.S. & Kumar .V, "Production and Costing", Khanna Publishers, (2000)
4. Phillip F. Ostwald & Jairo Munoz, "Manufacturing Processes And Systems", 9th Edition, Wiley student edition, (2002)
5. Robert Creese, Adithan M. &Pabla B. S., "Estimating and Costing for the Metal Manufacturing Industries", Marcel Dekker, (1992)

WEB RESOURCE:

www.ebookampubd.org/process planning and cost estimation

COURSE OUTCOMES:

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

CO1. Create a Process Plan for a given Product.
CO2. Prepare Cost elements for a given Product.
CO3. Allocate Overhead to different departments.
CO4. Estimate cost for the Casting, Welding and Forging products.
CO5. Analyze the costs for machining a product.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	2							1	1
CO2	3	3	2	2							1	1
CO3	3	3	2	2							1	1
CO4	3	3	2	2							1	1
CO5	3	3	2	2							1	1

HOD/MECH

19ME7717	INDUSTRIAL ROBOTICS	L-T-P	C
		3-0-0	3

Programme: B.E. Mechanical Engineering

Objectives:

- Explaining the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Reviewing the need and application of robots in different engineering fields.
- Exemplifying the different types of robot drive systems as well as robot end effectors.
- Applying the different sensors and image processing techniques in robotics to improve the ability of robots.
- Developing robotic programs for different tasks and analysing the kinematics motions of robot.
- Implementing robots in various industrial sectors and interpolating the economic analysis of robots.

Prerequisite: Hydraulic and Pneumatics

FUNDAMENTALS OF ROBOT **9**

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope Types and Classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their Functions – Need for Robots – Different Applications.

ROBOT DRIVE SYSTEMS AND END EFFECTORS **9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C.Servo Motors, Stepper Motors, A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives, End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic – Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

SENSORS AND MACHINE VISION **9**

Requirements of a sensor, Principles and Applications of the following types of sensors – Position sensors – Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis – Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications, Inspection, Identification, Visual Serving and Navigation.

ROBOT KINEMATICS AND ROBOT PROGRAMMING **9**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces – Manipulator Dynamics, Trajectory Generator, Expert system, Manipulator Mechanism Design – Derivations and problems. Lead through Programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End Effector commands and simple Programs.

IMPLEMENTATION AND ROBOT ECONOMICS **9**

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations – Economic Analysis of Robots.

Total Periods: 45

TEXT BOOKS:

1. Fu. K.S, Gonzalez. R.C, Lee. C.S.G "Robotics – Control, Sensing, Vision, and Intelligence", McGraw Hill, (2015)
2. Groover Mikell P, "Industrial Robotics -Technology Programming and Applications", McGraw Hill, (2014)

REFERENCES:

1. Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, (2017)
2. Deb S.R., "Robotics Technology and Flexible Automation" Tata McGraw Hill Book Co., (2013)
3. Maja J Mataric, "The Robotics Primer "Universities Press. (2013)
4. Robin R. Murphy "Introduction to AI Robotics" PHI Learning Private Limited, (2004)

WEB RESOURCE:

https://nptel.ac.in/courses/112/101/112101098/

COURSE OUTCOMES:

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

CO1. Explain the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Review the need and application of robots in different engineering fields
CO2. Exemplify the different types of robot drive systems as well as robot end effectors
CO3. Apply the different sensors and image processing techniques in robotics to improve the ability of robots
CO4. Develop robotic programs for different tasks and analyze the kinematics motions of robot
CO5. Implement robots in various industrial sectors and interpolate the economic analysis of robots

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2			2	2		2	2	3	3	3
CO2	3	2						2	2	3	3	3
CO3	3	2			2			2	2	3	3	3
CO4	3	2			2	2		2	2	3	3	3
CO5	3	2				2	2	2	2	3	3	3

HOD/MECH

19ME7718	**INDUSTRIAL SAFETY ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To impart knowledge on safety engineering fundamentals and safety management practices.
Prerequisite: Nil

INTRODUCTION **9**

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

CHEMICAL HAZARDS **9**

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation – Industrial Hygiene – Industrial Toxicology.

ENVIRONMENTAL CONTROL **9**

Industrial Health Hazards – Environmental Control – Industrial Noise – Noise measuring instruments, Control of Noise, Vibration – Personal Protection.

HAZARD ANALYSIS **9**

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

SAFETY REGULATIONS **9**

Explosions – Disaster management – catastrophe control, hazard control, Factories Act, Safety regulations Product safety – case studies.

Total Periods: 45

TEXT BOOKS:

1. John V.Grimaldi, "Safety Management", AITB S Publishers, (2003)
2. L M Deshmukh, "Industrial Safety Management", McGraw Hill, (2005)

REFERENCES:

1. David L.Goetsch, "Occupational Safety and Health for Technologists", Engineers and Managers, Pearson Education Ltd. 5th Edition, (2005)
2. Harold E. Roland, Brian Moriarty, "System Safety Engineering and Management", 2nd Edition, Wiley, (1990)
3. Naseer Elahi, "Industrial Safety Management", Kalpaz Publications, (2007)
4. Safety Manual, "EDEL Engineering Consultancy", (2000)

WEB RESOURCE:

https://nptel.ac.in/courses/110/105/110105094/

COURSE OUTCOMES:

At the end of the course, the students will be able to CO1.
Understand modern safety concepts and hazards CO2.
Analyse chemical exposure and industrial toxicology CO3.
Apply environmental control and personal protection
CO4. Calculate system safety analysis and risk assessment techniques
CO5. Understand disaster management, regulations and case studies

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1			2		2	1	1	1			1
CO2	1		1	3	3	3	2	1	2			1
CO3	1		2	3	2	3	3	2	2	2	1	1
CO4	2	3	2	3	3	2	2	1	3	3	2	2
CO5				3	1	3	2	2	1	2		2

HOD/MECH

19ME7719	**RESOURCE MENAGEMENT TECHNIQUES**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective:
- Be familiar with resource management techniques.
- Learn to solve problems in linear programming and Integer programming.
- Be exposed to CPM and PERT.

Prerequisite: Nil

LINEAR PROGRAMMING **9**

Principal components of decision problem – Modeling phases – LP Formulation and graphic solution – Resource allocation problems – Simplex method – Sensitivity analysis.

DUALITY AND NETWORKS **9**

Definition of dual problem – Primal – Dual relationships – Dual simplex methods – Post optimality analysis – Transportation and assignment model – Shortest route problem.

INTEGER PROGRAMMING **9**

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming

CLASSICAL OPTIMISATION THEORY **9**

Unconstrained external problems, Newton – Ralphson method – Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

OBJECT SCHEDULING **9**

Network diagram representation – Critical path method – Time charts and resource leveling – PERT

Total Periods: 45

TEXT BOOK:

1. H.A.Taha,"OperationResearch",PrenticeHallofIndia,(2002)

REFERENCES:

1. Paneer Selvam, "Operations Research", Prentice Hall of India, (2002)
2. Anderson "Quantitative Methods for Business", 8th Edition, Thomson Learning, (2002)
3. Winston "Operation Research", Thomson Learning, (2003)
4. Vohra, "Quantitative Techniques in Management", Tata Mc Graw Hill, (2002)
5. Anand Sarma, "Operation Research", Himalaya Publishing House, (2003)

WEB RESOURCES:

- https://nptel.ac.in/courses/112/106/112106134/
- https://learnengineering.in/cs6704-resource-management-techniques/

COURSE OUTCOMES:

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

CO1. Solve optimization problems using simplex method
CO2. Demonstrate the concept of duality to solve Shortest route problem
CO3. Explain integer programming method
CO4. Demonstrate the types of constraints and optimization methods
CO5. Utilize PERT and CPM in project management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1			3	3								
CO2			3	3	1							
CO3			3	2								
CO4			3	3	3							
CO5			3	3	1							

HOD/MECH

PROFESSIONAL ELECTIVES

SEMESTER VIII

19ME8701	FAILURE ANALYSIS AND DESIGN	L-T-P	C
		3-0-0	3

Programme: B.E. Mechanical Engineering

Objectives:
- To impart knowledge about various modes of failure which leads to safe design.
- To learn about large variety of fracture mechanisms and fracture modes associated with failure.
- To provide fundamental knowledge of corrosion and environmentally-assisted cracking.

Prerequisite: Strength of materials, Design of Machine Elements

MATERIALS AND DESIGN PROCESS **9**

Factors affecting the behavior of materials in components, effect of component geometry and shape factors, design for static strength, stiffness, designing with high strength and low toughness materials, material selection process, introduction to stress, two dimensional and three dimensional state of stress, Mohr's circle two and three dimensions, hydrostatic stress, von-Mises, maximum shear stress (Tresca), octahedral shear stress.

FRACTURE MECHANICS **9**

Ductile fracture, brittle fracture, cleavage – fractography, ductile to brittle transition, factors affecting ductile to brittle transition, fracture mechanics approach to design – energy criterion, stress intensity approach, time dependent crack growth and damage – Linear Elastic Fracture Mechanics: Griffith theory, energy release rate, Instability and R-curve, stress analysis of cracks-stress intensity factor, Crack growth instability analysis.

FATIGUE **9**

Statistical nature of fatigue, signal-noise curve, low cycle fatigue, strain life equations, structural feature of fatigue, fatigue crack propagation, effect of stress concentration, size, surface properties, metallurgical variables on fatigue, case studies, designing against fatigue, detail design, improvements after failure and service, fatigue of bolts, welded and adhesive joints. Fatigue Tests – Purpose, specimen, fatigue test procedures, evaluation of fatigue test results, crack growth measurement. Creep, stress rupture, elevated temperature fatigue, super plasticity.

CORROSION AND WEAR FAILURES **9**

Types of corrosion, Factors influencing corrosion failures, analysis of corrosion failures, stress corrosion cracking – sources, characteristics of stress corrosion cracking, procedure of analysing stress corrosion cracking, various types of hydrogen damage failures, corrective and preventive action. Types of wear, lubricated and non – lubricated wear, wear on different materials, different methods of wear measurement. Role of friction on wear, analysis of wear failures, wear tests – ferrography.

FAILURE ANALYSIS TOOLS **9**

Reliability concept and hazard function, application of Poisson, exponential and Weibull distribution for reliability, bathtub curve, parallel and series system, failure mode effect analysis – definition – Design, types, process, industrial case studies / Projects.

Total Periods: 45

TEXT BOOKS:

1. T.L.Anderson, "Fracture Mechanics: Fundamentals and Applications", CRC Press, (2005)
2. F.Michael and Ashby, "Material Selection in Mechanical Design", Butterworth Heinemann, (2004)

REFERENCES:

1. ASM Metals Handbook, "Failure Analysis and Prevention", ASM Metals Park, Ohio, USA, Vol.10, (2002)
2. J.E.Shigley and Mische, "Mechanical Engineering Design", McGraw Hill, (2000)
3. Yiannis Papadopoulos, "Engineering failure analysis and design optimization with HiPHOPS" Engineering Failure Analysis, Volume 18, Issue 2, pp 590–608, (2011)
4. F.Rui, Martins, "Failure analysis of bilge keels and its design improvement", Engineering Failure Analysis, Volume 27, pp 232–249, January (2013)

WEB RESOURCE:

http://nptel.ac.in/courses/112101005/28

COURSE OUTCOMES:

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

CO1. Understand the various modes of failure and material behaviour in fracture loading
CO2. Demonstrate the various parameters in fracture mechanisms
CO3. Understand and apply the various factors and applications of fatigue and creep
CO4. Demonstrate corrosion and wear failures.
CO5. Implement of failure analysis principles in innovative applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3								3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

HOD/MECH

19ME8702	**PRECISION MACHINE DESIGN**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To impart knowledge in the increasing quality concepts of parts, accuracy requirement of machine tools
- To understand the concept of precision machine design, its principles and importance as applicable to instruments and machines.

Prerequisite: Design of Machine elements, Metrology and Measurements

CONCEPTS OF ACCURACY AND MACHINE TOOLS **9**

Part Accuracy – errors, accuracy of machine tools – spindle accuracy – displacement accuracy – errors due to numerical interpolation – definition of accuracy of N.C. system – errors in the NC machines – feed stiffness – zero stability.

SYSTEM DESIGN CONSIDERATIONS **9**

Introduction – Manufacturing considerations – Materials – Structural design – Joint design – support systems – kinematic coupling design

BEARINGS WITH MECHANICAL CONTACT BETWEEN ELEMENTS **9**

Sliding Contact Bearings – Rolling Element Bearings – Rolling Element Rotary Motion Bearings – Rolling Element Linear Motion Bearings – Flexural Bearings – Design to Limit Thermal Effects on Bearing Performance – Hydrostatic bearings – Aerostatic bearings – Magnetic bearings

DIMENSIONING & CLAMPING ERRORS **9**

Definition of terms – key dimension – superfluous dimension – dimensional stepped shaft – assigning tolerances in the constituent dimensions – dimensional chains – Clamping errors – location of blank, prism, long and short cylinder, tapered hole – datum for measurement

STIFFNESS, THERMAL EFFECTS AND FINISH MACHINING **9**

Overall stiffness of lathe – compliance of work piece – errors caused by cutting forces – errors due to compliance in machining – deformation in turning – boring – milling – heat sources – thermal effects – heat sources – heat dissipation – geometry of thermal deformations – methods of decreasing thermal effects – finish turning, boring, grinding – surface roughness, influence of machining parameters and roughness.

Total Periods: 45

TEXT BOOKS:

1. Alexander H.Slocum, “Precision Machine Design”, Society of Manufacturing Engineers, (1992)
2. Stuart T.Smith., “Ultra-Precision Mechanism Design”, Tailor and Francis Books Ltd, (1994)

REFERENCES:

1. Murthy R.L., “Precision Engineering in Manufacturing”, New Age International Pvt, (2005)
2. Venkatesh, V.C. and Sudin, I., “Precision engineering”, Tata McGraw Hill Co, (2007)
3. James, D. and Meadow, S., “Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc., (1995)
4. Juliar W.Gardner and Vijay K. Varadan, “Micro Sensors, MEMS and Smart Devices”, 1st Edition, John Wiley and Sons, (2001)

WEB RESOURCE:

https://nptel.ac.in/courses/112/104/112104028/

COURSE OUTCOMES:

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

CO1. Gain knowledge on elements of precision Machine design.
CO2. Apply the concepts of design to structural components, joints and couplings.
CO3. Apply the concepts of design to different types of bearings.
CO4. Apply the concepts of design to stepped shafts, keys and chains.
CO5. Understand the use of quality concepts parts, accuracy requirements of machine tools

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2		1		2				2	2	2
CO2	2	2	2	1		2				2	2	2
CO3	2	2	2	1		2				2	2	2
CO4	2	2	2	1		2				2	2	2
CO5	2	2		1		2				2	2	2

HOD/MECH

19ME8703	INDUSTRIAL TRIBOLOGY	L-T-P	C
		3-0-0	3

Programme: B.E. Mechanical Engineering
Objective: To introduce and expose students to the field and fundamentals in tribology and its applications.
Prerequisite: Engineering Mechanics, Kinematics of Machinery, Design of Machine elements.

SURFACES AND FRICTION **9**

Topography of Engineering surfaces – Contact between surfaces – Sources of sliding 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.

WEAR **9**

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.

LUBRICANTS AND LUBRICATION TYPES **9**

Types and properties of Lubricants – Testing methods – Hydrodynamic Lubrication – Elasto hydrodynamic lubrication – Boundary Lubrication – Solid Lubrication Hydrostatic Lubrication.

FILM LUBRICATION THEORY **9**

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 – The Somerfield diagram.

SURFACE ENGINEERING AND MATERIALS FOR BEARINGS **9**

Surface modifications – Transformation Hardening, surface fusion – Thermo chemical processes – Surface coatings – Plating and anodizing – Fusion Processes – Vapour Phase processes – Materials for rolling Element bearings – Materials for fluid film bearings – Materials for marginally lubricated and dry bearings.

Total Periods: 45

TEXT BOOK:

1. A. Harnoy. “Bearing Design in Machinery”, Marcel Dekker Inc, New York, (2003)

REFERENCES:

1. Cameron, “Basic Lubrication theory”, Longman, U.K.., (1981)
2. E.P.Bowden and Tabor.D., “Friction and Lubrication”, Heinemann Educational Books Ltd., (1974)
3. M.M.Khonsari and E.R.Booser, “Applied Tribology”, John Willey & Sons, New York, (2001)
4. M.J.Neale (Editor), “Tribology Handbook”, Newnes Butter worth, Heinemann, U.K., (1995)

WEB RESOURCE:

https://nptel.ac.in/courses/112/102/112102014/

COURSE OUTCOMES:

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

CO1. Design according to different types of friction.
CO2. Understand various wearing mechanisms and measurements.
CO3. Understand the properties and testing methods of various lubricants.
CO4. Calculate shear stress, torque and co efficient of friction.
CO5. Understand surface process and bearing materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2	3	2	1							1
CO2	2	1										1
CO3	2	2	2	3								1
CO4	2	3	2		2							1
CO5	2											1

HOD/MECH

19ME8704	**NON DESTRUCTIVE TESTING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To impart knowledge on various Non-destructive Testing and its applications
Prerequisite: Engineering Materials, Mechanical Testing of Materials

SURFACE TECHNIQUES **9**

Introduction and Scope of NDT, Discontinuities and Defects in various manufactured Components, Various physical characteristics of materials and their applications in NDT, Relative merits and limitations of NDT, Types of NDT techniques, Visual or Optical Testing – Direct and remote visual inspection and Aides. Liquid Penetrant Testing (LPT) Principles – Types and properties of liquid penetrants and developers – Preparation of test materials – Advantages and limitations – Application of penetrants to parts – Fluorescent penetrant test

SUB SURFACE TESTING TECHNIQUES **9**

Magnetic Particle Testing (MPT) – Principles, applications, magnetization methods, magnetic particles – Dry particle technique and Wet fluorescent particle technique – Advantages and Limitations. Eddy Current Inspection – Principle, Methods, Equipment for ECT, Techniques, Sensitivity, Application, scope and limitations

ULTRASONIC TESTING **9**

Ultrasonic Testing (UT) – Principle, Types and characteristics of Ultrasonic waves – Attenuation, Couplants, Probes – Inspection methods – Pulse echo, Transmission and Phased Array techniques (PAUT), Types of scanning and displays – Angle beam inspection of welds – Calibration of ASTM Test blocks, International Institute of Welding (IIW) reference blocks – Applications

RADIOGRAPHY TESTING **9**

Radiographic testing (RT) – Principle, Sources of X-rays and Gamma rays and their characteristics – Absorption, scattering, Filters and screens, imaging modalities – Film radiography and Digital Radiography – Problems in shadow formation, Exposure factors, film handling and storage – Inverse square law, Exposure charts, and Radiographic equivalence, Penetrometers – Safety in radiography – Applications

SPECIAL NDT TECHNIQUES **9**

Acoustic Emission Testing (AET) Principle – Instrumentation and applications, advantages and limitations. Infra-Red Thermography (IRT) – Principle, Techniques and applications. Leak Testing – Principle, Testing Procedure and applications. LASER Stereography – Typical applications – Requirements – advantages and disadvantages.

Total Periods: 45

TEXT BOOKS:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd edition New Jersey, (2005)

REFERENCES:

1. Charles J. Hellier, "Handbook of Nondestructive Evaluation", McGraw-Hill Education; 2nd edition (2012)

2. Baldev Raj, Jayakumar T, Thavasimuthu M, "Practical Non-Destructive Testing", Narosa Publishing, (2009)
3. Mc Gonnagle W T, "Non-Destructive Testing", McGraw Hill Book Co., (1988)
4. Louis Cartz, "Non-Destructive Testing", ASM International, Metals Park Ohio, US, 1995
5. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, (2010)

WEB RESOURCES:

- https://nptel.ac.in/courses/113/106/113106070/
- https://nptel.ac.in/courses/112/107/112107259/

COURSE OUTCOMES:

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

CO1. Select appropriate surface inspection techniques for the components to be inspected
CO2. Explain the non-destructive testing method to identify the sub surface defects in materials
CO3. Select and explain the suitable testing method for testing internal defects
CO4. Apply radiography testing methods for different suitable applications
CO5. Choose the suitable special non-destructive technique for various applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	2	2	2			1					
CO2	1	2	2	2			1					
CO3	1	2	2	2			1					
CO4	1	2	2	2			1					
CO5	1	3	3	2			1					

HOD/MECH

19ME8705	**PRECISION MANUFACTURING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To express the need, significance and progress of precision manufacturing and the different levels of manufacturing
- To study the principle and working of different methods of precision machining
- To Select a suitable measurement solution

Prerequisite: Nil

PRECISION ENGINEERING **9**

Introduction to Precision Engineering, Need for precision manufacturing, Taniguchi diagram, Four Classes of Achievable Machining Accuracy – Normal, Precision, High-precision, Ultra-precision Processes and Nanotechnology.

PRECISION MACHINING **9**

Overview of Micro- and Nano-machining, Conventional micro machining techniques - micro-turning, micro-milling, micro-grinding, Ultra-precision diamond turning, Non-conventional micromachining techniques – abrasive jet and water jet micromachining, Ultrasonic micromachining, micro electrical discharge machining, photochemical machining, electro chemical micromachining, laser beam micromachining, Electron beam micromachining, Focused Ion Beam micromachining, etc.

MACHINE DESIGN FOR PRECISION MANUFACTURING **9**

Philosophy of precision machine design, Ultra-Precision Machine Elements: Guide- ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Bearings: Principle, construction and application of Rolling, Hydrodynamic and Hydrostatic Bearings, Aerostatic Bearings, Magnetic bearings.

MECHANICAL AND THERMAL ERRORS **9**

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors – background, thermal effects, Environmental control of precision machinery. Error mapping and error budgets.

MEASUREMENT AND CHARACTERISATION **9**

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus-Based Optical Metrology- Fringe projection method, Measurement of Typical Nanofeatures. Surface metrology – 3D surface topography – Need, Measurement – Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography.

Total Periods: 45

TEXT BOOKS:

1. Jain, V.K., “Introduction to micromachining”, Narosa publishers, (2018)
2. Venktesh V.C., SudinIzman, “Precision Engineering”, Tata McGraw Hill Publishing Company, New Delhi (2007)

REFERENCES:

1. David Dornfeld, Dae-Eun Lee, "Precision Manufacturing", Springer, (2008)
2. Jain, V.K., "Micromanufacturing Processes", CRC Press, (2012)
3. Joseph McGeough, "Micromachining of Engineered Materials", Marcel Dekker Inc., (2002)
4. Kevin Harding, "Handbook of Optical Dimensional Metrology, Series: Series in Optics and optoelectronics", Taylor & Francis, (2013)
5. Murty, R.L., "Precision Engineering in Manufacturing", New Age publishers, (2005)

WEB RESOURCE:

https://nptel.ac.in/courses/112/105/112105231/

COURSE OUTCOMES:

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

CO1. Explaining the need, significance and progress of precision manufacturing and the different levels of manufacturing.
CO2. Explaining the principle and working of different methods of precision machining.
CO3. Explaining the special construction requirements of precision machine tools.
CO4. Explaining the errors involved in precision machine tools and calculate the error budgets for a given situation.
CO5. Selecting a suitable measurement solution to measure and characterize precision machined features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2							
CO2	2	2	2	2	2							
CO3	2	2	2	2	2							
CO4	2	2	2	2	2							
CO5	2	2	2	2	2							

HOD/MECH

19ME8706	**FUNDAMENTALS OF COMBUSTION**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To make the student understand the fundamentals of combustion and to educate the different modes of combustion, flames and fuel burning characteristics.

Prerequisite: Engineering Chemistry, Engineering Thermodynamics

THERMODYNAMICS OF COMBUSTION **9**

Combustion Thermodynamics – stoichiometry – Thermo-chemical equations – Heat of formation – Activation energy – Multi-step reactions – Heat of reaction – first order, second order and third order reactions – Calculation of adiabatic flame temperature – Second law analysis for reacting flow – Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow

PREMIXED COMBUSTION **9**

Premixed Flame: One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame

NON PREMIXED COMBUSTION **9**

Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion

COMBUSTION IN GAS TURBINE ENGINES **9**

Combustion in gas turbine combustion chambers – Recirculation – combustion efficiency, Factors affecting combustion efficiency – Fuels used for gas turbine combustion chambers – combustion stability – Flame holder types

EMISSION CONTROL TECHNOLOGIES **9**

Chemical Emission from combustion, Quantification of emission, Emission control methods – Clean combustion technologies – Simulation on premixed, non-premixed combustion with emission levels

Total Periods: 45

TEXT BOOKS:

1. S.R. Turns “An Introduction to Combustion Concepts and Applications”, McGraw Hill, (2012)
2. Kenneth Kuo “Principles of Combustion”, John Wiley, (2005)
3. Irvin Glassman “Combustion”, Academic Press, (2015)
4. J.M. Beer and N.A. Chigier “Combustion Aerodynamics”, Applied Science Publishers Ltd. (1972)

REFERENCES:

1. F.A.Williams “Combustion Theory”, ABP, CRC press, (2018)
2. H.S.Mukunda “Understanding Combustion”, Macmillan India, (2007)
3. C. K. Law “Combustion Physics”, Cambridge University Press, (2010)
4. Mathur M.L. and Sharma R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition (2014)
5. Sutton G.P., “Rocket Propulsion Elements”, John Wiley, (1993)

WEB RESOURCES

- https://nptel.ac.in/courses/101/104/101104070/
- https://nptel.ac.in/courses/101/104/101104072/

COURSE OUTCOMES:

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

CO1. Apply the principles of physics, chemistry and thermodynamics to combustion
CO2. Acquire the knowledge on laminar and turbulent premixed combustion and its characteristics
CO3. Gain understanding on combustion and its characteristics of gaseous, liquid and solid fuel
CO4. Assimilate knowledge about combustion processes and strategies adapted in gas turbines
CO5. Identify novel combustion technologies that mitigate combustion driven emission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		3			3	3	3					
CO2		3			3	3	3					
CO3		3			3	3	3					
CO4		3			3	3	3					
CO5		3			3	3	3					

HOD/MECH

19ME8707	**NUCLEAR ENGINEERING**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes

Prerequisite: Engineering Physics

NUCLEAR PHYSICS **9**

Nuclear model of an atom – Equivalence of mass and energy – binding – radio activity – half life – neutron interactions – cross sections

NUCLEAR REACTIONS AND REACTION MATERIALS **9**

Mechanism of nuclear fission and fusion – radio activity – chain reactions – critical mass and composition – nuclear fuel cycles and its characteristics – uranium production and purification – Zirconium, thorium, beryllium.

REPROCESSING **9**

Reprocessing: nuclear fuel cycles – spent fuel characteristics – role of solvent extraction in Reprocessing-solvent extraction equipment.

NUCLEAR REACTOR **9**

Nuclear reactors: types of fast breeding reactors – design and construction of fast breeding reactors – heat transfer techniques in nuclear reactors – reactor shielding – Fusion reactors.

SAFETY AND DISPOSAL **9**

Safety and disposal: Nuclear plant safety – safety systems – changes and consequences of accident – criteria for safety – nuclear waste – types of waste and its disposal – radiation hazards and their prevention – weapons proliferation

Total Periods: 45

TEXT BOOKS:

1. Dan Gabriel Cacuci, "Handbook of Nuclear Engineering", Volume-I, Springer, (2010)
2. Thomas J. Cannoly, "Fundamentals of Nuclear Engineering", John Wiley publication, (1978)
3. Ian Hore-Lacy, Stephen Tarlton, Brigita Praznik and Raf Damiaens, "Nuclear Energy in the 21st Century: World Nuclear University Primer", Springer, (2012)

REFERENCES:

1. Dan Gabriel Cacuci, "Handbook of Nuclear Engineering", Volume-I, Springer, (2010)
2. Collier J.G., and Hewitt G.F, "Introduction to Nuclear power", Hemisphere publishing, New York, (1987)
3. Wakil M.M.El., "Power Plant Technology", McGraw-Hill International, (1984)
4. Martin, Harbison, Beach and Cole, "An Introduction to Radiation Protection 6E", Springer, (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/112101007/

COURSE OUTCOMES:

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

CO1 To understand the basic concepts of atoms, equivalence mass and energy

CO2 To recognize about the nuclear reactions and reaction materials

CO3 To know about the nuclear fuel cycle and its characteristics

CO4 To recognize about the functions of different nuclear reactor

CO5 To know about the safety and disposal methods of nuclear waste

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1	3					
CO2	3					1	3					
CO3	3					2	3					
CO4	3		3		1	2	3	2				1
CO5	3				1	2	3	2				1

HOD/MECH

19ME8708	CRYOGENICS	L-T-P	C
		3-0-0	3

Programme: B.E. Mechanical Engineering

Objectives:
- To learn about the cryogenic material properties and applications of cryogenics.
- To impart knowledge on Liquefaction cycles.
- To provide knowledge about gas separation and purification.
- To study the working of various cryo coolers.
- To learn about the construction of Dewar vessels and cryogenic instrumentation.

Prerequisite: Heat and Mass Transfer, Engineering Thermodynamics, Thermal engineering

INTRODUCTION TO CRYOGENICS **7**

Insight on cryogenics – properties of cryogenic fluids – material properties at cryogenic temperatures – Applications of cryogenics in space programs, superconductivity, cryo metallurgy, biological and medical applications

LIQUEFACTION CYCLES **9**

Basics of Refrigeration – Methods of production of low temperatures – Joule Thompson expansion – Inversion curve. Gas Liquefaction cycles – Carnot liquefaction cycle, Simple Linde Hampson cycle, Precooled Linde – Hampson cycle, Simple Claude cycle, Dual pressure Claude cycle – Figure of merit and yield of liquefaction cycle.

SEPARATION AND PURIFICATION SYSTEMS **11**

Basics of Gas separation – Ideal separation of gases, characteristics of mixtures and the governing laws – T-C and H-C diagrams. Principle of Rectification – Rectification column – Theoretical plate Calculations using McCabe – Thiele method, murphee efficiency. Gas purification.

CRYOGENIC REFRIGERATORS **9**

Cryocoolers – Fundamentals, classification, comparison and applications. Working of Stirling, Gifford – McMahon and Pulse tube cryocoolers

STORAGE AND INSTRUMENTATION **9**

Cryogenic Dewar vessels construction and design, cryogenic transfer Lines. Cryogenic insulation – vacuum, powder, multilayer, micro-sphere and foam-fibrous insulation – concept of vapour coated shields. Cryogenic instrumentation – temperature, flow and level measurements.

Total Periods: 45

TEXT BOOKS:

1. "Cryogenic Engineering", R.B. Scott Van Nostrand/Inc. New Jersey, (1959)
2. "Cryogenic Systems",Randall F. Barron, Randall Franklin Barron Oxford University Press, (1985)

REFERENCES:

1. Mamata Mukhopadhyay, "Fundamental of Cryogenic Engineering", PHI learning Private Limited, New Delhi, (2014)
2. Thomas M. Flynn, "Cryogenics Engineering", Marcel Dekker, New york, (2005)
3. G.G. Haselden, Cryogenics Fundamentals, Academic Press Inc., London, (1999)
4. K.D. Timmerhaus and T.M. Flynn, Cryogenics Process Engineering, Plenum Press, New York, (1989)
5. Randall F. Barron, "Cryogenic System", 2nd edition, Oxford University Press, New York, (1985)

WEB RESOURCE:

https://nptel.ac.in/courses/112/101/112101004/

COURSE OUTCOMES:

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

CO1. Explain the effect of material properties at cryogenic temperatures and applications of cryogens.
CO2. Compute the figure of merit and yield of various liquefaction cycles.
CO3. Assess the performance of rectification column for gas separation.
CO4. Compare the Stirling, Gifford-McMahon and Pulse tube cry coolers based on power consumption, pressure ratio and Coefficient of Performance.
CO5. Explain the construction of Dewar vessels and cryogenic instrumentation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2					1	1					2
CO2	2					1	1					2
CO3	2					1	1					2
CO4	2					1	1					2
CO5	2					1	1					2

HOD/MECH

19ME8709 SOLAR CELL - FUNDAMENTALS AND MATERIALS L-T-P C
3-0-0 3

Programme: B.E. Mechanical Engineering
Objective: To give an understanding of the fundamentals of solar cells and semiconductor properties of different types of solar cells and gaining knowledge about various advanced solar sell technologies available currently and emerging in future.
Prerequisite: Nil

EVULAUTION OF SOLAR CELLS **9**
Historical development; present and future global issues – commercialization/economic factors – basic components of PV systems. The solar spectrum – terrestrial and space spectra; air mass (AM0, AM1.5) – Introduction to 1st, 2ndand 3rdgeneration photovoltaics.

SOLAR CELL FUNDAMENTALS **9**
Photovoltaic effect – Principle of direct solar energy conversion into electricity in a solar cell – light absorption– creating charge carriers forming the electric field – driving the charge carriers – solar cell parameters– electrical characteristics – the ideal solar cell, solar cell in practice, the quantum efficiency and spectral response, optical properties – basics of solar cell device design.

SEMICONDUCTOR PROPERTIES **9**
Overview of semiconductor properties relevant to solar cell operations– semiconductor band structure, carrier statistics in semiconductors, the transport equations, carrier mobility, carrier generation by optical absorption– band to band transitions, free-carrier absorption, recombination– bulk recombination processes, surface recombination, minority carrier life time.

SILICON AND THIN FILM SOLAR CELLS **9**
Si photovoltaics– single crystal silicon cells – semicrystalline and polycrystalline silicon cells – overview of various thin film solar cells:gallium arsenide solar cells – fabrication techniques, InP & cadmium telluride based solar cells – copper indium diselenide solar cells – multijunction cells – environmental and health aspects.

ADVANCED SOLAR CELLS **9**
Advanced solar cell concepts – organic (polymer) photovoltaics – new concepts – quantum dots, wires, intermediate band, multiple exciton generation – Dye sensitized solar cells – perovskite solar cells – challenges in materials and device design – current and future research trends in PV

Total Periods: 45

TEXT BOOKS:
1. Fonash S. J., “Solar Cell Device Physics”, Academic, (2010)
2. Goetzberger, J. Knobloch, and B. “Voss Crystalline Silicon Solar Cells”, Wiley, (1998)
3. Green M. A. “Third Generation Photovoltaics: Advanced Solar Energy Conversion” Springer, (2006)

REFERENCES:
1. Chetan Singh Solanki., “Solar Photovoltaic: Fundamentals, Technologies and Application”, PHI Learning Pvt., Ltd., (2009)
2. Jha A.R., “Solar Cell Technology and Applications”, CRC Press, (2010)

WEB RESOURCE:

https://nptel.ac.in/courses/115/107/115107116/

COURSE OUTCOMES:

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

CO1. Demonstrate the knowledge about photovoltaics.
CO2. Gain knowledge about principle of operation of solar cells Allocate Overhead to different departments.
CO3. Realization about semiconducting materials used in the manufacture of PV cells
CO4. Demonstrate the knowledge of various thin film solar cells
CO5. Outline the various advanced solar cell technologies, their current status and future technological challenges

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	2			3					3
CO2	3	3	2	2			3					3
CO3	3	3	2	2			3					3
CO4	3	3	2	2			3					3
CO5	3		2	2			3					3

HOD/MECH

19ME8710	**INDUSTRIAL ENGINEERING & MANAGEMENT**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To provide student with knowledge and skill sets required in the industrial management and engineering profession
- To impart in the students, the ability to adopt a system approach to design, develop, implement and innovate integrated systems
- To enable the students to understand the interactions between engineering, society and environment.

Prerequisite: Nil

INTRODUCTION **9**

Industrial Engineering – definition, history, primitive activities – Applications in manufacturing and service sectors – functions of an Industrial Engineer Management approaches – FW Taylors scientific approach – Modern approach – Systems approach

FUNCTIONS OF MANAGEMENT **9**

Management functions – Roles of manager – Management and administration – Vision, mission and objectives of an organisation – management by Objectives

PLANT LAYOUT **9**

Factors governing plant location, types of production layouts, advantages and disadvantages of process and product layouts, applications, quantitative techniques for optimal layout design, Introduction to software for plant layout design

RESOURCE MANAGEMENT **9**

Concept of human resource management, personnel management and industrial relations, functions of personal management – Job evaluation, its importance and types, merit rating, quantitative methods, MTM, wage incentive plan, types

DECISION MAKING AND PROJECT MANGEMENT **9**

Types of decisions – theories of decision making – steps involved in decision making – Quantitative methods in decision making PERT, CPM – differences and applications, critical path, determination of floats, project crashing, smoothing – simple numerical

Total Periods: 45

TEXT BOOKS:

1. Martand Telsang, "Industrial Engineering and Management", S. Chand & Compagny Limited, (2006)
2. O.P Khanna, "Industrial Engineering and Management", Khanna publishers, (1985)
3. M I Khan, "Industrial Engineering", New age international (P) publishers ltd. (2004)

REFERENCES:

1. Philip E. Hicks, Anthony Lal, "Introduction to industrial engineering and management science", McGraw Hill, (1977)
2. G,Nadha muni Reddy, "Industrial Engineering and Management", New age international (P) publishers ltd., (2002)
3. V. Ravi, "Industrial Engineering and Management", PHI Learning Pvt Ltd., (2015)

WEB RESOURCE:

https://nptel.ac.in/courses/112/107/112107142/

COURSE OUTCOMES:

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

CO1. Recall the basics of industrial engineering and its applications in production and service sector

CO2. Infer the vision and mission of an organization and role of manager

CO3. Construct optimal layout design using software

CO4. Examine the human resource required for an organization

CO5. Defend the decision made during project management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2		3		2		3
CO2						2		3		2		3
CO3					3	2	1	3				3
CO4						2	1	3		2		3
CO5						2	1	3			3	3

HOD/MECH

19ME8711	**LEAN SIX SIGMA**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To gain insights about the importance of lean manufacturing and six sigma practices
Prerequisite: Manufacturing Engineering, Probability and Statistics

LEAN & SIX SIGMA BACKGROUND AND FUNDAMENTALS **9**

Historical Overview – Definition of quality – What is six sigma – TQM and Six sigma – lean manufacturing and six sigma – six sigma and process tolerance – Six sigma and cultural changes – six sigma capability – six sigma need assessments – implications of quality levels, Cost of Poor Quality (COPQ), Cost of Doing Nothing – assessment questions

THE SCOPE OF TOOLS AND TECHNIQUES **9**

Tools for definition – IPO diagram, SIPOC diagram, Flow diagram, CTQ Tree, Project Charter – Tools for measurement – Check sheets, Histograms, Run Charts, Scatter Diagrams, Cause and effect diagram, Pareto charts, Control charts, Flow process charts, Process Capability Measurement, Tools for analysis – Process Mapping, Regression analysis, RU/CS analysis, SWOT, PESTLE, Five Whys, interrelationship diagram, overall equipment effectiveness, TRIZ innovative problem solving – Tools for improvement – Affinity diagram, Normal group technique, SMED, 5S, mistake proofing, Value stream Mapping, forced field analysis – Tools for control – Gantt chart, Activity network diagram, Radar chart, PDCA cycle, Milestone tracker diagram, Earned value management.

SIX SIGMA METHODOLOGIES **9**

Design For Six Sigma (DFSS), Design For Six Sigma Method – Failure Mode Effect Analysis (FMEA), FMEA process – Risk Priority Number (RPN) – Six Sigma and Leadership, committed leadership – Change Acceleration Process (CAP) – Developing communication plan – Stakeholder.

SIX SIGMA IMPLEMENTATION AND CHALLENGES **9**

Tools for implementation – Supplier Input Process Output Customer (SIPOC) – Quality Function Deployment or House of Quality (QFD) – alternative approach –implementation – leadership training, close communication system, project selection – project management and team – champion training – customer quality index – challenges – program failure, CPQ vs six sigma, structure the deployment of six sigma – cultural challenge – customer/internal metrics.

EVALUATION AND CONTINUOUS IMPROVEMENT METHODS **9**

Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen

Total Periods: 45

TEXT BOOKS:

1. Michael L.George, David Rownalds, Bill Kastle, “What is Lean Six Sigma”, McGraw–Hill (2003)
2. Dennis P.Hobbs, “LEAN Manufacturing Implementation”, APICS, (2009)

REFERENCES:

1. Thomas Pyzdek, "The Six Sigma Handbook", McGraw-Hill, (2000)
2. Fred Soleimannejed , "Six Sigma, Basic Steps and Implementation", Author House, (2004)
3. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, "Managing Six Sigma:A Practical"Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, (2000)
4. James P. Womack, Daniel T.Jones, "Lean Thinking", Free Press Business, (2003)

WEB RESOURCE:

https://nptel.ac.in/courses/112/104/112104188/

COURSE OUTCOMES:

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

CO1. Understand the importance ofLean and six sigma.
CO2. Elaborate the scope oftools and techniques.
CO3. Plan the resources using six sigma methodologies.
CO4. Apply QFD to face the implementation and challenges.
CO5. Understand the process of evaluation and continuous improvement methods.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		2										3
CO2						2				2		3
CO3					2				2			
CO4	3				2		2				2	3
CO5			2			2	2	3				

HOD/MECH

19ME8712	**PRODUCTION PLANNING AND CONTROL**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.
- To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

Prerequisite: Process planning and cost estimation, Manufacturing Technology-I & II.

INTRODUCTION **9**

Objectives and benefits of planning and control – Functions of production control – Types of production – job – batch and continuous – Product development and design – Marketing aspect – Functional aspects – Operational aspect – Durability and dependability aspect aesthetic aspect. Profit consideration – Standardization, Simplification & specialization – Break even analysis – Economics of a new design.

WORK STUDY **9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

PRODUCT PLANNING AND PROCESS PLANNING **9**

Product planning– Extending the original product information– Value analysis– Problems in lack of product planning– Process planning and routing– Pre requisite information needed for process planning– Steps in process planning– Quantity determination in batch production– Machine capacity, balancing– Analysis of process capabilities in a multiproduct system.

PRODUCTION SCHEDULING **9**

Production Control Systems– Loading and scheduling– Master Scheduling– Scheduling rules–Gantt charts– Perpetual loading– Basic scheduling problems – Line of balance – Flow production scheduling– Batch production scheduling– Product sequencing – Production Control systems– Periodic batch control– Material requirement planning kanban – Dispatching– Progress reporting and expediting– Manufacturing lead time– Techniques for aligning completion times and due dates.

INVENTORY CONTROL AND RECENT TRENDS IN PPC **9**

Inventory control– Purpose of holding stock– Effect of demand on inventories– Ordering procedures. Two bin system – Ordering cycle system–Determination of Economic order quantity and economic lot size– ABC analysis – Recorder procedure– Introduction to computer integrated production planning systems– elements of JUST IN TIME SYSTEMS– Fundamentals of MRP II and ERP.

Total Periods: 45

TEXT BOOKS:

1. James B.Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition,(1992)
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S.Chand and Company, (2000)

REFERENCES:

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, (1995)
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8thEdition John Wiley and Sons, (2000)
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, (1990)
4. Kanishka Bedi, "Production and Operations management", 2ndEdition, Oxford university press, (2007)
5. Melynk, Denzler, "Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9thEdition, Thomson learning IE, (2007)
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn., (1984)
8. Upendra Kachru, "Production and Operations Management – Text and cases" 1st Edition, Excel books (2007)

WEB RESOURCE:

https://nptel.ac.in/courses/112/107/112107143/

COURSE OUTCOMES:

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

CO1. Know production planning and Control objectives, functions types and Economic analysis.
CO2. Prepare production planning and Control activities such as work study, Time study, Production study & Work sampling.
CO3. Knowledge in production planning and process planning.
CO4. Plan manufacturing requirements manufacturing requirement planning Production Control systems.
CO5. Gain complete knowledge about inventory control and recent trends in PPC,MRP-II & ERP.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		2			2				2		2	
CO2		2			2				2		2	
CO3		2			2				2		2	
CO4		2			2				2		2	
CO5		2			2				2		2	

HOD/MECH

19ME8713	**INDUSTRY 4.0**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: This course is designed to offer learners an introduction to Industry automation 4.0 and its applications and learners will gain deep insights into how smartness is being harnessed from data.

Prerequisite: Basic knowledge of computer and internet

INTRODUCTION TO INDUSTRY 4.0 **9**

Introduction to Industry 4.0- The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

INTERNET OF THINGS **9**

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics.

CYBER PHYSICAL SYSTEMS **9**

Technologies for enabling Industry 4.0 - Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security

3D PRINTING **9**

3D printing technologies, selection of material and equipment, develop a product using 3D printing in Industry 4.0 environment.

INDUSTRIAL IoT **9**

IIoT case studies, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management., Strategies for competing in an Industry 4.0 world

Total Periods: 45

TEXT BOOKS:

1. Alasdair Gilchrist, “INDUSTRY 4.0: Industrial Internet of Things”, A press, (2016)
2. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, Springer, (2010)

REFERENCES:

1. Klaus Schwab, “Fourth Industrial Revolution”, Random House USA Inc, New York, USA, (2017)
2. Oliver Grunow, “SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies”, Studylab Publications, (2016)
3. Sang C. Suh, U. John Tanik, John N Carbone, Abdullah Eroglu, “Applied Cyber-Physical Systems”, Springer Publications, New York, (2013)
4. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo JorgeBartolo, “Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0”, Automation in Construction, Vol. 103,pp. 251- 267, (2019)

WEB RESOURCE:

https://nptel.ac.in/courses/106/105/106105195/#

COURSE OUTCOMES:

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

CO1. Understand the main components of industrial revolution 4.0.

CO2. Understand IoT and its applications in smart manufacturing, smart cities etc.,

CO3. Understand the purpose and applications of cyber physical systems.

CO4. Understand the applications and how to develop a product using 3D printing.

CO5. Understand the concept of industrial IoT and its applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3		2	2	3				2			2
CO2	3		2	2	3				2			2
CO3	3		2	2	3				2			2
CO4	3		2	2	3				2			2
CO5	3		2	2	3				2			2

HOD/MECH

19ME8714	**ENTREPRENEURSHIP DEVELOPMENT**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

Prerequisite: Nil

ENTREPRENEURSHIP **9**

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

MOTIVATION **9**

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

BUSINESS **9**

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

FINANCING AND ACCOUNTING **9**

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

SUPPORT TO ENTREPRENEURS **9**

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

Total Periods: 45

TEXT BOOKS:

1. Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, (2013)
2. Donald F Kuratko, "Entreprenuership – Theory, Process and Practice", 9th Edition, Cengage Learning, (2014)

REFERENCES:

2. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, (2013)
3. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2nd Edition Dream tech, (2005)
4. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, (2011)
5. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, (1986)

WEB RESOURCE:

https://nptel.ac.in/courses/110/106/110106141/

COURSE OUTCOMES:

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

CO1. Comprehend the concepts of entrepreneurship
CO2. Motivate oneself to manage stress
CO3. Execute market survey and techno economic feasibility assessment
CO4. Raise fund from financial source
CO5. Identify and correct sickness in business

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1											2	1
CO2					3							1
CO3												1
CO4												1
CO5									2			1

HOD/MECH

19ME8715	**ENGINEERING ECONOMICS AND COST ANALYSIS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objective: To enable students to understand the fundamental concepts of economics applicable to engineering problems and to learn the techniques of incorporating depreciation, inventory and inflation factor in economic decision making.

Prerequisite: Nil

INTRODUCTION TO ECONOMICS **9**

Introduction to Economics – Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

VALUE ENGINEERING **9**

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor– equal payment series capital recovery factor – Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

CASH FLOW **9**

Methods of comparison of alternatives – present worth method (Revenue dominated cash flowdiagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

DEPRECIATION, REPLACEMENT AND MAINTENANCE ANALYSIS **9**

Depreciation – Introduction, Straight line method of depreciation, declining balance method ofdepreciation – Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation. Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

EVALUATION OF PUBLIC ALTERNATIVES, INFLATION AND INVENTORY CONTROL **9**

Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.Deterministic models; safety stock inventory control systems.

Total Periods: 45

TEXT BOOK:

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, (2001)

REFERENCES:

2. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, (2011)
3. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, (2010)
4. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, (2011)
5. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, (2012)

WEB RESOURCE:

https://nptel.ac.in/courses/112/107/112107209/

COURSE OUTCOMES:

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

CO1. Comprehend the concepts of engineering economics,
CO2. Realize the value of time and implement the concept of value engineering,
CO3. Apply the concept of cash flow method in economic decisions,
CO4. Employ the techniques of depreciation before replacement and maintenance of devices,
CO5. Evaluate public alternative, include inflation in economic decisions and determine inventory

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	1									3	1
CO2	3										3	1
CO3	2	2										1
CO4	2	2										1
CO5	3											1

HOD/MECH

19ME8716	**CURRENT TRENDS IN INDIAN ECONOMY**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To introduce the student to basic understanding of the Indian economy and measurement of various macroeconomic variables.
Prerequisite: Nil

PERSPECTIVE OF INDIAN ECONOMY **9**

Indian Economy as a Developing Economy, Basic Characteristics Overview of Economic Planning, Role of Monetary policy and Fiscal Policy, Budget terminology, Economic Growth, GDP and GDP Trends, Money Supply & Inflation, Inflation trends, RBI – overview of role and functions, Capital Markets – overview of role and functions, Concept of Poverty, Estimates of Poverty, Poverty Line, Economic Reforms and Reduction of Poverty, Concept of Inclusion, Need of inclusive growth, Financial inclusion.

HUMAN RESOURCES AND ECONOMIC DEVELOPMENT **9**

Theory of Demographic Transition, Size and Growth Rate of Population in India, Quantitative Population Growth Differentials in Different Countries, The Sex Composition of Population, Age Composition of Population, Density of Population, Urbanization and Economic Growth in India, The Quality of Population, Population Projections (2001-2026), Demographic Dividend. **Human Development in India** – The Concept and Measures of Human Development, Human development Index for Various States in India, National Human Development Report, Changing profile of GDP and employment in India, GDP, Employment and Productivity per Worker in India, Relative Shift in the Shares of NSDP and Employment in Agriculture, Industry and Services in Different States.

SECTORAL COMPOSITION OF INDIAN ECONOMY **9**

Primary, Secondary, Tertiary Sectors, Issues in Agriculture sector in India ,land reforms, Green Revolution and agriculture policies of India, Industrial development, small scale and cottage industries, Industrial Policy, Public sector in India, Services sector in India. Areas of Market Failure and Need for State Intervention, Redefining the Role of the State, Liberalization, Privatization and Globalization (LPG) Model of Development, Unorganized Sector and India's Informal Economy.

INEQUALITY AND ECONOMIC POWER IN INDIA **9**

FDI, Angel Investors and Start-ups, Unicorns, M&A, Investment Models, Role of State, PPP (Public-Private Partnership), Savings and Investment Trends. Growth of Large Industrial Houses Since Independence, Growth of Monopolies and Concentration of Economic Power in India, Competition Policy and Competition Law, Growth and Inequality, India as an Economic Superpower, Growth of the Indian Middle Class, Indian MNCs: Mergers and Acquisitions, Outsourcing, Nationalism and Globalization, Small-scale and Cottage Enterprises, The Role of Small-scale Industries in Indian Economy, Poverty, Vulnerability and Unorganized Sector Employment–The High Degree of Correlation, Estimate of Organized and Unorganized Workers.

THE FOREIGN TRADE OF INDIA **9**

Importance of Foreign Trade for a Developing Economy, Overview of Foreign Trade Since Independence, Composition of India's Foreign Trade, Direction of India's Foreign Trade, India's Balance of Payments on Current Account, Balance of Payments Crisis, Balance of Payments Since the New Economic Reforms of 1991, India's Trade Policy, India's Foreign Trade Policy, An Analysis of Trends in Exports and Imports, Special Economic Zones (SEZs)–An Overview.

Total Periods: 45

TEXT BOOKS:

1. Indian Economy , Dutt R and Sundharam K.P.M, S .Chand, Delhi
2. Indian Economy, Misra S.K. and Pury V.K., Himalaya Publishing House, New Delhi

REFERENCES:

1. Economic Environment of Business , Adhikary, Sultan Chand and Sons
2. Industrial Economy of India, Kuchhal S.C., Chaitanya Publishing House, Allahabad
3. Business, Government and Society, George A and Steiner G A, Macmillan

WEB RESOURCE:

https://nptel.ac.in/courses/109/103/109103171/

COURSE OUTCOMES:

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

CO1. Describe the present state of Indian Economy and LIST major economy policy issues in the current context.
CO2. Summarize the Sectoral composition of the Indian Economy and discuss the trends there in.
CO3. Predict consequences of Growth of monopolies concentration of economic power and inequality in the Indian economy.
CO4. Examine the changing profile of human capital employment, productivity and illustrate the linkages with GDP composition of India.
CO5. Evaluate the role of foreign trade in the Indian economy.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2							1				1
CO2						2		1				1
CO3	3				2			1				1
CO4				3				1		1		1
CO5							1	1				1

HOD/MECH

19ME8717	**INTELLECTUAL PROPERTY RIGHTS**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering
Objective: To give an idea about IPR, registration and its enforcement
Prerequisite: Nil

INTRODUCTION **9**

Introduction to IPRs, Basic concepts and need for Intellectual Property – Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR

REGISTRATION OF IPRs **9**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

AGREEMENTS AND LEGISLATIONS **9**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act

DIGITAL PRODUCTS AND LAW **9**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies

ENFORCEMENT OF IPRs **9**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies

Total Periods: 45

TEXT BOOKS:

1. S.V.Satarkar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, (2002)
2. V.Scople Vinod, Managing Intellectual Property, Prentice Hall of India Pvt. Ltd, (2012)

REFERENCES:

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, 3rd Edition, (2012)
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, (2011)
3. Derek Bosworth and Elizabeth Webster, "The Management of Intellectual Property", Edward Elgar Publishing Ltd., (2013)

WEB RESOURCE:

- https://nptel.ac.in/courses/110/105/110105139/
- https://nptel.ac.in/courses/109/106/109106137/
- cipam.gov.in/

COURSE OUTCOMES:

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

CO1. Understand the basic concepts on patent and copyright
CO2. Register the innovative work and get patent
CO3. Manage Intellectual Property portfolio to enhance the value of the firm
CO4. Get an adequate knowledge in agreements and legislations
CO5. Know the enforcement measures

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1								2				2
CO2								3				3
CO3								3				2
CO4								3				3
CO5								2				2

HOD/MECH

19ME8718	**HUMAN RESOURCE AND MANAGEMENT**	**L-T-P**	**C**
		3-0-0	**3**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand the basic concepts, role, functions and processes of human resource management and also the process of entrepreneurship
- To learn the managing skills for the enterprise

Prerequisite: Nil

INTRODUCTION TO HUMAN RESOURCE MANAGEMENT **9**

Evolution of human resource management – Definition, scope and objectives of human resource management –Functions of human resource department – Human resource planning– job analysis – job design – job evaluation –Recruitment and selection process.

CAREER PLANNING, TRAINING AND DEVELOPMENT **9**

Introduction – Promotion: Types, programme and procedure, Promotion system and policy – Demotion – Transfer:Policy and Procedure – Career planning – Employee training and development – Introduction – Need andImportance of training – Concept of training – Steps in training – Types of training methods – Executive development: Introduction – Executive development programmes.

PERFORMANCE EVALUATION AND ADMINISTRATION **9**

Introduction – Methods for appraisal performance – Components of appraisal evaluation – Problems of appraisal –Solutions – Ethics of appraisal – Wage and salary administration –Nature and purpose – Wages: types,determination process, factors influencing wage – Compensation – Incentives.

ENTREPRENEURSHIP DEVELOPMENT **9**

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality –Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation– Competencies – Mobility – Entrepreneurship Development Programmes (EDP).

LAUNCHING OF SMALL ENTERPRISE **9**

Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurialcareer – Role of small enterprise in economic development – Problems of small scale industries – Institutionalfinance to entrepreneurs – Institutional support to entrepreneurs – Total Quality Management for small Enterprises.

Total Periods: 45

TEXT BOOKS:

1. C.B.Mamoria and S.V.Gankar, "A Text Book of Human Resource Management", Himalaya Publishing Company,Seventh edition, (2013)
2. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, (2007)

REFERENCES:

1. Dessler, "Human Resource Management", Pearson Education Limited, (2007)
2. Bernadin, "Human Resource Management", Tata Mcgraw Hill, Sixth edition, (2006)
3. Eugence Mckenna and Nic Beach, "Human Resource Management", Pearson Education Limited, (2007)
4. Hisrich, "Entrepreneurship", Tata McGraw Hill, New Delhi, (2001)
5. P.Saravanavel, "Entrepreneurial Development", EssPeekay Publishing House, Chennai, (1997)

WEB RESOURCE:

- https://nptel.ac.in/courses/110/105/110105069/
- http://www.csb.gov.hk/english/publication/files/e-hrmguide.pdf

COURSE OUTCOMES:

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

CO1. Plan the human resources for the given jobs
CO2. Identify suitable training methods, promotion/demotion planning for the given situation
CO3. Evaluate the performance of human resources for appraisal
CO4. Develop entrepreneurial personality using EDP
CO5. Identify the opportunities for developing small scale industries

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1											2	1
CO2					3							1
CO3												1
CO4												1
CO5									2			1

HOD/MECH

INDUSTRIAL SUPPORT COURSES

INDUSTRIAL SUPPORTIVE COURSE

19ME6i01	INDUSTRIAL FRONTIERS TOOLS	L	T	P	C
		2	0	2	3

Mentor industry: ATG tires Pvt ltd, Unit of Yokohama
Plot No A2 SIPCOT Industrial Growth Centre, Gangaikondan, Tirunelveli – 627352

Syllabus committee: PN Rajendran – EVP - Operations RS Raghavan – VP MFG K.Bhavankumar – AGM Business Excellence

Faculty Team: PN Rajendran – Unit Head – Chairman RS Raghavan – AVP MFG– Program Lead K.Bhavankumar – AGM – Program Director & Faculty

Prerequisites for the course

Manufacturing Technology-I & II

Objectives

1. To empower our Students & Frontline Engineers to gain new knowledge or information that helps work man to do a job well.
2. To systematically prepare first-line and emerging Engineers to assume greater responsibilities and skill sets that continue to evolve over time.
3. To train students on industrial tools to implement new systems, generate opportunities and face the challenge of managing and motivating their teams and developing a leadership mind-set
4. To Train and engage to think like an engineer and get results through others.
5. To influence workman attitudes and perceptions toward learning for Self and organizational Improvements.

UNIT I	BASIC INDUSTRIAL DISCIPLINE	6

Basic Machine & Hand Tools -Need for industrial discipline- basic industrial discipline-principle of industrial discipline-code of discipline-Industrial Safety & Maintenance, Clean and Efficient Workspace - 5S - Case Studies- other related technologies.

UNIT II	PRODUCTIVITY IMPROVEMENT	6

Productivity - Productivity Improvement Indices- Japanese Productivity Improvement Techniques- Work Study as a Productivity Improvement Technique-case studies.

UNIT III	QUALITY AND TOTAL QUALITY MANAGEMENT	6

Quality -Total Quality Management-7QC Tools -Pareto Principle-Scatter Plots-Control Charts-Flow Charts-Cause and Effect (Fishbone, Ishikawa) Diagram. -histogram or Bar Graph-Check Lists-Check Sheets- control charts – case studies.

UNIT IV	KAIZEN TOOLS	6

Continuous Improvement- Kaizen- Gemba, PCDA cycle - Quality Circle - Brain storming - Kanban- Total Productive Maintenances (TPM) – case studies

UNIT V	QUALITY CULTURE AND LEAN SIX SIGMA PRINCIPLE	6

Quality Culture Building-Quality System Management-Environmental Management System- Lean-Six Sigma-Principles of Mistake-proofing/Poka-Yoke – case studies	
Total Periods	**30**
PRACTICAL AND INDUSTRIAL PRACTICES 1. 5S 2. 7QC Tools 3. Gemba, PCDA cycle 4. Brain storming **5.** Poka-Yoke	**30**

Suggestive Assessment Methods

Continuous Assessment Test (30 Marks)	**Formative Assessment Test (20 Marks)**	**End Semester Exams (50 Marks)**
2 Test EACH 15marks **MCQ/Descriptive Questions**	**Model practical**	**Descriptive Questions**

Outcomes

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

CO.1 Explain industrial structure, discipline, safety, maintenance and 5S principles
CO.2 Illustrate productivity improvement techniques-5s, work study
CO.3 Describe TQM, Continuous improvement, quality circle, quality system management
CO.4 Adapt kaizen techniques and quality control tools for TQM
CO.5 Use quality culture and implement lean tool poka yoke
CO.6 Combine frontiers tools to propose a solution of continuous improvement.

Text Books

1. Salman Taghizadegan, "Essentials of Lean Six Sigma", Elsevier Publications 2010
2. Productivity Press Development Team, "Kaizen for the Shop Floor: A Zero-Waste Environment with Process Automation", Taylor & Francis 2018
3. Rajiv Kumar Sharma, "Quality Management Practices in MSME Sectors", Springer 2020.

Reference Books

Web Recourses

1. https://nptel.ac.in/courses/110/105/110105039/
2. https://nptel.ac.in/courses/110/104/110104080/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
1	1	1							1	1	2	1			3
2	1	2	2						1	1		1			3
3	1	2		2					1	1		1			3
4	1	2	2	2	2			2	1	1	2	1			3
5	1	2	1	2				1	1	1	2	1			3
6	1	2	3	2	2			1	2	2		2			3

ADDITIVE MANUFACTURING SYLLABI

19MEAM01	ADDITIVE MANUFACTURING TECHNOLOGIES AND APPLICATIONS	L	T	P	C
		3	0	0	3

Prerequisites for the course

Nil

Objectives

Students undergoing this course are expected to

1. Know the principles, methods, areas of usage, possibilities and limitations of the additive manufacturing technologies
2. Be familiar with the characteristics of various materials that are used in additive manufacturing.

UNIT I	ADDITIVE MANUFACTURING FUNDAMENTALS	9

Need for time compression in product development, Need for Additive Manufacturing (AM), Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Classification of AM process, Comparison of AM with CNC and other technologies.

UNIT II	LIQUID-BASED AM SYSTEMS	9

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, Laser scanning, Applications, Advantages and Limitations, Case studies. Solid Ground Curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Polyjet: Process, working principle, Applications, Advantages and Limitations, Case studies. Introduction to microfabrication.

UNIT III	SOLID-BASED AM SYSTEMS	9

Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Fused Deposition Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Introduction to Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition and Directed Energy Deposition Processes.

UNIT IV	POWDER-BASED AM SYSTEMS	9

Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Limitations, Case studies.

UNIT V	AM APPLICATIONS	9

Applications of AM- Prototyping- Tooling- Production- Customization and Personalization- Spare Parts, Maintenance and Repair- Art, Design, and Architecture- Evaluating the Adoption of AM- Applications in Aerospace Industry, Automotive Industry, Jewellery Industryapplication. AM inMedical and

Bioengineering Applications: Planning and simulation of complex surgery, Customised Implants & Prosthesis, Design and Production of Medical Devices.

Total Periods	**45**

Suggestive Assessment Methods

Continuous Assessment Test (30 Marks)	**Formative Assessment Test (10 Marks)**	**End Semester Exams (60 Marks)**
2 Test EACH 15marks **MCQ/Descriptive Questions**	**2 test EACH 5 marks**	**Descriptive Questions**

Outcomes

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

CO.1 Explain the fundamentals of various Additive Manufacturing (AM)techniques.

CO.2 Describe the working principle, capability, limitation and applications of liquid, solid and powder based additive manufacturing techniques.

CO.3 Choose a suitable AM technique for the specified application.

CO.4 Compare different AM process and materials based on application.

CO.5 Explore the range of 3D printing and Prototyping technologies and their application for industrial, design, and creative field.

CO.6 Explain current and emerging 3D printing applications for various industrial environment.

Text Books

1. Olaf Diegel, "A Practical Guide to Design for Additive Manufacturing", Springer, 2019
2. Martin Leary, "Design for Additive Manufacturing", Elsevier, 2019.

Reference Books

1. Ben Redwood, "The 3D Printing Handbook: Technologies, Design and Applications",3D Hubs, 2017.
2. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.
3. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer , 2001
4. Wholers Report 2000 – Terry Wohlers, Wohlers Associates, 2000
5. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
6. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing,Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015

Web Recourses

Nil

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	1	1									2		3
2	3	1	1	2	1								2		3
3	3	2	3	2	2								2		3
4	3	2	2	2	2								2		3
5	3	2	2	2	2								2		3
6	3	3	3	2	2	2						3	2		3

19MEAM02	CAD FOR ADDITIVE MANUFACTURING	L	T	P	C
		3	0	2	4

Prerequisites for the course

Nil

Objectives

The course is aimed at giving exposure to and enhancing the knowledge and skills of fresh graduate engineers and engineers involved in the operation use of 3D Scanners and 3D printing / additive manufacturing with the aid of CAD packages and for those who want to provide training to others in this area. It gives exposure and on hand experience in the field of CAD packages, 3D Scanner and AM format.

UNIT-I	DESIGN OF SOLIDS	6

Introduction to modelling, Types of modelling, 3D modelling: Solid entities, Boolean operations, Types of solid model – Boundary representation (B-rep) technique and Construction Solid Modelling (CSG) approach, Advanced modelling methods-CAD Data exchange formats. AMF files, 3MF, XML, Meta Data, PLY, STEP for AM Application Protocols (AP).

UNIT-II	3D DATA CAPTURE AND SCANNING TECHNOLOGIES	6

Introduction to imaging, Portable CMM - Structured light, portable arm-based laser scanning - time-of-flight and phase shift (long range) scanners-X-Ray technology, -3D CT (X-Ray) scanners- Computed Tomography (CT), Basic Components of CT, Different Types of CT Scanners, Magnetic Resonance Imaging (MRI), Ultrasound imaging, 3-D laser scanners, Industrial CT Scanners.

UNIT-III	REVERSE ENGINEERING AND OBJECT DIGITIZATION	6

Reverse Engineering Methodology – Reverse Engineering Steps - The generic process-Three phases of reverse engineering-Phase I: Scanning, Phase II: Point processing, Phase III: Geometric model development, Case studies. Applications and selection of reverse engineering systems. Hardware and software involved. Point clouds, meshes (.stl), NURBS surface models and parametric CAD models.

UNIT-IV	3D RECONSTRUCTION	6

3D reconstruction, Image Reconstruction Procedure, Digital Communication Post processing the Captured Data - Handling Data Points - Curve and Surface and solid Creation. Layer-based Model Generation – Adaptive Slicing Approach for Cloud Data Modelling – Planar Polygon Curve Construction – Determination of Adaptive Layer Thickness – Application Examples.CAD Model Construction from Point Clouds, Data handling & Reduction Methods, AM Software (Magics, Mimics, 3Matic, Rhino)

UNIT-V	AM DATA FORMATS AND MESHING	6

Tessellated Models, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, and Newly Proposed Formats. STL File Manipulation and Repair Algorithms - Mesh Refining by Sub division Techniques.

S.No	List of Experiments	CO
1	2D sketching of product design ideas.	CO1
2	3D modelling and assembling.	CO1
3	Use of 3D digitalization scanners.	CO2
4	Use of point clouds/meshes editing software.	CO2
5	Preparation of 3D CAD models and stl file generation	CO3
6	File manipulations and repair using AMsoftware	CO5
Total Periods		**30 Theory +30 Lab**

Laboratory Requirements

2 Test EACH 15marks MCQ/Descriptive Questions		Experiments and record of work (10) & Model practical (10)		

Outcomes

Reference Books

Nil

Web Recourses

Nil

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	1	3								2		2
2	3	1	1	1	3								2		2
3	3	1	1	1	3								2		2
4	3	2	1	1	3								2		2
5	3	3	3	3	3								2		2
6	3	3	3	3	3								2		2

19MEAM03	3D PRINTING AND PROTOTYPING	L	T	P	C
		3	0	2	4

Prerequisites for the course

- Additive Manufacturing Technologies and Applications
- CAD for Additive manufacturing

Objectives

Students undergoing this course are expected to

- To explain pre-processing and model preparation in AM
- To Understand and operate on tessellated/meshed model
- To import knowledge on slicing process and software
- To explain AM data process like support generation
- To explain post processing techniques of AM

UNIT-I	PREPROCESSING IN ADDITIVE MANUFACTURING	6

Preparation of 3D-CAD model, Reverse engineering and Reconstruction of 3D-CAD model, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials. Introduction, Process, CAD Data formats, Data translation, Data loss, STL format. Pre-Processing -Preparation of 3D-CAD model, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials - post processing.

UNIT II	AM SOFTWARE	6

Need for AM software, Build Preparation-Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT III	AM Data Processing	6

AM Data Processing: Part Orientation and Support Structure Generation, Model Slicing and Contour Data Organization, Direct and Adaptive Slicing, Hatching Strategies and Tool Path Generation.Modelling of AM Process: Surface Roughness due to Staircase Effect, Part Build-time, Fabrication Cost, Optimal Orientation, Quantification of Building Inaccuracy and Part Stability.

UNIT IV	POST PROCESSING OF AM PARTS	6

Support Material Removal, Surface Texture Improvement- Polymer Surface Treatments - Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques- Gluing and Welding AM Parts – Heat Treatment and Aging. Product Quality - sanding, Acetone treatment, polishing- -Inspection and testing - Defects and their causes.

UNIT V	PROCESS SELECTION AND MATERIAL SCIENCE	6

Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.Materials

science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship.

S.No	List of Experiments	CO
1	Slicing of an engineering component	CO1
2	Fabrication of the component through 3D printer and dimensional analysis	CO2
3	Use of FDM, SLA, DLP and SLS machines to produce 3D physical models.	CO2
4	Simulation of additive manufacturing	CO2
Total Periods		**30 Theory +30 Lab**

Laboratory Requirements:

Suggestive Assessment Methods

Continuous Assessment Test (30Marks)	**Lab Components Assessments (20 Marks)**	**End Semester Exams (50 Marks)**
2 Test EACH 15marks **MCQ/Descriptive Questions**	**Experiments and record of work (10) & Model practical (10)**	**Descriptive Questions**

Outcomes

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

CO1: Explain the concept of preprocessing and slicing for additive manufacturing.
CO2: Compare the different features of AM packages
CO3: Explain the data processing techniques for additive manufacturing
CO4: Discuss the different post processing methods
CO5: Select a process parameter for different AM techniques
CO6: Perform AM simulation and fabricate 3D physical product using appropriate RP machines (Practical)

Text Books

1. Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2015

Reference Books

1. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.

3. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
4. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
5. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006 6. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018.
6. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004.
V. Raja and K. Fernandes, Reverse Engineering: An Industrial Perspective, Springer- Verlag, 2008.

Web Recourses

Nil

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	3								2		2
2	3	2	2	1	3								2		2
3	3	2	3	1	3								2		2
4	3	2	3	1	3								2		2
5	3	3	3	1	3								2		2
6	3	3	3	3	3					2			2		2

19MEAM04		L	T	P	C
		3	0	0	3

Prerequisites for the course

UNIT V	**COST &VALUE OF AMAND FUTURE OF AM**	**9**

A Cost Model of Conventional Manufacturing- Modelling the Cost of AM- Assessing the Value of AM- Cost and Value Scenarios. Future of AM: Functionally Graded Materials – Bio printing - Printed Electronics - Nano Printing - Food Printers.

Total Periods	**45**

Suggestive Assessment Methods

Continuous Assessment Test (30 Marks)	**Formative Assessment Test (10 Marks)**	**End Semester Exams (60 Marks)**
2 Test EACH 15marks MCQ/Descriptive Questions	2 test EACH 5 marks	Descriptive Questions

Outcomes

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

CO.1 Describe the design aspects for additive manufacturing.
CO.2 Convert the DFM/DFA into Design for Additive Manufacturing.
CO.3 Explain the design consideration of metal powder for AM process.
CO.4 Perform design of AM to reduce residual stresses.
CO.5 Describe the design aspects for polymer AM process.
CO.6 Compute the costing for AM products.

Text Books

1. Olaf Diegel, "A Practical Guide to Design for Additive Manufacturing", Springer, 2019.
2. Martin Leary, "Design for Additive Manufacturing", Elsevier, 2019.

Reference Books

1. Ben Redwood, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs, 2017.

Web Recourses

Nil

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	3
1	2	1	1	1									1		3
2	3	3	3	3	1								1	2	3
3	2	2	3	2	1								1	2	3
4	3	3	3	3	1								1	2	3
5	1	1	1	1	1								1	2	3
6	2	2	2	2	2						2		1	1	

19MEAM05	PROTOTYPING PROJECT	L	T	P	C
		0	0	8	4

Prerequisites for the course

2	First Project Part file	5

	3	First Project Printed Part	10	
		Final Project CAD files	15	
	4	Final Project Printed Parts	10	
	5	Final product assembly – functional test and quality	25	
	6	Final Printed Project & Presentation	30	

The project is structured to ensure that each team makes steady progress on the project throughout the semester, with adequate time at the end of the semester to allow for a variety of printing methods,

SAMPLE PROJECT DETAILS

The team started the project with a hand sketch to show the idea of the mechanism and its location in the machinery. An Internet search of results for similar objects was required for this part of the project. Documentation - project documentation required use of a CAD package. The required documentation format was an assembly drawing as a solid model, and a detailed 3-D drawing file as the necessary technical documentation for prototyping, manufacturing, inspection, and production preparation.

Prototyping - the next step was prototyping, or making physical models. Using additive method plastic objects were built on the FDM. This machine builds precision objects layer by layer. This method is useful for shape and fit evaluation. There were two important issues in this stage of the project. AutoCAD (Mechanical Desktop) and Reverse engineering, AM software from the courses. A third file format, stereolithography (STL files), was created for use by the 3D printer. When conversions were done, the new formats were inspected for possible errors before proceeding with prototyping. Analysis at this stage of the project concentrated on two elements: design flaws: fitting parts together and possibilities of design improvements by reducing the weight and material selection, as well as developing a concept of manufacturing and adapting the design to the process requirements.

Outcomes

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

CO.1 Apply tools and techniques acquired in AM courses for development of new product.
CO.2 Adapt an efficient problem-solving method in analysing industrial product needs.
CO.3 Formulate a real world problem, identify the requirement and develop the design solutions.
CO.4 Identify technical ideas, strategies and methodologies for prototyping
CO.5 Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
CO.6 Prepare technical report and oral presentations.

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			3	3	3						2	2	3		3
2			3	3	3						2	2	3		3
3			3	3	3						2	2	3		3
4			3	3	3						2	2	3		3
5			3	3	3						2	2	3		3
6									3	3		2			

ANNEXURE – II MANDATORY NON CGPA COURSES

(Offered in the Department of Mechanical Engineering)

Semester	Course Code	Course Name	Type	L	T	P	C	H
II	19GE2M01	Environmental Science and Engineering	BS	2	0	0	-	2
III	19GE3M01	Communication and Soft Skills	EEC	0	0	2	-	2
V	19GE5M01	Interpersonal Skills Essential	EEC	0	0	2	-	2
VI	19GE6M01	Professional Communication – Advanced Reading and Writing	EEC	0	0	2	-	2
VII	19ME7M13	Aptitude skills	EEC	0	0	2	-	2

ANNEXURE – III LIST OF VALUE ADDED COURSES

(Offered by the Department of Mechanical Engineering)

19ME0V01	3D Modelling For Design Engineer
19ME0V02	3D Printing
19ME0V03	Applied Finite Element Analysis
19ME0V04	Process Design and CNC Programming
19ME0V05	Non Destructive Testing

19ME0V01 3D MODELLING FOR DESIGN ENGINEER

Programme: B.E. Mechanical Engineering
Objectives: To impart knowledge on

- Handling 2D drafting and 3D modeling of product.
- Applying CAD in real life applications.
- Design, Optimization, Manufacturing and Product Development to bring new technologies.

Prerequisite:
- Engineering design
- Manufacturing technology

Part Modeling **6**

Selecting & Editing of Geometry, Features, Models – Sketcher Geometry & Sketcher Tools- Sketches & Datum Features – Extrudes-solid, Revolves-solid and Ribs.

Part Modeling **6**

Creating Holes-Coaxial, Linear, Radial and Diameter holes, Shells, Draft-Split draft & Patterns-Axis pattern – Creating rounds-by selecting a surface and edge, selecting two surfaces, full rounds, Chamfers & Layers.

Part Assembly **6**

Assembling with constraints-Assembly theory, default constraints, Coincident constraints, Distance constraints, Parallel, normal & angle constraints Exploding, Replacing components, Cross -Sections in Assemblies.

Part Modeling **6**

Creating Sweeps and Blend- sweeps with variable sections- helical sweeps and swept blends- groups, copy, mirror & UDF's- Measuring, Inspecting Models.

Flexible Modeling **6**

Introduction to flexible modeling- Editing, Transformations & Recognition in Flexible Modeling.

Total hours: 30

TEXTBOOK:

1. Sham Tickoo, "Pro/Engineer PTC Creo Parametric 3.0 for Engineers and Designers", Dreamtech,2015.

REFERENCE BOOK:

1. Randy H. Shih, "Parametric Modeling with Creo Parametric 2.0", SDC Publications, 2013.

EXTENSIVE READING:

1. Roger Toogood, Jack Zecher, "Creo Parametric 2.0 Tutorial", SDC Publications, 2013.

WEB REFERENCE:

http://www.creo.ptc.com/

COURSE OUTCOMES:

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

CO1. Apply the concepts and commands of a computer-aided design system.

CO2. Understand the basic concepts of 2D drafting and 3D modeling of product.

CO3. Providing theoretical and practical knowledge of computer tools necessary to transform the product ideas of Entrepreneurs into a marketable.

CO4. Develop commercially viable product which satisfies most of the customer's requirements.

19ME0V02 **3D PRINTING**

Programme: B.E. Mechanical Engineering

Objectives:
- To understand need of Additive Manufacturing process
- To understand about different Additive Manufacturing process
- To understand tools used in Additive Manufacturing techniques
- To understand FDM process and its parameters
- To understand about Reverse engineering

Prerequisite:
- Engineering design
- Manufacturing technology

I. Introduction on Additive Manufacturing, Materials, Applications **15**

Overview – History – Need-Classification -Additive Manufacturing Technology in Product development -Materials for Additive Manufacturing Technology – Tooling – Applications (BioMedical, Automobiles, Defence and Space Research) -Principle, Process parameters, process details and applications of various Additive Manufacturing processes -Stereo lithography systems, Selective Laser Sintering, Fused Deposition Modelling, Laser Engineered Net Shaping, 3D Printing.

II. Modeling and Slicing, Reverse Engineering **15**

Basic Concept – Software's for Additive Manufacturing Technology – CAD model preparation – CAD for Additive Manufacturing - Part Orientation and support generation – Model Slicing – Tool path Generation. -FDM- CAD model to Prototype- Static Model- Dynamic Model -FDM special Techniques- Temperature control- BED Alignment- Material Feeding- FDM process problem solving – Reverse engineering used 3d Scanner – Applications of Reverse engineering.

Total Periods: 30

REFERENCES:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

COURSE OUTCOMES:

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

CO1. Understand the principle, parameters and applications of Additive Manufacturing processes

CO2. Recognize various types of Additive Manufacturing

CO3. Understand the practical knowledge of product design and development of Additive Manufacturing Process

19ME0V03 APPLIED FINITE ELEMENT ANALYSIS

Programme: B.E. Mechanical Engineering

Objectives:
- To impart knowledge on define analysis requirements.
- To impart knowledge on analysis type, element selection, sizing, meshing and quality check.
- To acquire knowledge on solution setting, accuracy and result validation & verification.
- To learn interpretation of results and mapping the design requirements.

Prerequisite:
- Finite Element Analysis
- Design of Machine Elements
- Design of Transmission systems
- Strength of Materials

Design analysis requirements -Analysis parameters-dimension, scale, analysis type- Element description-field variables, output variables –Selection of element sizing, meshing -element aspect ratio-Meshing quality, quality check-Setting solution parameters-convergence- solution accuracy -result validation and verification - result interpretations-Mapping the design requirements.

Total Periods: 15

REFERENCES:

1. Applied Finite Element Analysis, Larry J. Segerlind, and Publisher: Wiley; 2nd edition (20 February 1985).
2. Applied Finite Element Analysis by G. Ramamurty, I.K International Publishing House Pvt. Ltd.,2010, ISBN: 9789380578453.

COURSE OUTCOMES:

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

CO1. Student will be able to define, apply FEA for design needs.

CO2. Student will be able to apply FEA mechanical design solutions.

CO3. Student will be able to organize, analyze and interpret FEA output data to produce meaningful design conclusions and recommendations.

19ME0V04 PROCESS DESIGN AND CNC PROGRAMMING

Programme: B.E. Mechanical Engineering

Objectives:
- Able to read the components drawing and part features.
- Able to develop process design considering production requirement.
- Develop and Optimize CNC part programs for a given product.

Prerequisite:
- Engineering Graphics
- Knowledge on Conventional Machining Operation

Drawing Interpretation – Machining Features – Setup Planning – GD & T and Surface finish requirements – Process design – Process sequencing - RawMaterials Selection and Evaluation – Machine Capability Study – Machine Selection – Process Parameter – Jigs and fixture selection - CNC Programming – CNC Controller (FANUC, SEIMNENS) – Axes – Simulation – Machining Parameter optimization – Product features for machining time and cost estimation.

Total Periods: 30

REFERENCES:

1. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
2. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2003.
3. FANUC Training Guide

COURSE OUTCOMES:

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

CO1. Upon Completion of this training program the student can able to provide manufacturing solutions to the new and existing products.

19ME0V05

NON DESTRUCTIVE TESTING

Programme: B.E. Mechanical Engineering

Objectives:
- To study and understand the various Non Destructive Evaluation and Testing methods, Codes and Standards, Interpretation of results.

Prerequisite:
- Mechanical Properties of Materials.
- Classification of Engineering Materials

Overview of NDT Techniques – Liquid Penetrant Testing – Testing Instruments, Procedure, Measuring features, Interpretation and evaluation of results – Hands on training on measuring defects - Magnetic Particle Testing – Testing Instruments, Procedure, Measuring features, Interpretation and evaluation of results – Hands on training on measuring defects – Ultrasonic Testing – Testing Instruments, Procedure, Measuring features, Interpretation and evaluation of results – Hands on training on measuring defects – Radiography testing - Testing Instruments, Procedure, Interpretation and evaluation of results. Codes and standards for LPT, MPT, UT, RT.

Total Periods: 30

REFERENCES:

1. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

COURSE OUTCOMES:

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

CO1. the student can able to explain the concept of different NDE techniques.

ANNEXURE – IV LIST OF ONLINE COURSES

S.NO	COURSE	COURSE LINK	NO OF WEEKS	NO OF CREDITS
1	Robotics	https://onlinecourses.nptel.ac.in/noc21_me76/preview	8 Weeks	2
	Introduction to Robotics	https://onlinecourses.nptel.ac.in/noc21_me32/preview	12 Weeks	3
	Robotics and Control : Theory and Practice	https://onlinecourses.nptel.ac.in/noc21_me49/preview	8 Weeks	2
2	Fundamentals of Additive Manufacturing Technologies	https://onlinecourses.nptel.ac.in/noc21_me115/preview	12 Weeks	3
3	Introduction to Mechanical Vibration	https://onlinecourses.nptel.ac.in/noc21_me80/preview	8 Weeks	2
	Principles of Vibration Control	https://onlinecourses.nptel.ac.in/noc21_me101/preview	4 Weeks	1
4	Basics Of Finite Element Analysis - I	https://onlinecourses.nptel.ac.in/noc21_me109/preview	8 Weeks	2
5	Introduction To Composites	https://onlinecourses.nptel.ac.in/noc21_me110/preview	12 Weeks	3
6	Refrigeration and air-conditioning	https://onlinecourses.nptel.ac.in/noc21_me85/preview	8 Weeks	2
7	Advanced Machining Processes	https://onlinecourses.nptel.ac.in/noc21_me89/preview	8 Weeks	2
	Non Traditional Abrasive Machining Processes Ultrasonic, Abrasive Jet and Abrasive Water Jet Machining	https://onlinecourses.nptel.ac.in/noc21_me05/preview	4 Weeks	1
8	Dynamic Behaviour Of Materials	https://onlinecourses.nptel.ac.in/noc21_me93/preview	12 Weeks (PG Course)	3
9	Heat Exchangers: Fundamentals and Design Analysis	https://onlinecourses.nptel.ac.in/noc21_me74/preview	12 Weeks	3
10	Rapid Manufacturing	https://onlinecourses.nptel.ac.in/noc21_me104/preview	12 Weeks	3
11	Welding Application Technology	https://onlinecourses.nptel.ac.in/noc21_me99/preview	8 Weeks	2
	Fundamental of Welding Science and Technology	https://onlinecourses.nptel.ac.in/noc21_me12/preview	8 Weeks	2
	Welding Processes	https://onlinecourses.nptel.ac.in/noc21_mm01/preview	12 Weeks	3
12	Foundation of Computational Fluid Dynamics	https://onlinecourses.nptel.ac.in/noc21_me77/preview	8 Weeks	2
	Computational Fluid Dynamics	https://onlinecourses.nptel.ac.in/noc21_me126/preview	12 Weeks	3
	Computational Fluid Dynamics using Finite Volume Method	https://onlinecourses.nptel.ac.in/noc21_me112/preview	12 Weeks	3
13	Energy conservation and waste heat recovery	https://onlinecourses.nptel.ac.in/noc21_mm23/preview	12 Weeks	3
14	Introduction to Turbomachinery	https://onlinecourses.nptel.ac.in/noc21_me127/preview	12 Weeks	3

S.NO	COURSE	COURSE LINK	NO OF WEEKS	NO OF CREDITS
15	Total Quality Management - II	https://onlinecourses.nptel.ac.in/noc21_mg72/preview	8 Weeks	2
	Total Quality Management - I	https://onlinecourses.nptel.ac.in/noc21_mg03/preview	8 Weeks	2
16	Fundamentals of Nuclear Power Generation	https://onlinecourses.nptel.ac.in/noc21_me54/preview	12 Weeks	3
17	Introduction to Industry 4.0 and Industrial Internet of Things	https://onlinecourses.nptel.ac.in/noc21_cs66/preview	12 Weeks	3
18	Entrepreneurship	https://onlinecourses.nptel.ac.in/noc21_mg70/preview	12 Weeks	3
	Entrepreneurship and IP Strategy	https://onlinecourses.nptel.ac.in/noc21_hs102/preview	8 Weeks	2
	Innovation, Business Models and Entrepreneurship	https://onlinecourses.nptel.ac.in/noc21_mg63/preview	8 Weeks	2
	Entrepreneurship Essentials	https://onlinecourses.nptel.ac.in/noc21_ge06/preview	12 Weeks	3
19	Fundamentals of industrial oil and hydraulics	https://nptel.ac.in/courses/112/105/112105047/	NA	NA
	Oil Hydraulics and Pneumatics	https://onlinecourses.nptel.ac.in/noc21_me51/preview	12 Weeks	3
20	Processing of Polymers and Polymer Composites	https://onlinecourses.nptel.ac.in/noc21_me17/preview	8 Weeks	2
21	IC Engines and Gas Turbines	https://onlinecourses.nptel.ac.in/noc21_me69/preview	12 Weeks	3
22	Computer Integrated Manufacturing	https://onlinecourses.nptel.ac.in/noc21_me65/preview	12 Weeks	3
23	Gas Dynamics: Fundamentals and Applications	https://onlinecourses.nptel.ac.in/noc21_ae03/preview	12 Weeks	3
24	Design and Analysis of Experiments	https://onlinecourses.nptel.ac.in/noc21_mg48/preview	12 Weeks	3
25	Fundamentals of Automotive Systems	https://onlinecourses.nptel.ac.in/noc21_de02/preview	12 Weeks	3
26	Advanced Thermodynamics	https://onlinecourses.nptel.ac.in/noc21_ch23/preview	12 Weeks	3
27	Failure analysis and Prevention	https://onlinecourses.nptel.ac.in/noc21_me14/preview	8 Weeks	2
28	Theory and Practice of Non Destructive Testing	https://onlinecourses.nptel.ac.in/noc21_mm02/preview	8 Weeks	2
29	Fundamentals of Combustion	https://onlinecourses.nptel.ac.in/noc21_me47/preview	12 Weeks	3
	Fundamentals of combustion for propulsion	https://onlinecourses.nptel.ac.in/noc21_me61/preview	8 Weeks (PG LEVEL)	2
30	Principles of Industrial Engineering	https://onlinecourses.nptel.ac.in/noc21_me15/preview	12 Weeks	3
31	Six Sigma	https://onlinecourses.nptel.ac.in/noc21_mg25/preview	12 Weeks	3

LIST OF ONLINE COURSE PORTALS

19ME0001	Swayam	https://swayam.gov.in/
19ME0002	NPTEL	https://nptel.ac.in/
19ME0003	MIT Open Courseware	https://ocw.mit.edu/index.htm
19ME0004	GIAN	https://gian.iitkgp.ac.in/
19ME0005	Coursera	https://www.coursera.org/
19ME0006	edx	https://www.edx.org/
19ME0007	Saylor	https://www.saylor.org/
19ME0008	Udemy	https://www.udemy.com/

ANNEXURE – V MANDATORY NON CGPA COURSES

(NON ACADEMIC COURSES)

19NC0M01 National Service Scheme (NSS)

1.	Pre –requisites/ Eligibility Conditions	-
2.	Detail of Course Content /Syllabus	
3.	Duration of the Course	Before 7th Semester
4.	Assessment Procedure	-
5.	Criteria for allocation of credit	Attend one orientation programme andparticipation certificate for 75 contact hours/year and participation certificate in 2 activities
6.	In case of failure	-

19NC0M02 National Sports Organization

1.	Pre –requisites / Eligibility Conditions	-
2.	Detail of Course Content / Syllabus	As prescribed by the Physical Education department
3.	Duration of the Course	50 Hours per Year Minimum contact hours required – 38 Hours per Year
4.	Assessment Procedure	As decided by the Physical Education department
5.	Criteria for allocation of credit	Participation in Ties / Zone / Inter Zone / Open Tournament or representation in intramural Sports &Games with 75% attendance in ground practice / Pass on Examination conducted by Physical Education department.
6.	Incase of failure	(If the students core less than 50 marks in the above criteria)Repeat the course

19NC0M03 Youth Red Cross (YRC)

1.	Pre –requisites / Eligibility Conditions	-
2.	Detail of Course Content /Syllabus	Periodical meetings, Blood Donation Camp, Orphanage visit, Awareness Programmes , Test related to YRC(Multiple Choice Questions)
3.	Duration of the Course	One year
4.	Assessment Procedure	Evaluation will be based on attending periodical meetings (Attendance) / Camp / Orphanage visit / Test / Awareness Programmes
5.	Criteria for allocation of credit	Participation certificate in 2 activities
6.	Incase of failure	-

19NC0M04 Yoga for Empowerment

1.	Pre –requisites/ Eligibility Conditions	As prescribed by Yoga class practitioners
2.	Detail of Course Content /Syllabus	
3.	Duration of the Course	60 Hours per Year. Minimum contact hours required – 45Hours per year
4.	Assessment Procedure	-
5.	Criteria for allocation of credit	Completion certificate issued by the Yoga Club / Yoga class practitioners
6.	Incase of failure	-

19NC0M05 Aptitude Proficiency Certification

1.	Pre –requisites/ Eligibility Conditions	As prescribed by the course coordinator
2.	Detail of Course Content / Syllabus	
3.	Duration of the Course	40 periods with minimum 70% of attendance
4.	Assessment Procedure	As prescribed by the course coordinator
5.	Criteria for allocation of credit	Pass in End Examination / Minimum score in GMAT/CAT /NAC/MAT
6.	Incase of failure	Repeat the course

19NC0M06 Critical and Creative Thinking

1.	Pre –requisites/ Eligibility Conditions	Prior permission from the HOD is must
2.	Detail of Course Content /Syllabus	Refer **Annexure-IV**
3.	Duration of the Course	15 Hours
4.	Assessment Procedure	As per the procedure specified for theory courses
5.	Criteria for allocation of credit	Proof for the successful completion of the course provided by the course instructor
6.	In case of failure	-

19NC0M07 English Proficiency Certification

1.	Pre –requisites/ Eligibility Conditions	As prescribed by the certifying authority
2.	Detail of Course Content / Syllabus	
3.	Duration of the Course	
4.	Assessment Procedure	
5.	Criteria for allocation of credit	A certificate for attending BEC course / Minimum score in TOFEL iBT / GRE/IELTS
6.	In case of failure	Repeat the course

19NC0M08 Foreign/Vernacular Languages

1.	Pre –requisites/Eligibility Conditions	-
2.	Detail of Course Content /Syllabus	As prescribed by the course conducting Universities / Schools
3.	Duration of the Course	
4.	Assessment Procedure	
5.	Criteria for allocation of credit	Pass certificate issued by the competing authority
6.	In case of failure	Repeat the course

19NC0M09 Globally Accepted Certification Courses

1.	Pre-requisites /Eligibility Conditions	Prior permission from the HOD is must
2.	Detail of Course Content / Syllabus	As prescribed by the certifying authority
3.	Duration of the Course	
4.	Assessment Procedure	
5.	Criteria for allocation of credit	Proof for the successful completion of the course provided by the globally accepted certifying agencies like HPATA / Microsoft / National Instruments (Lab View) / Oracle / IBM / CISCO Networking Academy / ADOBE / REDHAT / Sun Microsystems JAVA/ Softwares related to Mechanical and Civil Engineering
6.	Incase of failure	-

19NC0M10 Soft skills

1.	Pre –requisites/ Eligibility Conditions	Completion of 2nd semester
2.	Detail of Course Content /Syllabus	As prescribed by Training and Skill Development
3.	Duration of the Course	-
4.	Assessment Procedure	-
5.	Criteria for allocation of credit	Successful completion of Soft skill Training with minimum 20 contact hours
6.	Incase of failure	-

ANNEXURE – VI INDUSTRIAL TRAINING/INTERNSHIP

Industrial Training

1.	Pre –requisites/ Eligibility Conditions	After completion of the third semester. The student may undergo Industrial training in reputed organization after getting prior permission from HOD
2.	Detail of Course Content Syllabus	Inplant training in any organization like BSNL,TTPS, BHEL, NLC etc., related to their programmes
3.	Duration of the Course	As in Table below
4.	Assessment Procedure	1. Student has to submit a report. 2. Evaluation Committee will be constituted by the respective department HOD to assess the report based on the following criteria´s. • Evaluation of report given by the student(40%) • Student's presentation (40%) • Oral Examination (20%)
5.	Criteria for allocation of credit	Satisfactory completion certificate issued by the respective department HOD based on the performance of the student and a certificate from the organization concerned.
6.	In case of failure	

Duration of Industrial Training / Internship

Duration of Industrial Training / Internship	Credits
2 Weeks	1
4 Weeks	2
6 Weeks	3
8 or more Weeks	4

Internship

1.	Pre –requisites / Eligibility Conditions	After completion of the third semester. The student may undergo intensive training after getting prior permission from HOD
2.	Detail of Course Content / Syllabus	Internship Training in R&D organization like CSIR, DRDO, IITs and IISC etc related to their programmes
3.	Duration of the Course	As in Table below
4.	Assessment Procedure	1. Student has to submit a report for Internship 2. Evaluation Committee will be constituted by the respective department HOD to assess the report based on the following criteria's. • Internship Report(40%) • Student's presentation(40%) • Oral Examination (20%)
5.	Criteria for allocation of credit	Satisfactory completion certificate issued by respective department HOD based on the performance of the student and a certificate obtained from the organization concerned.
6.	Incase of failure	-

Duration of Industrial Training / Internship

Duration of Industrial Training / Internship	Credits
2 Weeks	1
4 Weeks	2
6 Weeks	3
8 or more Weeks	4

ANNEXURE –VII CRITICAL & CREATIVE THINKING

19NC0M06 CRITICAL &CREATIVE THINKING CREDIT : 1

Course Outcome:

CO1:After completing the course the students will be critical thinkers and creative problem solvers by generating new ideas

Creativity is not an external force or rare skill, it is a habit that can be learned and exercised every day. This course challenges preconceived notions about creativity and provides valuable tools that will unlock this skill to help you generate better ideas faster. We will lead you through few short, fun exercises that will bring little creativity and will also bring out your hidden thinking skills that you might not have realized before

INTRODUCTION

Types of Human Thinking:

Remembering and Recalling – Understanding – Applying – Analyzing – Evaluating Creating – Opposing – Categories of Types of Thinking, Vertical vs. Lateral Thinking – Concrete Thinking vs. Abstract Thinking – Convergent Thinking vs. Divergent Thinking – Logical vs. Analytical Thinking – Creative Thinking vs. Analytical Thinking – Sequential (linear) Thinking vs. Holistic Thinking – Errors in thinking – Partialism – Adversary Thinking – Time scale error – Initial Judgement – Arroganceand Conceit

Thinking Formula:

AIMS Goals Objective – Consider all factors – Plus Minus Interesting – Other Peoples View v Alternatives Possible choices

CRITICAL THINKING SKILLS

Interpretations Skill –Analysis,Skill –Inference Skills – Evaluation – Explanation – Self Regulation Skills

CREATIVE THINKING &INNOVATION

Creative vs. Critical Thinking –Creativity vs. Innovation –Invention vs. Innovation –Creativity and Innovation in Entrepreneurship –Creative Team and Collaborative Thinking –Exploring Innovation and Creativity within Organizations

DESIGN THINKING

What is Design Thinking –Design thinking process:Empathy understanding of Problem, Define the problem, Ideate (Generating new ideas for Problem Solving),Prototype, Test

IDEATION TOOLS AND METHODS

Brain storming –Reverse Brainstorming –Mind mapping tool – SWOT Analysis –SCAMPER method

HOD/MECH