MANAV RACHNA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM STRUCTURE

&

DETAILED SYLLABUS

B.Tech. Mechanical Engineering

BATCH: 2016-2020

MANAV RACHNA UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

B.TECH (MEU01)

SEMESTER - 1

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/ Workshop/ NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	T	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MEH101-T	ELEMENTS OF MECHANICAL ENGINEERING	ME	HARD	CORE	3	1	0	0	4	4
MEH101-P	ELEMENTS OF MECHANICAL ENGINEERING LAB	ME	HARD	CORE	0	0	2	0	2	1
PHH101-T	THERMODYNAMICS	PH	HARD	CORE	3	1	0	0	4	4
PHH101-P	THERMODYNAMICS LAB	PH	HARD	CORE	0	0	2	0	2	1
CHH101-T	GREEN CHEMISTRY	CH	HARD	CORE	3	1	0	0	4	4
CHH101-P	GREEN CHEMISTRY LAB	CH	HARD	CORE	0	0	2	0	2	1
MAH103-T	ENGINEERING MATHEMATICS-I	MA	HARD	CORE	3	1	0	0	4	4
MAH103-P	ENGINEERING MATHEMATICS-I LAB	MA	HARD	CORE	0	0	2	0	2	1
HLS101	BUSINESS ENGLISH	HL	SOFT	CORE	1	0	2	0	3	2
MEW102	WORKSHOP	ME	HARD	CORE	0	0	3	0	3	2
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**13**	**4**	**13**	**0**	**30**	**24**

	SEMESTER-2									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
ECH103-T	FUNDAMENTALS OF ELECTRICAL & ELECTRONICS ENGINEERING	EC	HARD	CORE	3	1	0	0	4	4
ECH103-P	FUNDAMENTALS OF ELECTRICAL & ELECTRONICS ENGINEERING LAB	EC	HARD	CORE	0	0	2	0	2	1
PHH104-T	MECHANICS	PH	HARD	CORE	3	1	0	0	4	4
PHH104-P	MECHANICS LAB	PH	HARD	CORE	0	0	2	0	2	1
CSH101-T	STRUCTURED PROGRAMMING	CS	HARD	CORE	3	1	0	0	4	4
CSH101-P	STRUCTURED PROGRAMMING LAB	CS	HARD	CORE	0	0	2	0	2	1
MAH105-T	ENGINEERING MATHEMATICS-II	MA	HARD	CORE	3	1	0	0	4	4
MAH105-P	ENGINEERING MATHEMATICS-II LAB	MA	HARD	CORE	0	0	2	0	2	1
HLS102	COMMUNICATIVE ENGLISH	HL	SOFT	CORE	1	0	2	0	3	2
MEW103	ENGINEERING DRAWING	ME	WORKSHOP	ELECTIVE	0	0	3	0	3	2
CHS102	ENVIRONMENTAL SCIENCE	CH	NTCC	UNIVERSITY COMPULSORY	1	0	2	0	3	0
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**14**	**4**	**15**	**0**	**33**	**24**
MEO104	SUMMER TRAINING POST 2nd SEMESTER									3

	SEMESTER-3									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MEH205-T	FLUID MECHANICS	ME	HARD	CORE	3	1	0	0	4	4
MEH205-P	FLUID MECHANICS LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH206-T	ENGINEERING MATERIALS AND THEIR BEHAVIOUR	ME	HARD	CORE	3	1	0	0	4	4
MEH206-P	ENGINEERING MATERIALS AND THEIR BEHAVIOUR LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH207-T	MECHANICS OF MATERIALS	ME	HARD	CORE	3	1	0	0	4	4
MEH207-P	MECHANICS OF MATERIALS LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH208-T	MANUFACTURING TECHNOLOGY-I	ME	HARD	CORE	3	1	0	0	4	4
MEH208-P	MANUFACTURING TECHNOLOGY-I LAB	ME	HARD	CORE	0	0	2	0	2	1
CDO201	APTITUDE DEVELOPMENT	CDC	OUTCOME	CORE	0	0	0	1	1	0.5
RDO201	INTRODUCTION TO RESEARCH	RESEARCH	OUTCOME	CORE	0	0	0	1	1	1
EDS288	APPLIED PHILOSOPHY	ALL	SOFT	ELECTIVE (HUMANITIES BASKET)	1	0	2	0	3	2
EDS289	APPLIED PSYCHOLOGY									
EDS290	APPLIED SOCIOLOGY									
MEW209	MACHINE DRAWING	ME	WORKSHOP	CORE	0	0	3	0	3	2
FLS103	FRENCH-I	MRCFL	NTCC	UNIVERSITY COMPULSORY	1	1	0	0	2	0
FLS101	SPANISH-I									
FLS102	GERMAN-I									
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**14**	**5**	**13**	**2**	**34**	**25.5**

	SEMESTER-4									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MEH210-T	THEORY OF MACHINES	ME	HARD	CORE	3	1	0	0	4	4
MEH210-P	THEORY OF MACHINES LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH211-T	MANUFACTURING TECHNOLOGY-II	ME	HARD	CORE	3	1	0	0	4	4
MEH211-P	MANUFACTURING TECHNOLOGY-II LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH212-T	THERMAL ENGINEERING	ME	HARD	CORE	3	1	0	0	4	4
MEH212-P	THERMAL ENGINEERING LAB	ME	HARD	CORE	0	0	2	0	2	1
MAH309-T	APPLIED NUMERICAL TECHNOLOGY & COMPUTING	MA	HARD	ELECTIVE	3	1	0	0	4	4
CHH219-T	POLYMER CHEMISTRY	CH								
PHH221-T	LASER TECHNOLOGY	PH								
MAH309-P	APPLIED NUMERICAL TECHNOLOGY & COMPUTING LAB	MA	HARD	ELECTIVE	0	0	2	0	2	1
CHH219-P	POLYMER CHEMISTRY LAB	CH								
PHH221-P	LASER TECHNOLOGY LAB	PH								
CHS234	ENVIRONMENT SUSTAINABLE DEVELOPMENT	CH	SOFT	ELECTIVE	1	0	2	0	3	2
ECS249	E-WASTE MANAGEMENT	EC								
CDO202	PERSONALITY DEVELOPMENT	CDC	OUTCOME	CORE	0	0	0	1	1	0.5
RDO202	TECHNICAL SEMINAR-I	RESEARCH	OUTCOME	CORE	0	0	0	1	1	1
MEW213	Design Software-I	ME	WORKSHOP	ELECTIVE	0	0	3	0	3	2
MEW214	Design Software-II									
FLS107	FRENCH-II	MRCFL	NTCC	UNIVERSITY COMPULSORY	1	1	0	0	2	0
FLS105	SPANISH-II									
FLS106	GERMAN-II									
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**14**	**5**	**13**	**2**	**34**	**25.5**
MEW215	SUMMER TRAINING POST 4TH SEMESTER									3

	SEMESTER-5									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MEH316-T	MACHINE DESIGN	ME	HARD	CORE	3	1	0	0	4	4
MEH316-P	MACHINE DESIGN LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH317-T	PRODUCTION MANAGEMENT	ME	HARD	CORE	3	1	0	0	4	4
MEH317-P	PRODUCTION MANAGEMENT LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH318-T	INTERNAL COMBUSTION ENGINES	ME	HARD	CORE	3	1	0	0	4	4
MEH318-P	INTERNAL COMBUSTION ENGINES LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH319-T	ADVANCED THERMODYNAMICS	ME	HARD	ELECTIVE	3	1	0	0	4	4
MEH320-T	COMPUTER AIDED MANUFACTURING & COMPUTER INTEGRATED MANUFACTURING	ME								
MEH321-T	HYDRAULIC MACHINES	ME								
MEH322-T	FOUNDRY TECHNOLOGY	ME								
MEH323-T	COMPUTER AIDED DESIGN AND ENGINEERING	ME								
CSH314-T	INFOSYS FOUNDATION PROGRAM FP4.0	CS								
ECH207-T	PRINCIPLES OF DIGITAL ELECTRONICS & CIRCUIT DESIGN	EC								
MEH319-P	ADVANCED THERMODYNAMICS LAB	ME	HARD	ELECTIVE	0	0	2	0	2	1
MEH320-P	COMPUTER AIDED MANUFACTURING & COMPUTER INTEGRATED MANUFACTURING LAB	ME								
MEH321-P	HYDRAULIC MACHINES LAB	ME								
MEH322-P	FOUNDRY TECHNOLOGY LAB	ME								
MEH323-P	COMPUTER AIDED DESIGN AND ENGINEERING LAB	ME								
CSH314-P	INFOSYS FOUNDATION PROGRAM FP4.0 LAB	CS								
ECH207-P	PRINCIPLES OF DIGITAL ELECTRONICS & CIRCUIT DESIGN LAB	EC								
LWS-321	LAW OF PATENTS & TRADITIONAL KNOWLEDGE	LW	SOFT	ELECTIVE	1	0	2	0	3	2
LWS-322	LAW OF COPYRIGHTS	LW								
LWS-323	CYBER LAWS	LW								
RDO303	TECHNICAL SEMINAR	RESEARCH	OUTCOME	CORE	0	0	0	1	1	1
MEW324	DESIGN SOFTWARE-I	ME	WORKSHOP	ELECTIVE	0	0	3	0	3	2
MEW325	DESIGN SOFTWARE-II	ME								
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**13**	**4**	**13**	**1**	**31**	**25**

	SEMESTER-6									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MEH326-T	HEAT TRANSFER	ME	HARD	CORE	3	1	0	0	4	4
MEH326-P	HEAT TRANSFER LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH327-T	MACHINE DESIGN-II	ME	HARD	ELECTIVE 1	3	1	0	0	4	4
MEH328-T	MECHANICAL VIBRATION	ME	HARD							
MEH329-T	SOLAR ENERGY ENGINEERING	ME	HARD							
MEH327-P	MACHINE DESIGN-II LAB	ME	HARD	ELECTIVE 1	0	0	2	0	2	1
MEH338-P	MECHANICAL VIBRATION LAB	ME	HARD							
MEH329-P	SOLAR ENERGY ENGINEERING LAB	ME	HARD							
MEH330-T	MECHNICS OF MATERIALS-II	ME	HARD	ELECTIVE 2	3	1	0	0	4	4
MEH331-T	MEASUREMENT, INSTRUMENTATION & CONTROL	ME	HARD							
MEH332-T	POWER PLANT ENGINEERING	ME	HARD							
MEH330-P	MECHNICS OF MATERIALS-II LAB	ME	HARD	ELECTIVE 2	0	0	2	0	2	1
MEH331-P	MEASUREMENT, INSTRUMENTATION & CONTROL LAB	ME	HARD							
MEH332-P	POWER PLANT ENGINEERING LAB	ME	HARD							
ECH327-T	CONTROLS SYSTEMS	EC	HARD	ELECTIVE 3	3	1	0	0	4	4
ECH435-T	MICRO ELECTRIC MECHANICAL SYSTEMS	EC	HARD							
ECH326-T	MICROPROCESSORS & INTERFACING	EC	HARD							
CSH316-T	ARTIFICIAL INTELLIGENCE & INTELLIGENCE SYSTEMS	CS	HARD							
ECH327-P	CONTROLS SYSTEMS LAB	EC	HARD	ELECTIVE 3	0	0	2	0	2	1
ECH435-P	MICRO ELECTRIC MECHANICAL SYSTEMS LAB	EC	HARD							
ECH326-P	MICROPROCESSORS & INTERFACING LAB	EC	HARD							
CSH316-P	ARTIFICIAL INTELLIGENCE & INTELLIGENCE SYSTEMS LAB	CS	HARD							
	BASKET OF COURSES BY MANAGEMENT DEPTT	MC	SOFT	ELECTIVE	1	0	2	0	3	2
MEW333	ANALYSIS SOFTWARE-I	ME	WORKSHOP	ELECTIVE	0	0	3	0	3	2
MEW334	ANALYSIS SOFTWARE-II									
RDO304	PROJECT PHASE-I	RESEARCH	OUTCOME	CORE	0	0	0	1	1	1
CDO306	PERSONALITY DEVELOPMENT	CDC	OUTCOME	CORE	0	0	0	1	1	0.5
CDS204	QUANTITATIVE APTITUDE	CDC	SOFT	ELECTIVE	1	0	2	0	3	2
	BASKET BY LAW	LW								
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**14**	**4**	**15**	**2**	**35**	**27.5**
MEW335	SUMMER TRAINING POST 6TH SEMESTER									3

	SEMESTER-7									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MEH436-T	REFRIGERATION AND AIR CONDITIONING	ME	HARD	CORE	3	1	0	0	4	4
MEH436-P	REFRIGERATION AND AIR CONDITIONING LAB	ME	HARD	CORE	0	0	2	0	2	1
MEH437-T	FINITE ELEMENT METHOD	ME	HARD	ELECTIVE	3	1	0	0	4	4
MEH438-T	ALTERNATE FUELS, POLLUTION AND CONTROL									
MEH439-T	QUALITY ENGINEERING									
MEH440-T	AUTOMOBILE ENGINEERING									
MEH437-P	FINITE ELEMENT METHOD LAB	ME	HARD	ELECTIVE	0	0	2	0	2	1
MEH438-P	ALTERNATE FUELS, POLLUTION AND CONTROL LAB									
MEH439-P	QUALITY ENGINEERING LAB									
MEH440-P	AUTOMOBILE ENGINEERING LAB									
MEN441	MINOR PROJECT	ME	NTCC	CORE	0	0	0	3	3	3
MEN442	SEMINAR	ME	NTCC	CORE	0	0	0	1	1	1
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**6**	**2**	**4**	**4**	**16**	**14**

	SEMESTER-8									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**T**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MEH443-T	HEATING VENTILATION AND AIR CONDITIONING	ME	HARD	ELECTIVE-I	3	1	0	0	4	4
MEH444-T	PRODUCT DESIGN AND DEVELOPMENT									
MEH445-T	PROJECT MANAGEMENT									
MEH443-P	HEATING VENTILATION AND AIR CONDITIONING	ME	HARD	ELECTIVE-I	0	0	2	0	2	1
MEH444-P	PRODUCT DESIGN AND DEVELOPMENT									
MEH445-P	PROJECT MANAGEMENT									
MEH446-T	COMPUTATIONAL FLUID DYNAMICS	ME	HARD	ELECTIVE-II	3	1	2	0	4	4
MEH447-T	MECHATRONICS									
MEH448-T	AUTOMATION IN MANUFACTURING									
MEH446-P	COMPUTATIONAL FLUID DYNAMICS LAB	ME	HARD	ELECTIVE-II	0	0	2	0	2	1
MEH447-P	MECHATRONICS LAB									
MEH448-P	AUTOMATION IN MANUFACTURING LAB									
MEN449	MAJOR PROJECT	ME	NTCC	CORE	0	0	0	8	8	8
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				**6**	**2**	**6**	**8**	**20**	**18**

*COURSE NATURE	
	Hard course (H): A course having L-T-P and/or O component ; L(Lecture), T(Tutorial), P(Practical) and O(Outcome)
	Soft Course (S): A course aimed at development of a person's emotional, social, ethical, professional and creative potentials. The
	Workshop course(W): A completely 'hands on' course conducted in laboratory, aimed at developing application/ implementation/
	Non Teaching Credit Course(N): The course involves no teaching and has P and O component. Shall include projects, seminars,

**OFFERING DEPARTMENT NAMES		A course shall be assigned credits as under:
EC	DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING	One credit for each lecture hour; One credit for each tutorial hour ; One credit for each Outcome hour; Two credits for each workshop/ laboratory/practical/project session of 3 hours; One credit for each laboratory or practical or project session of 2 hours
PH	DEPARTMENT OF PHYSICS	
CS	DEPARTMENT OF COMPUTER SCIENCE & TECHNOLOGY	
HL	DEPARTMENT OF HUMANITIES & LANGUAGES	
CH	DEPARTMENT OF CHEMISTRY	
MA	DEPARTMENT OF MATHEMATICS	
ME	DEPARTMENT OF MECHANICAL ENGINEERING	
MC	DEPARTMENT OF MANAGEMENT & COMMERCE	
MRCFL	MANAV RACHNA CENTRE OF FOREIGN LANGUAGES	

*** Electives are subject to change according to expertise available/ required.

MANAV RACHNA
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MANAV RACHNA UNIVERSITY
(FORMERLY MANAV RACHNA COLLEGE OF ENGINEERING
NAAC ACCREDITED 'A' GRADE INSTITUTION)
Declared as State Private University under section 2f of the UGC act, 1956

DEPARTMENT OF MECHANICAL ENGINEERING
B.TECH (ME) - MEU01
Batch-2016-20

MANAV RACHNA UNIVERSITY

Department of Mechanical Engineering

MANAV RACHNA UNIVERSITY

Vision

To educate students in frontier areas of knowledge enabling them to take up challenges as ethical and responsible global citizens

Mission

- **To impart outcome based holistic education**
- **To disseminate education in frontier areas**
- **To produce globally competitive, ethical and socially responsible human resources**
- **To produce human resources sensitive to issues of Environment and Sustainable Development**
- **To develop Environment and Sustainable development as a thrust area of research and development.**

Quality Policy

To continuously learn from the best practices, study role models and develop transparent procedures for empowerment of stakeholders.

Strategic Objectives

- **To facilitate, enhance & promote innovation in curriculum design and delivery and have Outcome-oriented Learning Culture.**
- **To promote Research Environment and Management Practices.**
- **To enhance the quality of the student learning experience.**
- **To provide Resources and Infrastructure for Academic Excellence.**

DEPARTMENT OF MECHANICAL ENGINEERING

Vision: To become centre of excellence by providing state-of-art education in teaching, research, innovation, entrepreneurship, environmental sustainability and develop an ethical human beings for service of the society.

Mission:

- To develop globally competent engineers, who address future issues of the society innovatively.
- Operating and maintaining various smart manufacturing aides optimally by providing state-of-art facilities and conduct research in latest technologies.
- To nurture talents who strive to serve society through sustainable methods while maintaining the highest professional and ethical standards.
- Maintaining highest quality standards and ensure satisfaction of all stakeholders.
- To work for continuous improvement in collaboration with Industry.

B.Tech. Mechanical Engineering

Programme Educational Objectives (PEOs):

PEO1	**To prepare mechanical engineering graduates with an outstanding knowledge of mathematical, scientific, engineering, technology, management, humanities and various other interdisciplinary subjects for a successful career.**
PEO2	**To equip students with modern tools, technology and advanced software's for deliberating engineering solutions.**
PEO3	**To equip students with broad based knowledge to support the service industries, economic development and to address social and engineering challenges of the nation.**
PEO4	**To inculcate students with leadership skills with high level of integrity and ethical values for team building and team work.**

Programme Specific Outcomes (PSOs):

PSO-1	**Our Students will be equipped with Industrial Management Skills and Interdisciplinary Technologies**
PSO-2	**Our Students shall be conscious of sustainable use of resources in professional work which they will undertake.**

PROGRAM OUTCOMES (POs):

PO1. Engineering Knowledge: Apply knowledge of mathematics, science and engineering fundamentals and Production and Industrial Engineering specialization to the solution of complex Production and Industrial Engineering problems.

PO2. Problem Analysis: Identify, formulate, research literature and analyze complex Production and Industrial Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex Production and Industrial Engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

PO4. Conduct investigations of complex Production and Industrial Engineering problems using research-based knowledge and research methods including analysis, interpretation of data and synthesis of information to provide valid conclusions.

PO5. Modern Tool Usage: To apply appropriate techniques, resources and engineering and IT tools for modelling of different Production and Industrial Engineering problems with an understanding of the limitations.

PO6. The Engineer and Society: Apply contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of professional Production and Industrial Engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of Production and Industrial Engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

PO10. Communication: Communicate effectively on complex Production and Industrial Engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of Production and Industrial Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12. Life Long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Semester 1 (24)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core	Elements of Mechanical Engineering (ME)		
			Workshop (ME)
Allied Core	Engineering Mathematics-1(Math)	Business English (Humanities)	
	Green Chemistry (Chemistry)		
	Thermodynamics-(Physics)		
Domain Elective			
Allied Elective			
Credits	20	2	2
AUDIT COURSE			
Total credits	24		
Total no of hours	30 Hours		

Semester 2 (28)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core			
			Engineering Drawing (ME)
Allied Core	Engineering Mathematics-II (Math)	Communicative English (Humanities)	
	Structured Programming (CSE)		
	Fundamentals of Electrical & Electronics Engineering (ECE)		
	Mechanics (Physics)		
	Environmental Sciences (Chemistry)		
Domain Elective			
Allied Elective			
Credits	20	2	2
Audit Courses			
Total Credits	28		
Total Hours	33		

Semester 3 (Total Credit-25.5)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) / NTCC Course (0-0-0-1) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core	Fluid Mechanics (ME)		
	Engineering Materials and their Behavior (ME)		
	Mechanics of Materials (ME)		
	Manufacturing Technology-I (ME)		Machine Drawing (ME)
Allied Core			
Domain Elective			
Allied Elective		Basket of Elective offered by Humanities Department	
NTCC		Professional Competency Enhancement-I	
		Introduction to Research	
Credits	20	3.5	2
Audit Course	Foreign Language (1-1-0) (MRCFL)		
Total Credits	25.5		
No of Hours	34		

Semester 4 (Total credit – 25.5)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) / NTCC Course (0-0-0-1) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core	Theory of Machines		
	Manufacturing Technology-II		
	Thermal Engineering		
Allied Core			
Domain Elective			Design Software-I
			Design Software-II
Allied Elective	Applied Numerical Technology and Computing (Math)	Baskets of Electives on Environmental Ethics and Sustainable Development	
	Polymer Technology (Chemistry)		
	Laser Technology (Physics)		
NTCC		Professional Competency Enhancement-II	
		Technical Seminar-I	
Credits	20	3.5	2
Audit Course	Foreign Language (1-1-0) (MRCFL)		
Total Credits	25.5		
No of Hours	34		

Semester 5 (Total credit – 25.5)

<table>
<tr><td>Nature of the course/
Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2) /
NTCC Course (0-0-0-1)
Name (Offering Department)</td><td>Workshop (0-0-3) name (Offering Department)</td></tr>
<tr><td rowspan="3">Domain Core</td><td>Machine Design (ME) (3-1-2-1)</td><td></td><td></td></tr>
<tr><td>Hydraulic Machines (ME)</td><td></td><td></td></tr>
<tr><td>IC Engines (ME)</td><td></td><td></td></tr>
<tr><td>Allied Core</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Domain Elective</td><td rowspan="4">E1-
-Computer Aided manufacturing and Integrated Manufacturing (CAM & CIM)
-Measurement & Instrumentation
-Advanced Thermodynamics
-Foundry Technology
-Computer Aided Design and Engineering (CAD&CAE)</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td>Analysis Software-I</td></tr>
<tr><td></td><td>Analysis Software-II</td></tr>
<tr><td rowspan="2">Allied Elective</td><td rowspan="2"></td><td>Basket of Elective offered by Law Department</td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2">NTCC</td><td></td><td>Professional Competency Enhancement-III</td><td></td></tr>
<tr><td></td><td>Technical Seminar-II</td><td></td></tr>
<tr><td>Credits</td><td>20</td><td>3.5</td><td>2</td></tr>
<tr><td>Total Credits</td><td colspan="3">25.5</td></tr>
<tr><td>Total Hours</td><td colspan="3">32</td></tr>
</table>

Semester 6 (Total credit – 25.5)

<table>
<tr><td>Nature of the course/
Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2) /
NTCC Course (0-0-0-1)
Name (Offering Department)</td><td>Workshop (0-0-3)
name (Offering Department)</td></tr>
<tr><td>Domain Core</td><td>Heat Transfer</td><td></td><td></td></tr>
<tr><td>Allied Core</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Domain Elective</td><td rowspan="5">E2-
-Machine Design-II
-Solar Energy Engineering
-Mechanical Vibration

E3-
-Mechanics of materials-II
-Power Plant Engineering
-Production Management</td><td></td><td>Analysis Software-I</td></tr>
<tr><td></td><td>Analysis Software-II</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td rowspan="6">Allied Elective</td><td rowspan="6">E4

-Control Systems (ECE)
-Micro Electric Mechanical Systems (ECE)
-Microprocessors & interfacing (ECE)

Artificial Intelligence & Intelligence Systems(CSE)

*A student can pick only one subject from Allied Electives</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Basket of Elective offered by Management Department</td><td></td></tr>
<tr><td>NTCC</td><td></td><td>Professional Competency Enhancement-IV</td><td></td></tr>
<tr><td></td><td></td><td>Project Phase-I</td><td></td></tr>
<tr><td>Credits</td><td>20</td><td>3.5</td><td>2</td></tr>
<tr><td>Total Credits</td><td colspan="3">25.5</td></tr>
<tr><td>Total No of Hours</td><td colspan="3">32</td></tr>
</table>

Semester 7 (Total credit - 14)

<table>
<tr><td>Nature of the course/
Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2)
Name (Offering Department)</td><td>NTCC (0-0-0-N) name</td></tr>
<tr><td rowspan="2">Domain Core</td><td>Refrigeration and Air Conditioning (ME)</td><td></td><td></td></tr>
<tr><td></td><td></td><td>Minor Project(0-0-0-3)</td></tr>
<tr><td></td><td></td><td></td><td>Seminar(0-0-0-1)</td></tr>
<tr><td>Allied Core</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Domain Elective</td><td rowspan="10">E5-
-Finite Element Method
-Alternate Fuels, Pollution and Control
-Quality Engineering
-Automobile Engineering</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Allied Elective</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Credits</td><td>10</td><td>2</td><td>4</td></tr>
<tr><td>Total Credits</td><td colspan="3">14</td></tr>
<tr><td>Total no of Hours</td><td colspan="3">16</td></tr>
</table>

Semester 8 (Total credit - 18)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) Name (Offering Department)	Project (0-0-0-8)
Domain Core			Major Project
Allied Core			
Domain Elective	E6- -Heating Ventilation and Air Conditioning -Product Design and Development -Project Management E7- -Computational Fluid Dynamics -Mechatronics -Automation in Manufacturing		
Allied Elective			
Credits	10		8
Total Credits	18		
Total No of Hours	20		

Semester 1-2	24+28 credits respectively
Summer Training Post 2nd Semester	3 credits : 60 hours module
Semester 3-4	25.5 credits per semester
Summer Training Post 4th Semester	3 credits : 60 hours module
Semester 5-6	25.5 credits per semester
Summer Training Post 6th Semester	3 credits : 60 hours module
Semester 7-8	14+18 credits respectively
MRSLP	2 credits
Total	197 Credits

SEMESTER-1

Nature of the course/ Type of the course	**Hard Course (3-1-2-0) Name (Offering Department)**	**Soft Course (1-0-2) Name (Offering Department)**	**Workshop (0-0-3) name (Offering Department)**
Domain Core	**Elements of Mechanical Engineering (ME)**		
			Workshop (ME)
Allied Core	**Engineering Mathematics-1(Math)**	**BUSINESS ENGLISH (Humanities)**	
	Green Chemistry (Chemistry)		
	Thermodynamics-(Physics)		
Domain Elective			
Allied Elective			
Credits	**20**	**2**	**2**
AUDIT COURSE			
Total credits	**24**		
Total no of hours	**30 Hours**		

Course Title/Code	ELEMENTS OF MECHANICAL ENGINEERING (MEH101)
Course Type	Core
Course Nature	Hard
L-T-P-O structure	3-1-2-0
Prerequisite	NIL

SECTION A

Basic Concept of Thermodynamics**:** Introduction of States, type of processes, Work, Heat, Temperature, Zeroth, 1st, 2nd and 3rd law of thermodynamics. Concept of internal energy, enthalpy and entropy. Problems

Steam generation and its thermodynamic properties**:** Dryness fraction. Use of steam tables and numerical on properties of steam and relations.

SECTION-B

Boilers & Steam Turbine**:** Introduction and classification of boilers, comparison of water and fire tube boilers mountings and accessories with their functions,

Introduction and Classification of Turbines**:** working Principle of Impulse and Reaction Turbine, Comparison of Impulse and Reaction turbines, Hydraulic Turbines & Pumps**:** Introduction, Classification, Construction details and working of Pelton, Francis and Kaplan turbines

SECTION-C

Power Transmission Methods and Devices**:** Introduction to power transmission- belt drive, rope drive, chain drive, gear drive. Introduction to gears, types of gears, Gear trains, Problems

Simple Lifting Machines**:** Definition of machine, velocity ratio, mechanical advantage, Efficiency, laws of machines, reversibility of machine

SECTION-D

Stresses and Strains**:** Introduction, concept & types of stresses and strains, poison's ratio, stresses and strains in simple and compound bars under axial loading, stress- strain diagrams, hooks law, Elastic constants and their relationships.

Refrigeration & Air-conditioning**:** Introduction to refrigeration and air -conditioning, Rating of refrigeration machines, Coefficient of performance, Simple refrigeration systems, Simple vapor compression refrigeration cycle,

Introduction to machine tools: commonly used machine tools in a workshop, lathe, shaper planer –milling, drilling slotter.

Introduction to Industrial Engineering

TEXT BOOKS & REFERENCES:

1. Elements of Mechanical Engineering by D.S. Kumar, S.K. Kataria and Sons

2. Fundamental of Mechanical Engineering by G.S. Sawhney, PHI Publication New Delhi

LIST OF EXPERIMENTS:

1. To calculate Enthalpy and Entropy of steam at different parameters by using Mollier chart.
2. To study water tube boiler

3. To study fire tube boiler
4. To Operate & Study the constructional features and working of Pelton Wheel Turbine, Francis Turbine and Kaplan Turbine
5. To calculate Mechanical Advantage, Velocity Ratio and Efficiency of Single Purchase and Double purchase winch crab and plot graphs
6. To calculate Mechanical Advantage, Velocity Ratio and Efficiency of a Simple Screw Jack
7. To calculate the Mechanical Advantage, Velocity Ratio and Efficiency of Single Start and Double Start Worm Wheel
8. To perform tensile test, plot the stress,-strain diagram and evaluate the tensile properties of a given metallic specimen
9. To Operate & Study the vapour compression Refrigeration System and determination of its C.O.P.

Course Title/ Code	THERMODYNAMICS (PHH101)
Course Type:	Core (Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Phases of Matter, System States, Thermodynamic Properties, Thermodynamic Equilibrium, Thermodynamic Processes, Pressure and Temperature Scales, The Zeroth Law of Thermodynamics, Conservation Concept, Conservation of Mass and Energy, System Energy, Enthalpy, Phase Diagrams, Thermodynamic Equations of State.
The First law of Thermodynamics, State and Path Functions, Heat Transfer Modes, Applications: Closed Rigid Containers, Electrical Work, Incompressible Liquids, Ideal Gases, Piston-Cylinder Device, Unsteady Flow Processes, Conservation of Energy and Conservation of Mass Equations for Open Systems, Flow Stream Specific Kinetic and Potential Energies, Throttling Process, Heat Exchangers, Shaft Work of Machines, Open System Unsteady Flow Processes.

SECTION B

Second Law of Thermodynamics, Carnot's Heat Engine, Absolute Temperature Scale, Entropy, Claussius's definition of Entropy, Entropy Balance and Entropy Rate Balance Equations, Reversible and Irreversible Processes, Applications: Diffusion Mixing, Nozzles, Diffusers, and Throttles, Heat Exchangers, Mixing, Shaft Work Machine, Unsteady State Processes in Open Systems, Third Law of Thermodynamics. Availability and Irreversibility: Availability, Maximum Reversible Work, Availability for Closed System, Availability Balance, Flow Availability, Open System Availability Rate Balance, Efficiency Based on the Second Law, Two New Properties: Helmholtz and Gibbs Functions, Gibbs Phase Equilibrium Condition, Irreversibility for open system and Closed SysteM

SECTION C

Pure Substance and its Properties, Phase and Phase Transformation, Vaporization, Evaporation and Boiling, Saturated and Superheat Steam, Solid – Liquid – Vapour Equilibrium, Ideal Gases and Real Gases: Concept of an Ideal Gas, Basic Gas Laws, Characteristic Gas Equation, Avogadro's law and Universal Gas Constant, P-V-T surface of an Ideal Gas, Vander Waal's Equation of state, Reduced Co-ordinates, Compressibility factor and law of corresponding states, Mixture of Gases, Mass, Mole and Volume Fraction, Gibson Dalton's law, Gas Constant and Specific Heats, Entropy for a Mixture of Non-Reactive Gases

SECTION D

Thermodynamic Relations: Maxwell Equations, Clapeyron Equation, Determining U, H, and S from P, V and T, Relations for Changes in Enthalpy and Internal Energy & Entropy, Specific Heat Capacity Relations, Joule Thomson Coefficient & Inversion Curve.

Production of Low Temperatures: Introduction, Common Methods of Cooling, Adiabatic Cooling, Joule Kelvin Expansion, Adiabatic Demagnetization, Helium Cryostats, Pomeranchuk Cooling.

TEXT BOOKS & REFERENCES:

1. Engineering Thermodynamics- P K Nag,Tata Mc Graw Hill
2. Fundamentals of Engineering Thermodynamics – E. Radhakrishnan, PHI, New Delhi
3. Theory and Problems of Thermodynamics – Y. V.C. Rao, Wiley Eastern Ltd., New Delhi

LIST OF EXPERIMENTS:

1. To determine J by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Copper by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Copper by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's Disc method.
5. To determine the Temperature Coefficient Resistance by Platinum Resistance thermometer (PRT).
6. To calibrate a Resistance Temperature (RTD) to measure temperature in a specified range using Null Method/ Off-Balance Bridge With Galvanometer based Measurement.
7. To study the variation of Thermo-Emf of a Thermocouple with Difference of temperature of its Two Junctions.
8. To Calibrate a Thermocouple to measure Temperature in a Specified Range using (1) Null Method (2) Direct Measurement using an Op-Amp Difference Amplifier and to determine Neutral Temperature.
9. To calculate the efficiency of four stroke Engine.

Course Title/ Code	**GREEN CHEMISTRY (CHH101)**
Course Type:	**Core (Allied)**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION-A

Introduction To Green Chemistry: Definition, history, need and goals of green chemistry, Green Chemistry in sustainable development, Importance of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Basic Principles Of Green Chemistry**:** Twelve Principles in Green Chemistry with their explanations and examples, Prevention of waste/by products, Atom Economy, Prevention/Minimization of hazardous/toxic products, Designing safer chemicals, Selection of safer solvents and auxiliaries, Design for energy efficiency (use of microwave and ultrasonic radiations), Use of renewable feedstocks, Avoidance of unnecessary derivatization, Use of catalytic reagents in preference to stoichiometric reagents, Designing biodegradable products, Prevention of chemical accidents (including releases, explosions and fires), Strengthening/Development of green techniques to prevent hazardous substances in chemical process.

SECTION-B

Green Lubricants & Polymers: Introduction, Properties and Applications of conventional and green lubricants, Synthesis of Green Lubricants

Introduction & Classification of polymers, Biodegradable and non-biodegradable polymers, Synthesis of Green Polymers, Polymer Composites

SECTION-C

Green Synthesis: Comparison with Conventional Synthesis: Green starting materials, Green reagents, Green solvents and reaction conditions: water as green solvent, Properties of water and their estimation (Hardness, Alkalinity, Dissolved Oxygen), Green catalyst (Biocatalysts, polymer supported & recoverable catalysts, etc.), Synthesis involving basic principles of green chemistry- Synthesis of Biodiesel and other green compounds, Quantitative Solid-solid synthesis.

SECTION-D

Green Engineering & Its Applications: Need and scope of green engineering, Basic principles of green engineering, Elimination of hazardous compounds by green compounds, Eco-friendly materials for computing

Case studies of Real World/ Indian Cases: Sony Ericsson: Bromine- and Chlorine-Free Mobile Phones, Bio-based composite resins design for electronic materials: Soy Plastics, US Presidential Green Chemistry Challenge Award Winners.

TEXT BOOKS & REFERENCES:

1. Green Chemistry: Theory and Practice, Oxford University Press, P. T. Anastas, J. C. Warner Green Catalysis. 2009.
2. Wiley-VCH, Paul T. Anastas, Robert H. Crabtree

LIST OF EXPERIMENTS:

1. Synthesis of Green compounds (Biodiesel from vegetable oil).
2. Characterization of Bio-diesel by using Spectrophotometer.
3. Determination of Flash and Fire Point & Viscosity Index of Green Liquid Compounds.
4. To determine Hardness of water sample.
5. To determine Alkalinity & dissolved oxygen of water sample.
6. Synthesis of green reagent Tetra butyl ammonium tri bromide (TBATB)
7. Solvent free Aldol Condensation between 3, 4-dimethoxybenzaldehyde and 1-indanone.
8. Preparation of gold nano particles using tea. Solvent-free and one-pot synthesis of Phthalocyanine Complex of Copper (II).
9. Extraction of D-limonene from orange peel using liquid carbon dioxide as a solvent.

Course Title/ Code	**ENGINEERING MATHEMATICS-I (MAH103)**
Course Type:	**Core (Allied)**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION A

Integral Calculus: Calculus of single variable: Taylor's & Maclaurin's expansion, Radius of curvature. Calculus of several variables: Partial differentiation, Euler's theorem, total differential, Taylor's theorem, Maxima-Minima, Lagrange's method of multipliers, Application in estimation of error and approximation.

SECTION B

Differential Calculus: Applications of definite integral to area, arc length, surface area and volume (in Cartesian, parametric and polar co-ordinates).

Multiple Integrals: Double integral (Cartesian and polar co-ordinates), change of order of integration; triple integrals (Cartesian, cylindrical and spherical co-ordinates), Gamma and Beta functions. Applications of multiple integration in area, volume, centre of mass, and moment of inertia.

SECTION C

Vector Calculus: Continuity and differentiability of vector functions, Scalar and vector point function, Gradient, Directional Derivative, divergence, curl and their applications, line integral, surface integral and volume integral, applications to work done by the force. Applications of Green's, Stoke's and Gauss divergence theorems.

SECTION D

Infinite Series: Tests for convergence of series (comparison, ratio, root, integral, Raabe's, logarithmic), Alternating series, Absolute convergence, Conditional convergence.

TEXT BOOKS & REFERENCES:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi.
2. R.K. Jain & S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, New Delhi.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & sons, New York.

LIST OF EXPERIMENTS:

1. Introduction to MATLAB and use of some simple MATLAB commands.
2. Introduction to some of the fundamentals of MATLAB: Variables, operators, expressions and Arrays(including vectors and matrices).
3. Introduction to graphics: Basic Two-Dimensional Graphs, Labels, Multiple plots on the same axes, Line styles, Markers and color, Axis limits and Subplots.

4. To Plot functions of Several Variables.
5. To find derivatives, partial derivatives & directional derivatives of functions.
6. To find limit, continuity & differentiability of function of several variables.
7. To find maxima & minima of function of several variables.
8. To find the Surface area and volume of solids of revolution by single integration.
9. Evaluation of Double and triple integral and their applications.
10. To find gradient of a scalar field (through graph also).
11. To find directional derivatives, divergence & curl (through graph also).
12. To find the limit of the sequences.
13.Study the convergence/ divergence of infinite series by plotting their sequences of partial sum.
14. Write the program to calculate series $\sum a_n$, where

$(i)\left|\frac{a_{n+1}}{a_n}\right|$ $(ii)|a_n|^{\frac{1}{n}}$ for n = 10^j, j = 1, 2, 3… and identify the convergent series.

Course Title/ Code	BUSINESS ENGLISH (HLS101)
Course Type:	Core
Course Nature:	Soft
L-T-P-O Structure	(1-0-2-0)
Prerequisite	NIL

SECTION-A

Grammar: Introduction to Grammar Adverbs, Adjectives, Articles, Noun (Compound, Countable, Uncountable) Active -Passive Voice

SECTION-B

Tense And Semantics: Tenses, Subject- Verb Agreement, Introduction to Verbs (Auxiliary and Modals, non-finite), Prepositions, Modifiers, Collocation, Synonym, Antonym, Phrasal Verbs, Idioms and Phrases.

SECTION-C

Oral Communication-I: Speech Pattern-1 (Intonation, Word Stress), Speech Pattern-2 (Indianisms, Sentence Stress, Connected Speech), Link Expressions, Question Tags.

SECTION-D

Technical Writing-I: ABC of Writing, KISS Concept, Essay Writing, Report Writing, Email Etiquette, Circular Précis Writing, Memos and Notices. English Vocabulary in use.Macarthy: Foundation Books, Oxford Uni. Press

TEXT BOOKS & REFERENCES:

1. High School English Grammar and Composition. Wren and Martin: S.Chand and Co.
2. A Textbook of English Phonetics for Indian Students. T.Bala Subhrmaniam: Macmillan

LIST OF EXPERIMENTS:

1. Exercises based on Grammar
2. Exercises based on Semantics.
3 .Introduction to Articulation Skills (Conversation: Telephonic and Face-to-Face)
4.Listening to Understand (Hearing vs. Listening)
5.Listening for Inter-personal Effectiveness
6. Techniques & Levels of Reading Comprehension
7. Essay Writing Session
8. Report Writing and Email Etiquette
9. Circular, Memos and Notice Writing
10.Business QUIZ &Idioms and Phrases
11.Individual Presentation
12.Feedback and Poster- Creation.

Course Title	**WORKSHOP (MEW102)**
Course Type	**Core**
Course Nature	**Workshop**
L-T-P-O structure	**0-0-3-0**
Prerequisites	**NIL**

LIST OF EXERCISES/EXPERIMENTS IN WORKSHOP:

1**.** Introduction to plant layout and safety measures.

2. Measuring Instruments**:** To operate and study different type of measuring tools used in meteorology and determine least count of vernier calipers, micrometers and vernier height gauge.

3. Introduction to Jigs and Fixtures of Different types and their uses

4. Machine tools/ Metal cutting**:** To prepare Jobs and study different types of machine tools (Lathe, Shaper, Milling, Drilling, Grinding machines) with regards to their construction and operations.

5. Lathe process**:** To prepare a job on a lathe involving facing, outside turning, step turning, Taper Turning, and study of Tool Signature (i.e. Geometry of cutting tool).

6. Shaping Process**:** To prepare a horizontal surface/ vertical surface/ slot or V-grooves on shaping machine.

7. Milling Process**:** To prepare a job involving side and face milling on milling machine.

8. Sheet Metal Process**:** To prepare sheet metal job giving knowledge of development of layout and introduction to gauge thickness of sheets.

9. Introduction of Drilling, Reaming and Tapping operations along with the related cutting tools

10. Fitting shop**:** To study different types of fitting tools and marking tools used in fitting processes, along with their operations and to prepare a job.

11.Welding Shop: Introduction of Various aspects of Welding **.**To prepare joints for welding suitable for butt welding, Lap welding and V-Joint.

12. Carpentry Shop**:** To study different types of carpentry tools and introduction to pattern making, pattern allowances, types of patterns and preparation of simple types of at least two wooden joints.

13. Foundry Shop: Introduction to Foundry and its different Tools used**.** To prepare a mould and core assembly; to pour metal in the mould and fettle the casting.

SEMESTER 2 (28)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core			
			Engineering Drawing (ME)
Allied Core	Engineering Mathematics-II (Math)	Communicative English (Humanities)	
	Structured Programming (CSE)		
	Fundamentals of Electrical & Electronics Engineering (ECE)		
	Mechanics (Physics)		
	Environmental Sciences (Chemistry)		
Domain Elective			
Allied Elective			
Credits	20	2	2
Audit Courses			
Total Credits	28		
Total Hours	33		

Course Title/ Code	FUNDAMENTALS OF ELECTRICAL &ELECTRONICS ENGINEERING (ECH103)
Course Type:	Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Electric Circuits and Measurements**:** Ohm's Law, Kirchoff's Laws, Steady State Solution of DC Circuits, Introduction to AC Circuits, Waveforms and RMS Value, Power and Power factor, Single Phase and Three Phase Balanced Circuits. Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters

SECTION B

Electric Machines **:** Single phase Transformer -Construction, Principle of Operation, EMF equation, DC generator- EMF equation, types, DC Motors- need of starter, types, construction, working principle of single phase and three phase induction Motor, synchronous motors.

SECTION C

Semiconductor Devices **:** Characteristics of PN junction diode, Zener effect, Zener diode and its characteristics, Half wave and full wave rectifiers, Voltage regulation, Bipolar junction transistor– CE configurations and characteristics, Operational amplifier: introduction and its ideal characteristics.

SECTION D

Introduction to Microprocessor & Embedded System**:** Binary Number System, Logic Gates, Boolean Algebra, Half and Full Adders. Bus Organization, Types of Memory

TEXT BOOKS & REFERENCES:

1.Mittle N, Basic Electrical and Electronics Engineering, Tata McGraw Hill Edition, New Delhi
2.Nagsarkar T K and Sukhija M S, Basics of Electrical Engineering, Oxford press
3. Sedha R S, Applied Electronics, S. Chand & Co

LIST OF EXPERIMENTS:

1. Familiarization with the components, breadboard, resistor coding and various types of meters and implementation of a circuit on breadboard.
2. Verification of Kirchhoff's law: (a) Kirchhoff's voltage law (b) Kirchhoff's current law.
3. Measurement of power in single phase AC circuits.
4. Calculation of efficiency and regulation of a single phase transformer OC and SC test on single phase transformer
5.To plot OCC for a DC separately excited shunt generator.
6. To perform direct load test on a DC separately excited shunt generator and plot load voltage vs load current
7. Armature voltage control and field current control of speed of DC shunt motor
8. Familiarization with the working knowledge of the CRO & Function generator, calculation of form factor, peak factor.
9. To plot V-I characteristics of PN junction diode, Zener diode and calculate cut-in voltage and break down voltage
10. Frequency response of CE configuration
11. Integrator and differentiator using op-amp

Course Title/ Code	MECHANICS (PHH104)
Course Type:	Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Contact Forces, Laws of Mechanics, and Vectors Vectorial Representation of Forces and Moments- Vector operations. Conservation of Linear and Angular Momentum, Free Body Diagram, General Equation of Equilibrium Under Two, Three and Four Forces, Lami's Theorem, Moment of a Morce, Couple, Varignon's Theorem ,Scalar and Vector fields, Introduction to Gradient, Divergence and Curl. Trusses-Assumptions, Rigid and Non Rigid Trusses, Simple Truss, Analysis of Simple Truss by Method of Joints and Method of Sections, Compound Truss and its Analysis, Analysis of Frames and Cables, Assumptions, Parabolic and Catenary Cables.

SECTION B

Equation of Rectilinear Motion, Motion Under Gravity, Curvilinear Motion, Tangential and Normal Coordinates, Radial and Transverse Coordinates, Relative Velocity, Motion in a Plane: Introduction to Polar Coordinates, Motion with Constraints, Motion with Friction and Drag, Instantaneous Centre of Rotation, Impulse, Momentum, Work and Energy, D'Alembert's Principle.

Centroid of Area, Volume and Composite Bodies, Pappu Guldinus Theorem, Moment of Inertia of Plane Area, Radius of Gyration, Parallel Axis Theorem, Perpendicular Axis Theorem, Principal Moment of Inertia, Mass Moment of Inertia of Circular Ring, Disc, Cylinder, Sphere and Cone about Axis of Symmetry, Product of Inertia, Rotation of Axis.

SECTION C

Undamped Free Vibrations Damped Free Vibrations, Forced Vibrations, Damped Forced Vibrations, Viscous Damped Free Vibrations, Viscous Damped Forced Vibrations, Energy Methods, Electrical Circuit Analogy. Average Kinetic and Potential Energy, Friction and Superposition.

Virtual Displacements, Principle of Virtual Work for Particle and Ideal System of Rigid Bodies, Degrees of Freedom, Conservative Forces and Potential Energy (Elastic and Gravitational), Energy Equation for Equilibrium. Applications of Energy Method for Equilibrium, Stability of Equilibrium.

SECTION D

Reference Frames, Galilean Transformations Michelson Morley Experiment, Lorentz Transformations and its Consequences: Length Contraction; Time Dilation; Velocity Transformation; Relativistic Momentum and its Conservation, Relativistic Energy, Transformation of Momentum and Energy, Transformation of the Rate of Change of Momentum, Constancy of Charge.

TEXT BOOKS & REFERENCES:

1. Vector Mechanics- Beer & Johnson, TMH Publication
2. Engineering Mechanics – I.H.Shames, Pearson Publication
3. Mechanics- A Berkley Physics Course – Charles Kittle, TMH Publication

LIST OF EXPERIMENTS:

1. To determine the acceleration due to gravity and velocity for a free falling body, using Digital Timing Techniques.
2. To determine the Moment of Inertia of a Flywheel.
3. To determine the coefficient of viscosity of water by Capillary Flow Method (Poiseuille's Method).
4. To determine the Young's Modulus of a wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a wire by Maxwell's Needle.
6. To determine the Elastic Constants of a wire by Searle's Method.
7. To determine g by Kater's Pendulum.
8. To determine g by Compound Pendulum.
9. Study of response of series/parallel LCR circuit.
10. To determine the frequency of A.C. Mains using Sonometer.
11. To study the motion of a spring and measure the spring constant.
12. To find the unknown weight of a body by the method of vector addition of forces.

Course Title/ Code	STRUCTURED PROGRAMMING (CSH101)
Course Type:	Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION-A

Programming and UNIX: Students will learn the basics of programming using Scratch; they will learn to use statements, expressions, conditions, selection, iteration, variables, functions, arrays, threads and events. In addition, they will be introduced to basic UNIX commands under Bash.

Introduction to Programming, test driven development

Scratch: Introduction, statements, expressions, conditions, selection, iteration, variables, functions, arrays,.

Unix: Basic commands- pwd, ls, cd, rm, cat, less, mkdir, rmdir; permissions, root C language: statements, expressions, conditions, selection iteration, variables, functions, arrays.

SECTION-B

Applying Programming Constructs: Students will learn how to write programs that satisfy unit tests. The instructor will build the unit tests, demonstrating how to break a problem down into smaller components. In the labs and homework, students will construct programs that satisfy the unit tests. Students become familiar with the constructs of the C programming language.

Types, constants, and variables, Statements, Expressions, Conditions, Selection, iteration, Functions and recursion

Decision making within a program, Conditions, Relational Operators, Logical Connectives, if statement, if-else statement, Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement, structured Programming

One dimensional arrays: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; Null terminated strings as array of characters, Standard library string functions

Introduction to Top-down approach of problem solving, Modular programming and functions, Standard Library of C functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, Passing arguments to a Function: call by reference, call by value, Recursive Functions, arrays as function arguments Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions. Students will become familiar with the concepts.

SECTION-C

Practical Programming: During the third quarter of the class, students will begin building their own programs by decomposing problems into smaller tasks and writing unit tests that will check to see that the program accurately accomplishes the task using Test Driven Development. They will then write the program that satisfies their own unit tests. Students will learn to apply the constructs of the C programming language to create programs.

Application of Top-down approach of problem solving, Modular programming and functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, Passing arguments to a Function: call by reference, call by value, Recursive Functions, arrays as function arguments.

Students will learn to apply these programming techniques: Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions. Students will be able to use these techniques to develop programs Concept of Files, File opening in various modes and closing of a file, Reading from a file, writing onto a file.

SECTION-D

Memory Management and Abstraction: During the final quarter, students will be introduced to dynamic memory allocation and dynamic data structures including: dynamic arrays, linked lists, and stacks. They will consolidate their ability to use the C programming techniques they have learned in the earlier sections.

Address operators, pointer type declaration, pointer assignment, pointer initialization, pointer arithmetic, functions and pointers, Arrays and Pointers, pointer arrays, pointers and structures, dynamic memory allocation.

Linked list

TEXT BOOKS & REFERENCES:

1. The C Programming Language, Brian Kernighan and Dennis Ritchie

2. The UNIX Programming Environment

LIST OF EXPERIMENTS:

1. Swap two numbers
2. Fibonacci series, Factorial
3. GCD
4. Sieve of Eratosthenes
5. Square Root
6. Sorting
7. Decimal to binary conversion
8. Linked lists
9. Program to support humans playing chess against each other.
10. Stacks and queues
11. Manipulating files

Course Title/ Code	ENGINEERING MATHEMATICS-II (MAH105)
Course Type:	Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Matrices: Rank of a matrix, inverse of a matrix using elementary transformations, consistency of linear system of equations; Eigen-values and eigenvectors of a matrix, Cayley Hamilton theorem, Diagonalisation of matrix.

SECTION B

Ordinary Differential Equations & Their Applications**:** Existence & uniqueness of Differential equation, Differential equations of first order & first degree, formation of differential equation, Bernoulli's differential equation, Exact differential equation and equations reducible to exact differential equation, Applications(Heat flow, Newton's law of cooling, Orthogonal trajectories).

Differential equations of higher order & first degree , Linear differential equations, Method of Variation of Parameter, Cauchy's linear equation, Legendre's equation, Simultaneous linear Differential equations, Applications to simple harmonic motion, and mass-spring system.

SECTION C

Partial Differential Equations & Their Applications: Formation of partial differential equations, Lagrange' linear partial differential equation, first order non-linear partial differential equation, Method of separation of variables and its applications to wave equation, one dimensional heat equation and two-dimensional heat flow (steady state solutions only)

Applications of Partial Differential Equations Method of separation of variables for solving partial differential equations, Wave equation up to two dimensions, Laplace equation in two-dimensions, Heat conduction equations up to two-dimensions.

SECTION D

Fourier Series & Transforms: Fourier series, Even and odd functions, half range series, Applications of Fourier series in frequency spectrum of a periodic pulse. Harmonic analysis, Fourier Transforms, Transforms of derivatives and integrals, Applications to boundary value problem in ordinary differential equations (simple cases only).

TEXT BOOKS & REFERENCES:

1. B.S. Grewal,,"Higher Engineering Mathematics", Khanna Publishers, New Delhi.
2. R.K. Jain & S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, New Delhi.

LIST OF EXPERIMENTS:

1. MATLAB Fundamentals: Decisions – if statement, if-else, Input and Output. Introduction to Loops in MATLAB.To find the Rank of a matrix, Inverse of a Square matrix and to reduce a matrix into Normal Form.

2. To solve the system of simultaneous linear equations. To find the Eigen values and Eigenvectors of a square matrix.
3. To solve ODE & LDE & plot the graph of the solution of LDE.
4. To solve & plot solutions the system of two & three ordinary differential equations.
5. To solve the linear differential equations with variable coefficients (Cauchy & Legendre Differential equations) and plot the graph of the solution.
6. To find the Fourier series expansion of a given periodic functions and plot the same
7. To find the Fourier series expansion of a given periodic functions and plot the same
8. To find the Fourier Transform of given function.

Course Title/ Code	COMMUNICATIVE ENGLISH (HLS102)
Course Type:	Core
Course Nature:	Soft
L-T-P-O Structure	(1-0-2-0)
Prerequisite	NIL

SECTION-A

LEXIS and SYNTAX: Homonym, Homophones, Words often confused, Foreign Words, s Sentence, Kinds of Sentence, Parts of Sentence, The Phrase, The Clause, Synthesis of Simple Sentence, Spotting the Errors (Articles, Pronoun, Preposition, Adjective, Verb).

SECTION-B

Oral Communication-II: Importance of Speech Sounds, IPA Symbols (Vowels and Consonants), Phonetic Transcription, Phoneme and Syllables.

SECTION-C

Technical Writing-II: Business Letters, Job Application and CV Writing, Paraphrasing, Punctuation, Situation Writing, Paragraph Writing, Developing Outlines.

SECTION-D

Literature: Goodbye Party for Miss. Pushpa T.S.- Nissim Ezekiel, Why Scientists and Engineers Need Literature- Troy Camplin
The Time-MACHINE- H.G.Wells

TEXT BOOKS & REFERENCES:

1. High School English Grammar and Composition. Wren and Martin: S.Chand and Co.
2. A Textbook of English Phonetics for Indian Students. T.Bala Subhrmaniam: Macmillan
3. English Vocabulary in Use. MaCarthy: Foundation Books, OUP

LIST OF EXPERIMENTS:

1. Exercise on Lexis.
2. Exercise on Syntax
3. Exercise on Spotting the Errors
4. One- Man Task
5. Role-Play Activity
6. Mock-Interview
7. Paragraph Writing
8. Situation Writing
9. Slogan Writing
10. Phonetic Transcription
11. Synthesizing Sentence
12. Presentation (Book Review/ Movie Review)

Course Title/ Code	ENGINEERING DRAWING (MEW103)
Course Type:	Core
Course Nature:	WORKSHOP
L-T-P-O Structure	(0-0-3-0)
Prerequisite	NIL

SECTION-A

Introduction to Engineering Drawing: Concept of Engineering drawing, drawing instruments, types of projections, first and third angle of orthographic projection, sheet layout, types of scales, types of lines & selection of line thickness, selection of pencils, importance of lettering.

Projection of Points**:** Introduction, Projection of points in different quadrants.

Projection of Line**:** Projection of straight line - parallel to one or both reference planes, inclined to the H.P. and/or V.P., the determination of their true lengths, the true inclination to the H.P. and V.P./traces of lines.

SECTION-B

Projection of Planes**:** Projection of planes - parallel to one reference plane/inclined to one plane but perpendicular to other/inclined to both reference planes.

Projection of Solids**:** Types of solids - polyhedral & solids of revolution in simple position with axis perpendicular to a plane/with axis II to both planes/with axis II to one & inclined to other plane.

SECTION-C

Section of Solids and Development of Solids: Projection of section of polyhedra and solids of revolution, their true shape. Development of surface of polyhedra and solids of revolution, their truncated portions.

Orthographic and Isometric Projections**:** Orthographic & isometric projections - introduction, isometric scale, isometric view of plane figures, solids. Orthographic projection from Isometric views.

SECTION-D

Introduction to Computer-Aided Designing**:** Basic commands - object selection methods, erase, move, copy, offset, fillet, chamfer, trim, extend, mirror; display commands: zoom, pan, redraw, and regenerate; simple dimensioning and text, simple exercises. Basics of 2-D and 3-D solid modeling, orthographic, iso-metric projection drawing and sectional views of simple machine elements.

TEXT BOOKS & REFERENCES:

1. Elements of Engineering Drawing, N.D. Bhatt, Charotar Publishing House, Anand

2. Engineering Drawing, P.J. Shah, S. Chand, New Delhi

Course Title/ Code	ENVIRONMENTAL SCIENCE (CHH137)
Course Type:	Core
Course Nature:	Hard
L-T-P-O Structure	(3-0-0-1)
Prerequisite	NIL

SECTION-A

Multidisciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness. Natural Resources: Renewable and non-renewable Resources: Natural resources and associated problems, Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people, Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

SECTION-B

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem:-Forest ecosystem Grassland ecosystem Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: Introduction – Definition : genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity.Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India.Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

SECTION-C

Environmental Pollution: Definition, Cause, effects and control measures of :-Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides.

Social Issues and the Environment: From Unsustainable to Sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies, Wasteland reclamation, Consumerism and waste product, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

SECTION-D

Human Population and the Environment: 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.

Field work:Visit to a local area to document environmental assets, river/forest/grassland/hill/mountain , Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc

TEXT BOOKS & REFERENCES:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R).
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p

Semester 3 (Total Credit-25.5)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) / NTCC Course (0-0-0-1) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core	Fluid Mechanics (ME)		
	Engineering Materials and their Behavior (ME)		
	Mechanics of Materials (ME)		
	Manufacturing Technology-I (ME)		Machine Drawing (ME)
Allied Core			
Domain Elective			
Allied Elective		Basket of Elective offered by Humanities Department	
NTCC		Professional Competency Enhancement-I	
		Introduction to Research	
Credits	20	3.5	2
Audit Course	Foreign Language (1-1-0) (MRCFL)		
Total Credits	25.5		
No of Hours	34		

Course Title/ Code	FLUID MECHANICS (MEH205)
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)

SECTION A

Fluid Properties and Fluid Static: Concept of fluid flow, ideal and real fluids, viscosity, continuum concept, and properties of fluids, Pressure, Viscosity, surface tension, capillarity and cavitation, Types of fluids. Pascal's law, hydrostatic equation, hydrostatic forces on plane and curved surfaces, stability of floating and submerged bodies, Buoyancy, Determination of Meta centric height.

SECTION B

Fluid Kinematics and Dynamics: Eulerian and Lagrangian description of fluid flow; stream, streak and path lines; types of flows, continuity equation, stream and potential functions, Euler's equation, Bernoulli's equation, Measurement of flow through pitot tube, notches and weirs, venture meter, orifices, orifice meter, mouthpieces, free and forced vortex flow.

SECTION C

Viscous Flow, Turbulent Flow and Flow through Pipes:Viscous Flow: Flow regimes and Reynolds's number, Relationship between shear stress and pressure gradient, viscous flow through pipes, uni-directional flow between stationary and moving parallel plates

Turbulent Flow: Shear stress in turbulent flow, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough surfaces

SECTION D

Flow Through Pipes**:** Major and minor losses in pipes, Darcy-Wiesbach equation, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, power transmission through pipes, Flow through Syphons, Flow through channels.

Boundary Layer Flow**:** Boundary layer concept, displacement, momentum and energy thickness, von-karman momentum integral equation, laminar and turbulent boundary layer flows, drag on a flat plate, boundary layer separation and control.

.**TEXT BOOKS & REFERENCES:**

1. Fluid Mechanics and Fluid Power Engineering D S Kumar, S K Kataria and Sons Ltd., New Delhi,1995.

2. R.K.Bansal, Fluid Mechanics and Hydraulics Machines, Laxmi Publications**.**

LIST OF EXPERIMENTS:

1. To determine Meta centric height for a floating body
2. To Verify Bernoulli's theorem.
3. To calculate Reynolds no. for different types of flows
4. To calculate coefficient of discharge through Venturimeter.
5. To determine friction factor for pipes
6. To determine coefficient of discharge, contraction and velocity of an orifice meter
7. To determine the minor losses due to sudden enlargement and sudden contraction
8. To calculate coefficient of discharge through orifice-meter
9. To calculate coefficient of discharge thru V-Notch
10. To verify impulse-momentum equation.

Course Title/Code	ENGINEERING MATERIALS AND THEIR BEHAVIOR (MEH206)
Course Type	Core
Course Nature	Hard
L-T-P-O structure	3-1-2-0
Prerequisites	NIL

SECTION A

Introduction**:** Historical perspective, classification of materials.

Crystallography: Review of crystal structure, space lattice, crystal planes and crystal directions, co-ordination number, number of atoms per unit cell, atomic packing factor, Imperfection in metal crystals: Crystal imperfections and their classifications, point defects, line defects, edge & screw dislocations, surface defects, volume defects & effects of imperfections on metal properties. Problems

SECTION B

Solid solutions and phase diagram: Introduction to single and multiphase solid solutions and types of solid solutions, importance and objectives of phase diagram, systems, phase and structural constituents, cooling curves, unary & binary phase diagrams, Gibbs's phase rule, Lever rule, eutectic and eutectoid systems, peritectic and peritectoid systems, iron carbon equilibrium diagram, and TTT diagram, Allotropic transformation of iron and steel, Properties of austenite, ferrite, pearlite, martensite

Heat Treatment: Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering, carburizing, nitriding, cyaniding, flame and induction hardening..

SECTION C

Deformation of Metal**:** Elastic and plastic deformation, mechanism of plastic deformation, twinning, conventional and true stress strain curves for polycrystalline materials, yield point phenomena, strain ageing, work hardening, Bauschinger effect, season cracking. Recovery, re-crystallization and grain growth.

Fracture & its Prevention: Fracture - Mechanism of brittle fracture (Griffith's theory) and ductile fracture - Difference between brittle and ductile fractures - Fatigue failure and its prevention

Creep - different stages in creep curve - Factors affecting creep resistant materials - Mechanism of creep fracture, Mechanical properties.

SECTION D

Plastics**:** Various types of polymers/plastics and its applications. Mechanical behavior and processing of plastics, future of plastics

Ceramics**:** Structure types and properties and applications of ceramics. Mechanical/Electrical behavior and processing of Ceramics

Other materials**:** Brief description of other material such as optical and thermal materials concrete, Composite Materials and its uses. Brief introduction to Smart materials& Nano-materials and their potential applications

Corrosion & its Prevention: Various types of corrosion, factors effecting corrosion and methods of preventing corrosion

TEXT BOOKS & REFERENCES:

1. Material Science & Engineering by V. Raghvan, Prentice Hall of India Pvt. Ltd, New Delhi

2. Material Science by Narula, Narula and Gupta. New Age Publishers

3. A Text Book of Material Science & Metallurgy by O.P. Khanna, Dhanpat Rai & Sons

LIST OF EXPERIMENTS:

1. Preparation of mild steel specimen and metallographic examination of the prepared specimen
2. To study solidification curve for a given specimen.
3. Determine the hardness of given sample before & after the Heat Treatment (Hardening (water as quenching media), Annealing & Normalizing)
4. Study the effect of different quenching media on the hardness (Rockwell Hardness) of given mild steel samples.
5. Study of microstructure of welded component and HAZ (Heat Affected Zone) macro and micro examination
6. Determine the izod impact strength of given acrylic sheets and study the effect of thickness of the sheet on the impact strength
7. To study the creep behavior of a given specimen
8. To measure the hardness of the sample by varying distance from quenching medium by Jominy end quench test apparatus.
9. To illustrate the effects of fatigue on a metal.
10. To study effect of different media on the rate of corrosion.

Course Title/ Code	MECHANICS OF MATERIALS (MEH207)
Course Type	Domain Core
Course Nature	Hard Course
L-T-P-O Structure	3-1-2-0
Prerequisites	NIL

SECTION-A

Introduction to stress & strain, St. Venant principle, Temperature stresses, Stresses on oblique plane, pure shear, general two dimensional stress system principal planes & stresses, Mohr's circle of stresses.

Shear force & bending moment diagrams for different types of beams subjected to various types of loads,

Bending stresses & shear stresses in beams, composite beam.

SECTION-B

Slope & Deflection of Beams: By method of integration Macaulay's method, Mohr's moment area method, calculations for slope and deflection of (i) cantilevers and (ii) simply supported beams with or without overhang under concentrated load, Uniformly distributed loads or combination of concentrated and uniformly distributed loads,

Fixed Beams: Deflections, reactions and fixing moments with SF & BM calculations & diagrams for fixed beams under (i) concentrated loads, (ii) uniformly distributed load and (iii) a combination of concentrated loads & uniformly distributed load.

SECTION-C

Column & Struts, Definition,. Limitations of Euler's Theory, Rankine- Gorden, Formula, Johnson's parabolic Formula, Straight line Formula.

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano & Maxwell's theorems

SECTION D

Torsion in circular shafts: normal and varying cross sections, Compound shafts, Solid and hollow circular Shafts, tapered shaft. Stepped and composite shafts, Combined Bending and Twisting, effect of end thrust.

Springs**:** Stresses in open & closed coiled helical spring subjected to axial loads and twisting couples.

TEXT BOOKS & REFERENCES:

1. Strength of Materials GH Ryder- Macmillan Publishers
2. Strength of Materials, R.Subramanian, Oxford Publication
3. Mechanics of Solids, Gere and Timoshenko CBS Publishers & Distributor.

LIST OF EXPERIMENTS:

1. To perform tensile and compression tests on UTM.
2. To perform bending test on UTM
3. To determine spring stiffness of open and closed coiled spring on spring testing machine.
4. To determine the Rockwell hardness of a given specimen.
5. To determine the Brinell hardness of a given specimen.
6. To determine the flexural rigidity of the material of SSB under different load conditions.
7. To compare the deflection of different types of columns, and estimate equivalent length.
8. To find out slope and deflection of SSB with Mohr's Moment area method.

Course Title/Code	**MANUFACTURING TECHNOLOGY-I (MEH208)**
Course Type	**Core**
Course Nature	**Hard**
L-T-P-O structure	**3-1-2-0**
Prerequisites	**NIL**

SECTION A

Manufacturing Process**:** Introduction, Technological considerations in manufacturing, classification of manufacturing processes, materials and manufacturing processes for common items.

Metal Cutting and Tool Life**:** Mechanics of metal cutting. Geometry of tool and nomenclature, ASA system, Orthogonal vs. oblique cutting, Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required, Tool wear and tool life, Machinability, dynamometer, Brief introduction to machine tool vibration and surface finish.

Cutting Tool Materials & Cutting Fluids**:** Characteristics of tool materials, various types of cutting tool materials, coated tools, cutting tool selection, Purpose and types of cutting fluids, basic actions of cutting fluids, effect of cutting fluid on tool life, selections of cutting fluid, Special purpose lathe, Capstan and turret and Automatic lathe.

SECTION B

Machine Tools**:** Tool layout, Milling Cutter, Dividing head and indexing methods in milling operation, Drilling and boring, reaming tools, Methods of grinding and surface finishing operations

Metal Casting Process**:** Introduction to Casting Processes, step involved in Casting Processes, advantages, limitations and applications of casting process, Patterns types, allowances for pattern, pattern materials, Sand Casting- Sand Properties, Constituents and Preparation. Mould and Core making with assembly and its types, Gating System. Melting of Metal, Furnaces and Cupola, Metal Pouring, Fettling, casting Treatment, Inspection and Quality Control, Sand Casting Defects & Remedies, Special casting processes: Centrifugal, Die, Investment, Casting defects, Causes and remedies.

Casting Design**:** Design considerations in casting,Gating and Riser - directional solidification in castings, Metallurgical aspects of Casting.

SECTION C

Jigs and Fixtures**:** Introduction, principles of locations, locating and clamping devices, jigs bushes, drilling jigs, milling fixtures, turning fixtures, boring and broaching fixtures, welding fixtures, different material for jigs and fixtures, economics of jigs and fixtures, Layouts.

Powder Metallurgy**:** Introduction, Production and characterization of powders, Compaction and of metal powders: Die compaction, and Hot isostatic pressing, sintering of powder compacts, Post sintering operations, Applications.

SECTION D

Basic Joining Process**:** Introduction, types of welding -Metal arc welding, Effect of welding parameters, selection of electrodes, flux,- shielded metal arc welding, GTAW,GMAW,SAW,ESW, - friction welding, -Resistance welding (spot, seam, projection, flash types), -Electron beam,-laser welding, -atomic hydrogen arc welding, -thermit welding,-Gas welding,--use of oxyacetylene, flame cutting, Soldering, brazing and their application.

TEXT BOOKS & REFERENCES:

1. Manufacturing Engineering Technology by Kalpakjian, Pearson Education.

2. Manufacturing Technology: Foundry, Forming and Welding by P.N.Rao, TMH
3. Fundamentals of Metal Cutting and Machine tools by Boothroyd

LIST OF EXPERIMENTS:

1. Study and Practice of Orthogonal & Oblique Cutting on a Lathe.
2. Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe and finding out cutting efficiency.
3. Calculation of Tool Life while milling a component on the Milling Machine.
4. Machining of hexagon & square in shaping machine
5. Machining and machining time estimation for taper turning.
6. Designing of a pattern and pattern making with proper calculations.
7. Fabrication of circumferential butt joint in the given samples by using shielded metal arc welding
8. Study on influence of welding parameters in arc and gas welding with demonstration.

Course Tittle/Code	MACHINE DRAWING (MEW209)
Course Type	Domain Core
Course Nature	Workshop
L-T-P-O Structure	0-0-3-0
Prerequisite	NIL

SECTION A

Introduction graphic language classification of drawing, principal of drawing, IS codes for machine drawing, lines, scales, section dimensioning, standard abbreviation, – Limits, fits and Tolerance (Dimensional and Geometrical tolerance), Surface finish.

Orthographic projections: principle of first and third angle projection, orthographic views from isometric views of machine parts / components.

SECTION B

Gears: Gear terminology, spur gears, helical gears, bevel gears, worm and worm wheel, Cam and Followers.

Drawing of sectional views: Coupling, Crankshaft, Pulley, Piston and Connecting rod, Cotter and Knuckle joint.

SECTION C

Riveted Joint and Welded Joint. Free hand sketching: Need for free hand sketching of standard parts and simple machines components.

Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies: Lathe Tail stock, Machine vice, Pedestal bearing.

SECTION D

Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies Steam stop valve, Stuffing box, Drill jigs and Milling fixture.

Miscellaneous: Screw jack, drill press vice, Plummer block.

TEXT BOOKS & REFERENCES:

1. Machine Drawing, N.D. Bhatt, Charotar Book Stall, Anand.
2. A Text Book of Machine Drawing, P.S.Gill, S.K.Kataria, Delhi.

Course Title/Code	APPLIED PHILOSOPHY (EDS 288)
Course Type	Soft Elective
L-T-P-O Structure	0-2-0-0
Prerequisite	NIL

SECTION A

INTRODUCTION TO PHILOSOPHY: Philosophy: Meaning, Nature and Scope, Practical uses of Philosophy, Branches of Philosophy.

SECTION B

THOUGHTS OF PHILOSOPHERS AND THEIR IMPLICATIONS: General Philosophy of John Dewey, Swami Vivekananda and Rabindra Nath Tagore, Philosophy of life and success: Steve Jobs, N.R. Narayana Murthi, Dr. A.P.J. Abdul Kalam and Muhammad Yunus, Philosophy of Science and technology- Francis Bacon and Martin Heidegger.

SECTION C

PHILOSOPHICAL PERSPECTIVES OF SOCIO-POLITICAL SCENARIO IN INDIA: Nature of Democracy and its implications, Meaning and requirements of National Integration, Universal Human Rights

SECTION D

PHILOSOPHICAL PERSPECTIVES OF RELIGIOUS SCENARIO IN INDIA: Secularism—its nature and implications, Moral Philosophy of religion with special reference to Hinduism, Jainism, Buddhism, Islam, Christianity, Sikhism. Religious pluralism and Religious tolerance.

Reference Books and Readings:

1. Bhatia, K. & Bhatia, B. (1974) The Philosophical and Sociological Foundations of Education. Delhi: Doaba House.
2. Brubacher, John. S. (1969). Modern Philosophies of Education, New Delhi: Tata McGraw-Hill
3. Dewey, J. (1966). Democracy in Education, New York: Macmillan.
4. Ferre, F.(1995). Philosophy of Technology. University of Georgia Press.
5. Gandhi, M. K. (1956). Basic Education. Ahmedabad, Navajivan.
6. Goel, A. & Goel S. L. (2005). Human values and Education. New Delhi: Deep and Deep Publications Pvt. Ltd.
7. Palmer, Joy A. et.al. (2001). Fifty major thinkers on education from confucious to Dewey. New Delhi: Rutledge.

Course Title/Code	APPLIED PSYCHOLOGY (EDS 289)
Course Type	Soft Elective
L-T-P-O Structure	0-2-0-0
Prerequisite	NIL

Section A

PSYCHOLOGY: ATTITUDE FORMATION

Psychology: Meaning, nature, and scope, Role of psychology across multi-disciplinary aspects, Introduction: Attitude, Stereotypes, Prejudice, and Discrimination, Formation of attitude and attitude change.

Section B

PERSONALITY AND PERSONALITY DEVELOPMENT

Definition of personality and personality development, State/ Trait approach to personality, Bandura's Social-Cognitive theory of personality

Section C

SOCIAL PSYCHOLOGY

Introduction to social identity, social cognition, and social influence, social conflicts and its resolutions, Group dynamics: Introduction, formation, types of groups, cooperation, competition, and conflict in groups

Section D

ORGANIZATIONAL PSYCHOLOGY

Organizational Psychology: Definition, fundamental concepts and importance, Introduction to job satisfaction, work motivation, and organizational commitment. Introduction to participation, empowerment, and team work

References Books and Readings:

1. Arrow, K. J. (1995). Barrier to Conflict Resolution. NY: W. W. Norton.
2. Bandra, A., & Walters, R. H. (1963). Social Learning and Personality Development. New York: Holt, Rinehart, & Winston.
3. Bandra, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice- Hall, Inc.
4. Baron, R. A., Byrne, D. (1997). Social Psychology (8th Ed.). Boston, MA: Allyn & Bacon.
5. Baron, R. A. (2001). Psychology (5th ed.). London: Pearson.
6. Cialdini, R. B. (2001). Influence: Science and Practice (4th Ed.). Boston, MA: Allyn & Bacon.
7. Feldman, R. S. (2008). Essentials of Understanding Psychology. New Delhi: Tata McGraw Hill.
8. Friedkin, N. (1998). A structural theory of social influence. Cambridge: Cambridge University Press.
9. Gage, N. L., & Berliner, D. C. (1992). Educational Psychology (5th Ed.). Boston, MA: Houghton Mifflin Co.
10. Hall, C. S., Lindzey, G. & Campbell, J. B. (2004). Theories of Personality (4th Ed.). New York: Wiley.
11. Hunt, R. R., & Ellis, H. C. (2006). Fundamentals of Cognitive Psychology. New Delhi: Tata McGraw Hill.
12. McDavid, J. M., & Harari, H. (1994). Social Psychology: Individuals, Groups, and Societies. New Delhi: CBS Publishers.
13. Millward, L. (2005). Understanding Occupational and Organizational Psychology. London: Sage Publications.
14. Morgan, C. T., King, R. A., Weisz, J. R., & Schopler, J. (1993). Introduction to Psychology. (7th Ed.). New Delhi: Tata McGraw Hill.
15. Woolfork, A. E. (2014). Educational Psychology (12th Ed.). Boston: Allyn & Bacon.

Course Title/Code	APPLIED SOCIOLOGY (EDS 290)
Course Type	Soft Elective
L-T-P-O Structure	0-2-0-0
Prerequisite	NIL

Section A

Introduction and Applications of Sociology:

- Society, Community, Social Institutions, Social Groups, Introduction to Applied Sociology
- Sociology and Social Processes
- Sociology and Social Change
- Sociology and Social Problems
- Clinical Sociology

Section B

Sociological Processes:

- Social Stratification, Social Mobility and their impact on society
- Socialization, Agents of Socialization, Assessing the effects of Socialization
- Social Movements: Concept, Impact of Environmental Movements in India: Chipko Movement, Narmada Bachao Andolan

Section C

Processes and Issues of Social Change:

- Social Change: Westernization, Urbanization, Privatization, Globalization, Sustainable development
- Issues in urban development-Population, poverty, unplanned growth and ecological issues
- Conflict management:
  - Intergroup: Causes, Resolutions
  - Organizational Conflict, Conflict Management and Grievance Handling

Section D

Field Survey & Report Writing:

- Need, Meaning of Survey
- Types of Survey
- Steps in Conducting Survey
- Data Collection Methods
- Salient Features of Report Writing

References: Books and Readings

1. Andrew, W. (1997) Introduction to the Sociology of Development. New Jersey, Palgrave Macmillan.
2. Berg, L.B. (2001). Qualitative Research Methods for the Social Sciences (4th edition). Boston: Allyn and Bacon
3. Bhatia, H.(1970). Elements of Social Psychology. Bombay: Somaiyya Publications Pvt Ltd.
4. Bhattacharyya D.K (2009). *Organizational Behavior*, Oxford University Press, UK.
5. Dastupta Driskle(2007) : Discourse on Applied Sociology Volume-II, 2007
6. Desai, B Sonalde et al. (2010). Human Development in India: Challenges for a Society in Transition. OUP
7. Deshpande, S.(2003). Contemporary India: A Sociological View. New Delhi: Viking.
8. Hall R.H (2009). *Organizational Structures, Processes & outcomes, Asia*: Pearson Education Publications.
9. Hodegetts R M. (2009). *Organizational Behavior*, Macmillan.
10. Mc Michael.P. (1996). Development and Social change: A global perspective. California Thousand Oaks.
11. Merton, R and Nisbet, (1976) Contemporary Social Problems, New York: Harcourt, Brace and World.
12. Metha, S. (2009). Women and Social Change, Jaipur: Sage.
13. Michael Edwards (2011). Civil Society in India, edited The Oxford Handbook of Civil Society, Oxford, Oxford University Press
14. Mitra et.al. (2009). Democracy, Agency and Social Change in India, New Delhi: Sage
15. Pratt henry Fairchild(2009) : Outline of Applied Sociology, 2009

16. Ranjitkumar : Research Methodology, Person Education, Delhi.
17. Schaefer, R.T (2004). Sociology a Brief Introduction, (5thed.) New York: McGraw-Hill Inc..
18. Sirclaus Moser & G. Kalton: Survey Methods in Social Investigation, Heinemann Educational Books, London.
19. Sanderson. (2010). Social Psychology, New York: John Wiley.
20. Tepperman, L. & Curtis, J. (Eds.) (2009). Principles of Sociology: Canadian perspectives. Don Mills, ON: Oxford University Press.
21. Young, K. (2001). Handbook of Social Psychology, London: Routledge and Kegal Paul Ltd.

Course Tittle/Code	**FRENCH-I (FLS103)**
Course Type	**University Compulsory**
Course Nature	**NTCC**
L-T-P-O Structure	**1-1-0-0**
Prerequisite	**NIL**

SECTION-A

Les Salutations & forms of politeness, Alphabets, Taking leave expression

SECTION-B

Les pronoms sujets, Les verbes ER, Self introduction

SECTION-C

Les noms, Verbes Avoir, Etre, Aller & Faire, Les articles define et indefini

SECTION-D

Les moin de l'annee, les jours de la semain, Repondez aux questions

Course Tittle/Code	SPANISH-I (FLS101)
Course Type	University Compulsory
Course Nature	NTCC
L-T-P-O Structure	1-1-0-0
Prerequisite	NIL

SECTION-A

Presentation on Spanish language, Greetings and goodbye's

SECTION-B

Introduction cntd, Alphabets, Numbers 1-20

SECTION-C

Personal pronouns, Hobbies and Professions

SECTION-D

Café related vocabulary and dialogues, Revision personal pronouns, Common verbs and their conjugations, Introduction of VerboSER

Course Tittle/Code	**GERMAN-I (FLS102)**
Course Type	**University Compulsory**
Course Nature	**NTCC**
L-T-P-O Structure	**1-1-0-0**
Prerequisite	**NIL**

SECTION-A

Salutations/Greetings, Introduction

SECTION-B

Uses of Verbo SER, Introduction of Nationality, Professions and vocabulary related to professions, Adjectives related to Verbo SER, Counting till number 20.

SECTION-C

Introduction of Articles and Indefinite articles, Interrogatives, Adjectives to describe things and place and Counting till number 90

SECTION-D

Introduction of Verbo ESTAR, Uses of Verbo ESTAR with respect to positioning of objects, Prepositions related to the positioning of an object.

Semester 4 (Total credit – 25.5)

Nature of the course/ Type of the course	Hard Course (3-1-2-0) Name (Offering Department)	Soft Course (1-0-2) / NTCC Course (0-0-0-1) Name (Offering Department)	Workshop (0-0-3) name (Offering Department)
Domain Core	Theory of Machines		
	Manufacturing Technology-II		
	Thermal Engineering		
Allied Core			
Domain Elective			Design Software-I
			Design Software-II
Allied Elective	Applied Numerical Technology and Computing (Math)	Baskets of Electives on Environmental Ethics and Sustainable Development	
	Polymer Technology (Chemistry)		
	Laser Technology (Physics)		
NTCC		Professional Competency Enhancement-II	
		Technical Seminar-I	
Credits	20	3.5	2
Audit Course	Foreign Language (1-1-0) (MRCFL)		
Total Credits	25.5		
No of Hours	34		

Course Title / Code	THEORY OF MACHINE (MEH210)
Course Type	Domain Core
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Link, Pair & Mechanism**:** Introduction to kinematics, pairs, elements and structure, Links-types, Kinematics pairs-classification, types of joints, Constraints-types, Degrees of freedom of planar mechanism, kutzbach criteria, Grubler's equation, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain, Pantograph, Analysis of Hooke's joint, Davis and Ackermann steering gear mechanisms.

Velocity and Acceleration in Mechanisms**:** Velocity of point in mechanism, relative velocity method, Instantaneous center method, Types & location of instantaneous centers, Kennedy's theorem, Acceleration of a point on a link, Acceleration diagram, Coriolis component of acceleration, Klein's construction for Slider Crank mechanism and Four Bar mechanism, Analytical method for velocity and acceleration determination of slider crank mechanism.

SECTION B

Cams and Followers - Classification & terminology, Cam profile by graphical methods with knife edge and radial roller follower for uniform velocity, simple harmonic and parabolic motion of followers, Analytical methods of cam design – tangent cam with roller follower and circular cams.

Gears & Gear Trains**:** Fundamentals, Classifications and nomenclature of gears; law of gearing, Interference and remedies to avoid interference, Gear Trains: synthesis of simple, compound and reverted gear trains, analysis of epicylic gear trains, problems.

SECTION C

Turning Moment & Flywheel**:** Turning moment on crankshaft, Turning moment diagrams-single cylinder double acting steam engine, four stroke IC engine and multi-cylinder steam engine, Fluctuation of energy, Flywheel.

Balancing of Machines**:** Static and dynamic balancing, Balancing of several masses in the same plane and different planes, Balancing of reciprocating masses, Balancing of primary force in reciprocating engine, Balancing of primary and secondary forces in-line cylinder engines, V cylinders engines.

SECTION D

Governors: Terminology, Centrifugal governors-Watt governor, Dead weight governors-Porter & Proell governor, Spring controlled governor-Hartnell governor, Sensitivity, Stability, Hunting, Isochronisms, Effort and Power of governor, Controlling force diagrams for Porter governor and Spring controlled governors.

Gyroscopic Motion: Principles, Gyroscopic torque, Effect of gyroscopic couple on the stability of aero planes, automobiles & ships.

TEXT BOOKS & REFERENCES:

1. Theory of Mechanisms and Machines: Amitabh Ghosh and Ashok Kumar Malik, Third Edition Affiliated East-West Press.
2. Theory and Machines: S.S. Rattan, Tata McGraw Hill.
3. Mechanics of Machines: Elementary theory and examples. By: J. Hannah and R.C.Stephens.

LIST OF EXPERIMENTS:

1. To study various types of Kinematic links, pairs, chains and Mechanisms.
2. To study inversions of 4 Bar Mechanisms, Single and double slider crank mechanisms.
3. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism.
4. To study various type of cam and follower arrangements.
5. To plot follower displacement vs cam rotation for various Cam Follower systems.
6. To perform experiment on Watt and Porter Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
7. To perform experiment on Proell Governor to prepare performance characteristic curves, and to find stability & sensitivity.
8. To perform experiment on Hartnell Governor to prepare performance characteristic Curves, and to find stability & sensitivity.
9. To study gyroscopic effects through models.
10. To determine gyroscopic couple on Motorized Gyroscope.
11. To perform the experiment for static balancing on static balancing machine.
12. To perform the experiment for dynamic balancing on dynamic balancing machine.

Course Title / Code	MANUFACTURING TECHNOLOGY-II (MEH211)
Course Type	Domain Core
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Forming Processes: Basic Principle of Hot & Cold Working, Hot & Cold Working Processes, Rolling, Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, Impact extrusion, Hydrostatic extrusion.

Sheet metal forming: Spring back effect, Stamping, Blanking, Bending, Drawing, Piercing, Coining, Embossing, Stretch forming, Hot and cold spinning. Special forming: Hydro forming, High energy rate forming, Drawing, Wire Drawing and Spinning.

Forging: Principles of forging, Tools and dies, Types: Smith forging, Drop Forging, Forging hammers, Rotary forging, forging defects.

SECTION B

Unconventional Machining Processes**:** Abrasive jet machining: Principles, applications, process parameters, Ultrasonic machining: Principles, applications, analysis of process parameters, Electro-chemical machining and grinding: Principles, classifications, choice of electrolytes, applications, Electric discharge machining: Principles, selection of tools materials and dielectric fluid, Electron beam machining: Generation of electron beam, relative merits and demerits, Laser beam machining: Principles and applications, Plasma Arc Machining, Electron Beam Machining, Ion Beam Machining.

SECTION C

Numerical Control of Machine Tools**:** Introduction, Numerical Control & its growth, NC Machines tools, Axes of NC Machines, Classification of NC System, CNC, DNC and Machining Centre. Machine Control unit, NC tools & Tool changer. Manual Part Programming; coordinate, Feed, Speed & Tool, Preparation & Miscellaneous functions, Examples of two axes part programming for Turning and Milling Operations.

SECTION D

Group Technology**:** Definition and concept, Group and Family, working of group technology, Stages for Adopting Group Technology, Advantages of Group Technology, Component Classification and Coding, Personnel and Group Technology, Planning the introduction of Group Technology, Group Technology layout.

Metrology**:** Measurement, linear and angular simple measuring instruments, various clampers, screw gauge, sine bar, auto-collimator, comparator- mechanical, electrical, optical, surface finish and its measurements, micro and macro deviation, factors influencing surface finish and evaluation of surface finish.

TEXT BOOKS & REFERENCES:

1. Manufacturing Technology – Vol. – 2 by P.N. Rao, T.M.H, New Delhi
2. Computer Aided Manufacturing by S Kumar & B Kant Khan, Satya Prakashan, New Delhi
3. Principles of Machine Tools by G.C. Sen& A. Bhattacharya, Tata McGraw Hill, New Delhi

LIST OF EXPERIMENTS:

1. Study of Speed, Feed, Tool, Preparatory (Geometric) and miscellaneous functions for N. C part programming.

2. Part Programming and Proving on an NC Machine:-Point to Point Programming, Absolute Programming, Incremental Programming
3. Part Programming and Proving for Milling a Rectangular Slot
4. Electrical Discharge Machining (EDM): Measurement of MRR, TWR and surface finish
5. Experiment on Powder metallurgy: sintering & Making green compact
6. Formability test on sheet metals
7. Basic experiment on forging-preparation of at least two models in smithy shop
8. Experiment on sheet metal development: Preparation of models-tray, funnel, truncated cone, pyramid, transition piece etc.

Course Title / Code	**THERMAL ENGINEERING (MEH212)**
Course Type	**Domain Core**
Course Nature	**Hard Course**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**Elements of Mechanical Engineering**

SECTION-A

Steam Properties: Pure Substance and its Properties, Phase and Phase Transformation, Vaporization, Evaporation and Boiling, Saturated and Superheat Steam, Solid – Liquid –Vapour Equilibrium, T-V, P-V and P-T Plots During Steam Formation, Properties of Dry, Wet and Superheated Steam, Property Changes During Steam Processes, Temperature – Entropy (T-S) and Enthalpy – Entropy (H-S) Diagrams, Throttling and Measurement of Dryness Fraction of Steam

Steam generators: Classification of Boilers, Selection of boilers, Fire tube boilers: Simple Vertical boiler, Cochran Boiler, Cornish Boiler, Lancashire boiler, Locomotive boiler, Scotch Boiler. Water tube boilers: Babcock and Wilcox water tube boiler, Stirling Boiler. High-pressure boilers- Lamont Boiler, Benson Boiler, Loeffler Boiler and Velox Boiler, Supercritical and Supercharged Boilers, performance and rating of boilers.

SECTION-B

Phase Change Cycles: Vapor Carnot cycle and its limitation, Rankine cycle, effect of boiler and Condenser pressure and superheat on end moisture and efficiency of rankine cycle, modified Rankin cycle, reheat cycle, perfect regenerative cycle, Ideal and actual regenerative cycle with single and multiple heaters, open and closed type of feed water heaters, regenerative-reheat cycle, supercritical pressure and binary-vapor cycle, work done and efficiency calculations.

Gas power Cycles: Rankine Cycle, Stirling Cycle, Ericson cycle and Brayton cycle

SECTION-C

Compressible Flow: speed of sound, in a fluid mach number, mach cone, stagnation properties, one-dimensional isentropic flow of ideal gases through variable area duct-mach number variation, area ratio as a function of mach number, mass flow rate and critical pressure ratio, effect of friction, velocity coefficient, coefficient of discharge, diffusers, normal shock.

Steam nozzles: isentropic flow of vapors, flow of steam through nozzles, condition for maximum discharge, effect of friction, super-saturated flow.

SECTION-D

Air compressors: Working of reciprocating compressor, work input for single stage

compression different, compression processes, effect of clearance, volumetric efficiency real indicator diagram, isentropic & isothermal and mechanical efficiency, multi stage compression, inter - cooling, condition for minimum work done, classification and working of rotary compressors.

Steam condensers, cooling towers and heat exchangers: introduction, types of condensers,

back pressure and its effect on plant performance air leakage and its effect on performance of condensers, various types of cooling towers, design of cooling towers.

TEXT BOOKS & REFERENCES:

1. Thermal Engineering-by P.L. Ballaney, Khanna Publishers

2. Thermal Engineering-by Mathur & Mehta, Jain Publishers

3. Basic and applied Thermodynamics-by P.K.Nag; TMH

LIST OF EXPERIMENTS:

1. Study of working of some of the high pressure boilers like Lamont or Benson.
2. Determination of Calorific value of fuel
4. Determination of efficiency of steam Nozzles.
5. Determination of efficiency of condenser
6. Determination of efficiency of Boiler
7. To perform Heat Balance Analysis on Boiler
8. Determination of thermal efficiency of steam power plant
9. To find out efficiencies of a reciprocating air compressor and study of multistage Compressors.

Course Title/Code	APPLIED NUMERICAL TECHNIQUES AND COMPUTING (MAH309)
Course Type	Elective
Course Nature	Hard Course
L-T-P-O structure	3-1-2-0
Prerequisite	NIL

SECTION A

Errors In Numerical Calculations: Introduction, numbers and their accuracy, absolute, relative and percentage errors and their analysis, general error formula.

Interpolation And Curve Fitting**:** Introduction to interpolation, Lagrange approximation, Newton's formula for Equi spaced & non Equi spaced points (forward, backward and divided difference), hermite interpolation. Curve fitting by a straight line and a second degree curve and laws reducible to linear law.

SECTION B

Numerical Differentiation and Integration**:** Approximating the derivatives, numerical differentiation formulas (forward, backward and central), introduction to numerical quadrature, Newton- cotes formula, Gaussian quadrature - Gauss Legendre & Gauss Chebyshev's.

Solution of Nonlinear Equations: Bracketing methods for locating a root, initial approximations and convergence criteria, bisection method, Regula falsi, Newton- Raphson and secant method.

SECTION C

Solution of Linear Systems**:** Direct methods, Gaussian elimination, matrix inversion, iterative methods for linear systems (Gauss Seidel & Gauss Jacobi), LU decomposition.

Eigen Value Problems**:** Jacobi, Given's and Householder's methods for symmetric matrices, power and inverse power methods.

SECTION D

Solution of Differential Equations**:** Introduction to differential equations, Initial value problems, Picard's method, Taylor series method , Euler's methods, classical method of Runge-Kutta method of order IV Predictor-Corrector methods(Milne's & Adam's Bashforth).

Partial Differential Equations: Solution of hyperbolic, parabolic and elliptic equations.

TEXT BOOKS & REFERENCES:

1. M.K. Jain, S.R.K. Iyengar and R.K.Jain, "Numerical Methods for Scientific and Engineering Computation", New Age international Publishers.

2. Laurene V, Fausett, "Applied Numerical Analysis using MATLAB", Pearson.

3. S.S. Sastry, "Introductory Methods of Numerical Analysis", Published by Prentice Hall of India.

LIST OF EXPERIMENTS:

1. To find roots of an equation using Bisection method.
2. To find roots of an equation using Regula Falsi method.
3. To find roots of an equation using Newton Raphson Method.
4. To find roots of an equation using Secant method.
5. To find the value of a dependent variable for a given value of an independent variable using Lagrange's interpolation method for a given set of data.

6. To find the value of a dependent variable for a given value of an independent variable using Newton divided difference interpolation for a given set of data.
7. To find the value of a definite integral using Trapezoidal rule of integration.
8. To find the value of a definite integral using Simpson's 1/3 rule of integration.
9. To find the value of a definite integral using Simpson's 3/8 rule of integration.
10. To find the solution of an ordinary differential equation of first order by Euler's modified method.
11. To find the solution of an ordinary differential equation of first order by R-K method
12. To find the solution of a system of simultaneous algebraic equations using the Gauss-Jacobi iterative method.
13. To find the solution of a system of simultaneous algebraic equations using the Gauss-Seidel iterative method.
14. To fit a straight line using the method of least squares.

Course Title/Code	POLYMER CHEMISTRY (CHH219)
Course Type	Elective
Course Nature	Hard Course
L-T-P-O structure	3-1-2-0
Prerequisite	NIL

SECTION A

Introduction And History Of Polymeric Materials: Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality And Its Importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

SECTION B

Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and Crystalline: Determination of crystalline melting point and degree of crystalline, Morphology of crystalline polymers, Factors affecting crystalline melting point.

SECTION C

Nature and Structure of Polymers: Structure Property relationships. Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometer, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Poly dispersity index. Glass transition temperature (Tg) and determination of Tg, Factors affecting glass transition temperature (Tg).

Polymer Solution: Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

SECTION D

Properties of Polymers (Physical, Thermal, Flow & Mechanical Properties): Brief introduction to preparation, structure, properties and application of the following polymers: polyolefin's, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers.

TEXT BOOKS & REFERENCES:

1. R.B. Seymour & C.E. Carraher: Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York, 1981.
2. G. Odian: Principles of Polymerization, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971.

LIST OF EXPERIMENTS:

1. Purification of monomer (Acrylamide)
2. Preparation of nylon 66 and nylon 6
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparations of novalac resin
6. Determination of molecular weight of polymers by viscometry
7. Determination of the viscosity-average molecular weight of poly(vinyl alcohol).
8. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).

Course Title/Code	LASER TECHNOLOGY (PHH221)
Course Type	Elective
Course Nature	Hard Course
L-T-P-O structure	3-1-2-0
Prerequisite	NIL

SECTION-A

Elements of Laser**:** Review of basic concepts (Absorption, spontaneous and stimulated emission, population inversion, pumping, active materials, laser action, properties of laser light), radiative decay and lifetime of a level, emission broadening and line width due to radiative decay (natural broadening and Doppler broadening) Einstein's coefficients (possibility of amplification), kinetics of optical absorption (exponential increase in the intensity of beam in an active material).

SECTION-B

Development and Growth Of Laser Beam**:** Saturation pumping intensity, development and growth of laser beam, shape or geometry of amplifying medium, exponential growth factor, threshold requirements for a laser, resonators, decay time of a laser beam within an optical cavity, basic laser cavity rate equations(linear variation of photon flux with pumping flux).

SECTION-C

Laser Rate Equations and Laser Systems**:** Two – level system, steady – state inversions and three and four - level systems, pumping techniques, Factors affecting population inversion, Helium – Neon laser, CO_2 laser, Ruby laser, Semiconductor diode laser, excimer laser(ArF),dye lasers.

SECTION-D

Applications of Lasers**:** Holography (recording and reconstruction), laser welding, laser cutting, laser drilling, Lidar (Light detection and ranging used for monitoring the environment), laser cooling, laser in communication, thin film deposition using laser (pulsed laser deposition)

TEXT BOOKS & REFERENCES:

1. Laser Fundamentals by William T. Silfvast Cambridge University Press.
2. Introductory University Optics by John Beynon, (PHI).
3. Laser – B. B. Laud.

LIST OF EXPERIMENTS:

1. To measure the diameter of hair using a semiconductor laser.
2. To determine the wavelength of semiconductor laser using a plane transmission diffraction grating.
3. To observe a hologram using a semiconductor laser.
4. To determine refractive index of a prism using a semiconductor laser.
5. To measure the coherence length of a laser using Michelson interferometer.
6. To study the scattering from chalk particles using laser light.
7. To determine absorption coefficient of a medium using laser light.

Course Title/Code	ENVIRONMENT SUSTAINABLE DEVELOPMENT (CHS234)
Course Type	Elective
Course Nature	Soft Course
L-T-P-O structure	1-0-2-0
Prerequisite	NIL

SECTION A

Introduction to Sustainable Development**:** Definition of Sustainable Development; Triple Bottom Line, Components of TBL, Changing Perspective & Debates in Sustainable Development - Need for Sustainable Development, Evolution of the concept of Sustainable Development: Stockholm Conference, The Brundtland Commission, Earth Summit, Agenda 21; Millennium Development Goals

SECTION B

Challenges to Sustainable Development and Sustainable Development Goals (SDGs): Challenges to Sustainable Development - Agriculture, Population & Food Security, Public Health and Nutrition, Education, Natural Resources (Forests, Energy, Water), Climate Change Sustainable Development Goals (SDGs) - Introduction, Challenges to SDGs, Indian Scenario.

SECTION C

Sustainability Strategies & Reporting: Sustainability Strategies & Reporting - Introduction, Rationale and Mechanisms, Key Principles, Sustainability Strategies Adopted by Different Enterprises – Case Studies

SECTION D

Sustainable Development and Contemporary Issues: Sustainable Consumption, Indigenous Knowledge, Gender Issues, Population & Sustainable Agriculture, Sustainable Tourism.

TEXT BOOKS & REFERENCES:

1. Environmental Management for Sustainable Development; C.J. Barrow; Routledge Publishers
Roberts, J.T., and Hite, A., 2000.
2. Modernization to Globalization - Perspectives on Development and Social Change, Blackwell Publishing.
3. Sachs, J., 2004, Stages of Development, Speech at the Chinese Academy of Arts and Sciences

LIST OF EXPERIMENTS:

1. Survey- Business and non-business students' perception towards TBL (based on the readings listed above); inferences on the basis of survey; http://www.aabri.com/manuscripts/121249.pdf 2.Workshop based - Sustainable agriculture- Mushroom farm
2. Workshop based - Back to nature - DIY composting bin
3. Review - Sustainable Consumption in India: Challenges and Opportunities; Divesh Kumar,Praveen Goyal, Zillur Rahman, Ishwar Kumar; IJMBs Vol. 1, Issue 3, September 2011; http; ://www.ijmbs.com/13/devesh.pdf
4. Calculate Carbon Footprint/Ecological footprint
5. Stimulus Activity (Piece of writing) - Sustainable Consumption
6. CSR - Workshop for Village school children
7. Simulation Activity - Challenges to Sustainable Development
8. Case Studies - Sustainability initiatives @ TATA Motors, CAIRN INDIA, Mahindra & Mahindra, Subaru Isuzu, Disney, Novo Nordisk, etc.

Course Title/Code	E-WASTE MANAGEMENT (ECS249)
Course Type	Elective
Course Nature	Hard Course
L-T-P-O structure	1-0-2-0
Prerequisite	NIL

SECTION A

Introduction: What is E-Waste, Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of e-waste, Possible hazardous substances present in e-waste, Environmental and Health implications.

SECTION B

E-Waste Legislation: Regulatory regime for e-waste in India, The hazardous waste(Management and Handling) rules 2003, E- waste management rules 2015, Regulatory compliance including roles and responsibility of different stakeholders – producer, manufacturer, consumer etc., Proposed reduction in the use of hazardous substances(RHS), Extended producer responsibility (EPR).

SECTION C

End of Life Management of E-Waste**:** Historic methods of waste disposal – dumping, burning, landfill; Recycling and recovery technologies – sorting, crushing, separation; Life cycle assessment of a product – introduction; Case study – optimal planning for computer waste.

SECTION D

Environmentally Sound E-Waste Management: Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, Environmentally sound treatment technology for e-waste, Guidelines for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.

TEXT BOOKS & REFERENCES:

1. Electronic Waste Management R E Hester, RMRSC Harrison
2. E-waste: Implications, regulations and management in India and current global best practices, Rakesh Johri, TERI PRESS

LIST OF EXPERIMENTS:

1. Video Lecture:
2. E-Waste: A Big Issue- https://www.youtube.com/watch?v=d5oi4QOeQ3I&t=21s
3. The Electronic Wasteland- https://www.youtube.com/watch?v=cVORBbZBbOk
4. E Waste in India-https://www.youtube.com/watch?v=sFfaYc_pIx8
5. Reading (articles/research papers):
6. Step: Solving the E-Waste Problem. White Paper: One Global Definition of E- waste. **http://www.step-initiative.org** 3
7. . E-waste management in India – Electronics For You, **http://electronicsforu.com/technology-trends/e-waste-management-india**
8. Identify the hazardous materials present in printed circuit boards.
9. Extraction of copper of printed circuit boards in etching solution.
10. Demo of recycling process through videos.
11. Invited guest lecture.
12. Field visit to a waste management initiative in NCR.
13. Activity based learning: survey of the household practice of e-waste disposal and awareness.
14. Case study – presentation and group discussion.

Course Tittle/Code	DESIGN SOFTWARE-I (MEW213)
Course Type	Domain Core
Course Nature	Workshop
L-T-P-O Structure	0-0-3-0
Prerequisite	NIL

SECTION A

Introduction to design software: a solid modeler, Feature-Based, Parametric, and Associative

The design software interface : screen layout, Main Window ,Pull-Down Menus Toolbar, Display Area , Message Area, working with models ,Using Dialog Boxes Retrieving Models, Retrieving Multiple ,Models ,Saving Changes, Closing Windows, Deleting Files ,pick and place features: Creating the Straight Hole Feature, Creating the Simple Round , Specifying Radius Values for a Simple Round, Creating an Edge Chamfer

Sketcher basics: The sketcher environment, he sketcher interface, intent manager ,pop-up menus sketcher mode functionality, sketcher menus , specifying references , creating geometry ,dimensioning, constraining ,additional sketcher tools, setting sketcher preferences

sketcher philosophy, rules of thumb ,laboratory practical.

SECTION B

Sketched features: Two sketched features, specifying extruded and revolved forms, sketching and reference planes, The Sketching Plane's Default Orientation

Datum planes: Using base features and datum planes, the base feature and its importance, datum plane, using default datums as the base feature, creating additional datum planes, defining a datum plane, internal datums.

SECTION C

Parent/child relationships: Parent/child relationships with pick-and-place features, parent/child relationships with a sketched feature, changing the parents of a feature , order of feature regeneration, using feature insert mode

Sweeps and blends: Swept features, defining a sweep, sweep sections and trajectories, blend features, creating parallel blends

Duplicating features: patterns and copy : Creating a pattern, benefits of patterning, types of patterns , pattern options , the copy feature, specifying location, choosing features , establishing dependence

SECTION D

Drawings and views: Drawing fundamentals, creating a drawing, adding drawing views, types of views, adding a cross section, manipulating views, laboratory practical

Creating assemblies Assembly creation: the surface normal vector, constraint options, packaging or under-constrained, components, assembly modification, changing design intent of the assembly, other assembly options, extracting a bill of materials, creating exploded views.

TEXT BOOKS & REFERENCES

1. Design Software: Tutorial and Multimedia CD

Course Title/Code	DESIGN SOFTWARE-II (MEW214)
Course Type	Domain Core
Course Nature	Workshop
L-T-P-O Structure	0-0-3-0
Prerequisite	NIL

SECTION-A

Introductory Concept: line, infinite line, bi-tangent line, bisecting line and line normal to curve.
Constraint, contact constraint, fixes together, auto constraint, animate constraint and edit multi constraint.
Circle, three point circle, circle using coordinates, tri-tangent circle, arc, three point arc and three point arc starting with limits.

SECTION-B

Profile**:** rectangle, oriented rectangle, parallelogram, elongated hole, cylindrical elongated hole, keyhole profile, hexagon, centered rectangle and centered parallelogram.
Axis and Point**:** axis, point, point using coordinates, equidistant points, intersection point and projection point.
Operation**:** corner, chamfer, trim, break, quick trim, close, complement, mirror, symmetry, translate, rotate, scale and offset and sketch analysis.

SECTION-C

Sketch Based Feature**:** pad, pocket, drafted filleted pad, drafted filleted pocket, shaft, groove, hole, rib, slot, stiffener, multi-sections solid, remove multi-sections solid, multiple pad, multiple pocket, solid combine.

Dress-Up Feature**:** edge fillet, variable fillet, chordal fillet, face-face fillet, tri-tangent fillet, chamfer, draft, drafted reflect line, variable angle draft, shell, thickness, thread/tap, remove face, replace face.

SECTION-D

Transformation Features**:** translation, rotation, symmetry, mirror, rectangular pattern, circular pattern, user pattern**,** Scaling.
Boolean Operation**:** add, remove, intersect and draft both sides.

TEXT BOOK & REFERENCE BOOK:

1. CATIA for Engineers and Designers by Sham Tickoo, Dreamtech Press
2. CATIA V5 Design Fundamentals by Jaecheol Koh

Semester 5 (Total credit – 25.5)

<table>
<tr><td>Nature of the course/
Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2) /
NTCC Course (0-0-0-1)
Name (Offering Department)</td><td>Workshop (0-0-3) name (Offering Department)</td></tr>
<tr><td rowspan="3">Domain Core</td><td>Machine Design (ME) (3-1-2-1)</td><td></td><td></td></tr>
<tr><td>Hydraulic Machines (ME)</td><td></td><td></td></tr>
<tr><td>IC Engines (ME)</td><td></td><td></td></tr>
<tr><td>Allied Core</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Domain Elective</td><td rowspan="4">E1-
-Computer Aided manufacturing and Integrated Manufacturing (CAM & CIM)
-Measurement & Instrumentation
-Advanced Thermodynamics
-Foundry Technology
-Computer Aided Design and Engineering (CAD&CAE)</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td>Analysis Software-I</td></tr>
<tr><td rowspan="2"></td><td>Analysis Software-II</td></tr>
<tr><td>Allied Elective</td><td></td><td>Basket of Elective offered by Law Department</td><td></td></tr>
<tr><td rowspan="2">NTCC</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Professional Competency Enhancement-III</td><td></td></tr>
<tr><td></td><td></td><td>Technical Seminar-II</td><td></td></tr>
<tr><td>Credits</td><td>20</td><td>3.5</td><td>2</td></tr>
<tr><td>Total Credits</td><td colspan="3">25.5</td></tr>
<tr><td>Total Hours</td><td colspan="3">32</td></tr>
</table>

Course Title / Code	**MACHINE DESIGN (MEH316)**
Course Type	**Domain Core**
Course Nature	**Hard Course**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION A

Introduction: Types of design, General considerations and procedures of machine design, Types of loading, selection of materials and its designation, Design stress & factor of safety, selection of FOS. Application of theories of failure to design, tolerance, fits & limits.

Design for fatigue strength; S-N diagrams, Low & High Cycle fatigue, Endurance limit modifying factors, Fatigue strength under fluctuating stresses, Cumulative damage, surface strength.

SECTION B

Design of solid and hollow shafts subjected to torsion, bending and axial load for strength and stiffness. Shafts subjected to dynamic loading .Design of Keys, Spines, pins, cutters and shaft couplings.

SECTION C

Design of Screws, bolts and their types, bolted joints including eccentrically loaded joint, riveted joint, welded joint, welded joint in eccentrically loaded condition, welded joint in cylindrically vessels and power screws.

SECTION D

Belt Drives: flat and V-belt drives, effect of centrifugal tension, initial tension, maximum power, Design of flat and V-belt, design of ropes. Description of Clutches and Brakes, Performance Parameters, design & characteristics of clutches & brakes.

TEXT BOOK & REFERENCE BOOK:

1. Sharma & Aggarwal, Machine Design, Kataria Publications.
2. V. B Bhandari: Design of Machine Elements, McGraw Hill
3. Joseph E. Shigley; Mechanical Engineering Design, McGraw Hill.

LIST OF EXPERIMENTS:

1. Design of shaft subjected to static load.
2. Design of shaft subjected to fluctuating load.
3. Design of different type of keys & couplings.
4. Design of bolted joints.
5. Design of riveted joints
6. Design of welded joints
7. Design of flat belt
8. Design of v-belt
9. Design of clutches
10. Design of brakes

Course Title / Code	HYDRAULIC MACHINES (MEH317)
Course Type	Domain Core
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	Fluid Mechanics

SECTION A

Impact of free jets: Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships. Impulse Turbines: Classification – impulse turbine, construction, ,Analysis of Force on the Bucket and Power Generation, efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets, Performance Characteristics, governing mechanism of a Pelton wheel.

SECTION B

Reaction turbines: Francis Turbines- construction and operation of a Francis turbine, Draft Tube and its types, Head across a Reaction Turbine, Blade Efficiency and design parameters, degree of reaction, inward/outward flow reaction turbines Performance Characteristics, Governing mechanism. Propeller and Kaplan turbines: construction and operation of a Propeller, Kaplan turbine, differences between the Francis and Kaplan turbines, cavitations, specific speed, unit quantities, Performance Characteristics, Compounding of turbines, number of blades and nozzles.

SECTION C

Centrifugal Pumps: Classification, velocity vector diagrams and work done, manometric efficiency, pressure rise in impeller, minimum starting speed, design considerations, multi-stage pumps, specific speed, net positive suction head, cavitation, performance characteristics. Brief introduction to submersible pumps. Reciprocating Pumps: Construction and operational details, difference between centrifugal vs. reciprocating pumps, slip, work and power input, effect of acceleration and friction on indicator diagram (pressure – stroke length plot),separation, air vessels and their utility, rate of flow into or from the air vessel, maximum speed of the rotating crank, characteristic curves.

SECTION D

Fluid Systems: Working principle, construction and operation of Hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift and hydraulic press and their applications, Fluid coupling and torque converter, Hydraulic ram, Problems, Dimensional analysis: Principles of Similarity and Dimensional Analysis, similitude, Buckingham's _-theorem, dimensionless numbers and their significance, problems.

TEXT BOOKS & REFERENCES:

1. R.K.Bansal, Fluid Mechanics and Hydraulics Machines, Laxmi Publications
2. Hydraulics& Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi

LIST OF EXPERIMENTS:

1. To Explain the model of Hydro power plant and draw its layout
2. To perform experiment on a Pelton turbine and calculate its efficiency.
3. To explain governing mechanism of impulse turbine.
4. To perform experiment on a Francis turbine and calculate its efficiency.
5. To perform experiment on a Kaplan turbine and calculate its efficiency.
6. To draw performance characteristics of a Pelton, Francis and Kaplan turbine.
7. To perform experiment on a Centrifugal pump and calculate its efficiency.
8. To perform experiment on a Reciprocating pump and calculate its efficiency.
9. To perform experiment on a Gear Oil pump and calculate its efficiency.
10. To perform experiment on a Hydraulic Ram and calculate its efficiency.

Course Title / Code	INTERNAL COMBUSTION ENGINES (MEH318)
Course Type	Domain Core
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Classification: Historical development of I.C. engines, Classification based on fuel, working cycle, method of fuel supply, Ignition and Governing, Scavenging of two stroke engines, Fuel – air cycles & actual air cycles and their analysis. Spark Ignition Engines: Flame speed-effect of turbulence and other parameters, Valve timing diagram, Normal and abnormal combustion, Auto ignition and Pre ignition, Fuel requirements, knock ratings, combustion chambers, Carburetion-mixture strength requirements, Simple carburetor-limitations, compensating arrangements, Gasoline injection systems, mpfi system for modern automobiles.

SECTION B

Compression Ignition Systems: Low and high speed types, Air utilization and output, Combustion process-Ignition delay, Detonation, factors affecting detonation and limits of detonation, Knocking and effect of variables, Fuel requirements and rating, Combustion chambers, Fuel injection systems, fuel punp and fuel injectors. Types of nozzle, size of nozzle orifice, spray formation, quality of fuel.

Super Charging: Types of engine supercharging, Engine supercharging devices, Turbo charging, effect of supercharging and limit of supercharging.

SECTION C

Performance of IC Engines: Measurement of engine power, analysis of engine performance, Indicator diagram, Factors effecting efficiency and power, heat loss, pumping loss, Geometry, Speed, Air/Fuel ratio, Heat balance test, BIS standards for testing and rating.

Modern Developments: Wankel engine, stirling engine, Stratified charge engine, Dual-fuel engines, HCCI concept.

SECTION D

Engine Emissions: SI and CI engine emissions, Harmful effects, Emissions measurement methods, Methods for controlling emissions, EURO and BHARAT emission norms.

Gas Turbines: Brayton cycle; Components of a gas turbine plant; open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; multi stage compression with inter-cooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines.

TEXT BOOK & REFERENCES:

1. Ganesan,V., Internal Combustion Engines, Tata McGraw Hill Publishing Company, 2007. Mathur, M.L., and Sharma, R.P.**,**

2. A Course in Internal Combustion Engines, Dhanpat Rai and Sons,2008

3. John, B.H., Internal Combustion Engine Fundamentals, McGraw Hill, 1988**.**

LIST OF EXPERIMENTS:

1. I.C. Engine valve timing diagram
2. I.C. Engine port timing diagram
3. I.C. Engine performance test on single cylinder 4 stroke diesel engine
4. Performance test on single cylinder 2 – stroke petrol engine
5. Morse test on 4 - cylinder 4 - stroke petrol engine

6. Evaluation of engine friction by conducting motoring/retardation test on single cylinder 4 stroke diesel engine
7. Heat balance test on single cylinder 4 stroke diesel engine.
8. Determination of air/fuel ratio and volumetric efficiency on 4-stroke diesel engine
9. Disassembly /assembly of I.C. engine

Course Title / Code	ADVANCED THERMODYNAMICS (MEH319)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	Thermodynamics

SECTION-A

Review of I and II Laws of Thermodynamics: Transient flow analysis,

Entropy balance, Entropy balance for closed system, Entropy balance for steady flow system. Mechanism of Entropy transfer, entropy generation

Exergy Analysis: Concepts, exergy balance, exergy transfer, exergetic efficiency, exergy analysis of power and refrigeration cycles.

SECTION-B

Real Gases and Mixtures: Equations of state, thermodynamic property relations, residual property functions, properties of saturation states, Redlich-Kwong Equation, Beattie-Bridgeman Eqation, Virial Equation of State

SECTION-C

Thermodynamic Properties of Homogeneous Mixtures: Partial molar, properties, chemical potential, fugacity and fugacity coefficient, fugacity relations for real gas mixtures, ideal solutions, phase equilibrium, Rault's law.

SECTION-D

Reacting Systems: I and II law analysis of reacting systems, absolute entropy and the third law, fuel cells, chemical energy, exergetic efficiency of reacting systems, Equilibrium criteria, equilibrium and chemical potential, chemical equilibrium constant, equilibrium composition, equilibrium flame temperature.

TEXT BOOK & REFERENCES:

1. Engineering Thermodynamics- P K Nag,Tata Mc Graw Hill
2. Fundamentals of Engineering Thermodynamics – E. Radhakrishnan, PHI, New Delhi
3.Theory and Problems of Thermodynamics – Y. V.C. Rao, Wiley Eastern Ltd., New Delhi

LIST OF EXPERIMENTS:

1. To do exergy and entropy analysis of Boiler.
2. To do exergy and entropy analysis of Turbine
3. To do exergy and entropy analysis of Refrigeration System.
4. Study of Fuel Cells.
5. To study the properties of Steam at saturated state

Course Title / Code	COMPUTER AIDED MANUFACTURING /COMPUTER INTEGRATED MANUFACTURING (MEH320)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Computer Integrated Manufacturing (CIM**):** Introduction to CIM, Types of Manufacturing, CIM hardware and software, Elements of CIM, Product development through CIM, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.

Computer Aided Manufacturing**:** CAM Concepts, Objectives & Scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM.

SECTION B

Programmable Logic Controllers**:** Relay Device components, Programmable controller architecture, programming a programmable controller, tools for PLC logic design.

NC/CNC Machine Tools**:** NC and CNC Technology*:* Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators.

CNC hardware*:* Elements of CNC viz. Ball screws, rolling guide ways, structure, drives and controls, standard controllers. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, Canned Cycles, Parametric sub routines.

SECTION C

Group Technology & Computer Aided Production Planning (CAPP): Introduction, Part families, Part classification and coding systems: OPITZ, PFA, FFA, Cell design, rank order clustering, composite part concepts, Benefits of group technology. Approaches to Process Planning, Different CAPP system, application and benefits.

Flexible Manufacturing System**:** Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of flexibility and FMS, FMS lay out and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Flexible Fixturing, Flexible Assembly Systems.

SECTION D

Robot Technology**:** Introduction, Robot Anatomy, Laws of Robot, Human System and Robotics, Coordinate system, Specifications of Robot. Power sources, actuators and Transducers, Robotic Sensors, Grippers, Robot Safety, Robot Programming and Robot Applications, Economic Considerations of Robotics system, Robot Kinematics and Dynamics, Robot Arm Dynamics. Concepts of Computer Vision and Machine Intelligence.

Integrated Production Management System**:**

Introduction*:* PPC fundamentals, Problems with PPC, MRP-I, MRP-II.

Just in Time philosophy*:* JIT & GT applied to FMS, concepts of Expert System in Manufacturing and Management Information System.

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TEXT BOOKS & REFERENCES:

1. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education**.**

2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, Pearson Education**.**
3. Robotics Technology and Flexible Automation, by S R Deb, S Deb, McGraw Hill Education Private Limited.

LIST OF EXPERIMENTS:

1. Study of Computer Integrated System: Basics, Types of Manufacturing, role of management and CIM wheel.
2. NC/CNC technology: Definition, Classification, Specification, Construction details, Sensors and Actuators, and different controllers.
3. CNC part Programming: Lathe and Milling jobs.
4. Exercise on PLC for Simple problems.
5. Problems on GT and Industrial case problems on coding.
6. Problems on CAPP and Industrial case problems.
7. Study of Flexible Manufacturing system.
8. Study of Robotics Technology.
9. Problems on MRP-I, MRP-II.
10. Study of Expert System in Manufacturing and MIS

Design based Problems (DP)/Open Ended Problem:

1. Industrial case problems on CNC programming.
2. PLC programming on simple cases.

Case problems on GT and CAPP.

Problems on Understanding of Kinematics of Robotics

Course Title / Code	MEASUREMENTS, INSTRUMENTATION & CONTROL (MEH321)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Instruments and Their Representation: Introduction, Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Classification of Instruments, Standards and Calibration.

Static and Dynamic characteristics of Instruments : Introduction, Accuracy, Precision, Resolution, Threshold, Sensitivity, Linearity, Hysteresis, Dead Band, Backlash, Drift, Formulation of Differential Equations for Dynamic Performance- Zero Order, First Order and Second order systems, Response of First and Second Order Systems to Step, Ramp, Impulse and Harmonic Functions.

SECTION B

Transducer Elements : Introduction, Analog and Digital Transducers, Electromechanical; Potentiometric, Inductive Self Generating and Non-Self Generating Types, Electromagnetic, Electrodynamics, Eddy Current, Magnetostrictive, Variable Inductance, Linearly Variable Differential Transformer, Variable Capacitance, Piezo-Electric Transducer and Associated Circuits, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits, Single Double and Four Active Arm Bridge Arrangements, Temperature Compensation, Balancing and Calibration, Ionisation Transducers, Mechano Electronic Transducers, Opto-Electrical Transducers, Photo Conductive Transducers, Photo Volatic Transducers, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer, Binary codes, Digital Encoders.

SECTION C

Motion, Force and Torque Measurement : Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass & Force Balance Type, Calibration, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Separation of Force Components, Electro Mechanical Methods, Strain Gage, Torque Transducer, Toque Meter.

Intermediate, Indicating and Recording Elements : Introduction Amplifiers, Mechanical, Hydraulic, Pneumatic, Optical, Electrical Amplifying elements, Compensators, Differentiating and Integrating Elements.

SECTION D

Pressure and Flow Measurement: Pressure & Flow Measurement, Introduction: Moderate Pressure Measurement, Monometers, Elastic Transducer, Dynamic Effects of Connecting Tubing, High Pressure Transducer, Low Pressure Measurement, Calibration and Testing, Quantity Meters, Positive Displacement Meters, Flow Rate Meters, Variable Head Meters, Variable Area Meters, Rota meters, Pitot-Static Tube Meter, Drag Force Flow Meter, Turbine Flow Meter, Electronic Flow Meter, Electro Magnetic Flow meter. Hot-Wire Anemometer.

Temperature Measurement : Introduction, Measurement of Temperature, Non Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Pressure Thermometer, Electrical Methods

Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials, Radiation Methods (Pyrometry), Total Radiation Pyrometer, Selective Radiation Pyrometer.

TEXT BOOKS & REFERENCES:

1. Measurement systems Application and Design. Ernest O. Doebelin, Tata McGraw Hill Edition (Fourth Edition) 2002.

2. Measurement and Instrumentation in Engineering, Francis S. Tse and Ivan E. Morse, Marcel Dekker.

LIST OF EXPERIMENTS:

1. To Study various Temperature Measuring Instruments and to Estimate their Response times.
   i. Mercury – in glass thermometer
   ii. Thermocouple
   iii. Electrical resistance thermometer
   iv. Bio-metallic strip
2. To study the working of Bourdon Pressure Gauge and to check the calibration of the gauge in a dead-weight pressure gauge calibration set up.
3. To study a Linear Variable Differential Transformer (LVDT) and use it in a simple experimental set up to measure a small displacement.
4. To study the characteristics of a pneumatic displacement gauge.
5. To measure load (tensile/compressive) using load cell on a tutor.
6. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.
7. To measure the speed of a motor shaft with the help of non-contact type pick-ups (magnetic or photoelectric).
8. To measure the stress & strain using strain gauges mounted on simply supported beam/cantilever beam.
9. To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
10. To test experimental data for Normal Distribution using Chi Square test.
11. To learn the methodology of pictorial representation of experimental data and subsequent calculations for obtaining various measures of true value and the precision of measurement using Data acquisition system/ calculator.
12. Vibration measurement by Dual Trace Digital storage Oscilloscope.
13. To find out transmission losses by a given transmission line by applying capacitive /inductive load.
14. Process Simulator.

Course Title / Code	FOUNDRY TECHNOLOGY (MEH322)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	Manufacturing Technology-I

SECTION A

Introduction**:** Introduction to foundry, steps involved in foundry process, advantages and disadvantages. Pattern: Types, pattern making, allowances, materials and color codes, storing of pattern, Steps in pattern making.

Technology of Molding & Core Making**:** Molding sands, Principal ingredients of molding sands, Specification and testing of molding sands, Classification of Molding sands, Additives to molding and Core making sands, Mold Dressings, Sand Conditioning.

SECTION B

Molding Processes**:** Types of sand molding, Tools for hand molding, Characteristics of cores and core sands, Types of cores, Use of chaplets, Processes based on organic binders. Cores: Definition, Need, Types. Method of making cores, Binders used, core sand molding, Core making machines. Molding Machines: Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger

Casting Processes**:** Sand castings, pressure die casting, permanent mold casting, centrifugal casting, precision investment casting, shell Molding, continuous casting-squeeze casting, electro slag casting, Casting of non-ferrous materials, heat treatments for casting, Fettling and cleaning of castings: Basic steps, Casting defects, Causes, features and remedies.

SECTION C

Casting Design**:** Design considerations in casting, Gating and Riser - directional solidification in castings, Metallurgical aspects of Casting.

Melting, Pouring and Testing**:** Melting furnaces crucibles oil fired furnaces-electric furnaces cupola, selection of furnace, calculation of cupola charges Degasification, inoculation, pouring techniques, Inspection of castings.

SECTION D

Casting Defects & Their Remedies**:** Shaping faults arising in pouring, Inclusions and sand defects, gas defects, shrinkage defects during solidification in liquid phase. Contraction defects, Dimensional errors, compositional errors and segregation.

Modernization & Mechanization of Foundries**:** Need, Area for mechanization, Material handling, Pollution control in foundries, Pollutants in a foundry, Plant layout for foundries, steps in planning a foundry layout.

TEXT BOOKS & REFERENCES:

1. Principles of Foundry Technology by P.L Jain, Tata McGraw Hill
2. Principles of Metal Casting by R.W. Heine, Carl Loper, and P.C. Rosenthal, Tata McGraw Hill
3. Manufacturing Technology by P.N. Rao, Tata McGraw Hill

LIST OF EXPERIMENTS:

1. Testing of Molding sand and Core sand Preparation of sand specimens and conduction of the following tests:
   a. Compression, Shear and Tensile strengths on Universal Sand Testing Machine.
   b. Permeability test
   c. Core hardness &Mold hardness tests.
   d. Sieve Analysis to find Grain Fineness number of Base Sand
   e. Clay content determination in Base Sand.

2. Foundry Practice

a. Use of foundry tools and other equipment.
b. Preparation of molds using two molding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).
c. Preparation of one casting (Aluminum or cast iron-Demonstration only)

Course Title / Code	COMPUTER AIDED DESIGN/ COMPUTER AIDED ENGINEERING (MEH323)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Introduction to computer aided design (CAD), Hardware for CAD, vector representation, co-ordinate system, Introduction to programming, programming language for CAD, Geometric transformation in 2D and 3D, Modeling techniques, geometric modeling techniques and its functions i.e wireframe, B-rep, CSG, Hybrid modelers, feature based modeling, parametric variation. Review of Computer Graphics, Transformation, Segmentation, Graphics programming. CAD Model and Drafting of 2-D and 3-D models.

SECTION B

Space curve design: Analytical and synthetical approach Cubic spline, B-spline, Bezier curves, 7 NURBS and their manipulation, Integration of CAD Analysis and Design.
Plane design: Modeling of biparametric surface coons, Bezier, B spline and NURBS Patches

Computer aided linkage synthesis: Animation of machine parts, linkage displays and synthesis, interactive acceleration analysis. Concept of optimal design, deterministic design options problems; the probalistic design option problems, value curves, interaction curves and trade off curves.

SECTION C

Techniques of optimizations, classical methods, linear and non-linear programming in reference to various mechanical design problems, use of tables, charts, interactive optimization.
Introduction to Finite Element Method (FEM), direct and variation approach, coordinate transformation, 1-D and 2-D linear and triangular element, isoperimetric elements, FEM formulation of solid mechanics problems, CAD application to FEM, interfaces to CAD.

SECTION D

Introduction to Expert systems for CAD, Artificial intelligence in CAD, applications of AI in CAD,
Components of an expert system, structure and building of expert systems, knowledge representation, inference mechanisms.

TEXT BOOKS & REFERENCES:

1. CAD/CAM Theory and Practice - Ibrahim Zeid - McGraw Hills.
2. CAD/CAM –Groover And Zimmer- PHI Publication

LIST OF EXPERIMENTS:

1. Setting up of drawing environment by setting drawing limits, drawing units, naming the drawing, naming layers, setting line types for different layers using various type of lines in engineering drawing, saving the file with .dwg extension.
2. Layout drawing of a building using different layer and line colors indicating all Building details. Name the details using text commands, Make a title Block.

3. To Draw Orthographic projection Drawings (Front, Top and side) of boiler safety valve giving name the various components of the valve.
4. Make an Isometric dimensioned drawing of a connecting Rod using isometric grid and snap.
5. Draw quarter sectional isometric view of a cotter joint.
6. Draw different types of bolts and nuts with internal and external threading in Acme and square threading standards. Save the bolts and nuts as blocks suitable for insertion.
7. Draw 3D models by extruding simple 2D objects, dimension and name the objects.
8. Draw a spiral by extruding a circle.

Course Title/ Code	LAW OF PATENT AND TRADITIONAL KNOWLEDGE (LWS321)
Course Type:	ELECTIVE
Course Nature:	SOFT
L-T-P-O Structure	(1-0-2-0)

SECTION A

The Concept of patents: objective of patents, theories of patent protection: economic and moral justifications for patent, Historical development of patent law in India, International instruments dealing with patent protection: Paris Convention for Protection of Industrial Property, Patent Cooperation Treaty (PCT) , TRIPS Agreement Budapest Treaty for Microorganisms.

SECTION B

Patentable Subject matter, Patentability of Computer Programs, Algorithms and Mathematical Formulae, Pharmaceutical Patent, Patentability of diagnostic method, Patentability of Traditional Knowledge

Cases: Novartis A.G. v. Union Of India & Others, AIR 2012, Diamond V. Chakrabarty (447 U.S. 303 (1980). Criteria for patent: novelty, inventive step, and industrial application.

SECTION C

Procedure for filing of patents: national filing , International filing of patents: PCT ,Revocation of patents , Opposition to patents

SECTION D

Infringement of patents, Remedies for infringement of patents, Exceptions/defenses to infringement of patents, Licensing of patents: basics, and statutory provisions, Traditional Knowledge: Meaning and basics, Traditional Knowledge Digital Library (TKDL), interaction with patent law, case studies on TK: patenting of turmeric, neem, and basmati rice.

Tutorial Exercises (2 hours per week)

1. Drafting exercises on patent drafting and filing 2. Drafting exercises on licensing of patents.

TEXT BOOKS & REFERENCES:

1. B.L. Wadhera, B.L. Wadhera, Law Relating to Intellectual Property, Universal Publishing Company, 5th Edition.
2. Narayanan, P., Patent Law (Kolkata: Eastern Law House, 1998.

Course Title/ Code	LAWS OF COPYRIGHT (LWS322)
Course Type:	ELECTIVE
Course Nature:	SOFT
L-T-P-O Structure	(1-0-2-0)

SECTION A

Meaning and historical evolution of the law of copyright in India, International conventions dealing with law of copyright. Berne Convention for Literary and Artistic works (1886), TRIPs Agreement (1994) . WIPO Copyright Treaty.

SECTION B

Subject matter of copyright protection, Ownership of copyright, Authorship in copyright, Author's special rights: moral right under Section 57 of the Copyright Act, 1957.

SECTION C

Notion of infringement and Criteria of infringement, Infringement of copyright by films of literary and dramatic works, Importation and infringement , Defenses to copyright infringement: fair use doctrine, compulsory licensing, access to copyrighted works in special cases, Remedies for copyright infringement, Injunction: Anton pillar orders, john doe, Damages

SECTION D

Concept of neighboring rights in copyright, International conventions dealing with neighboring rights**,** Neighboring rights under Indian copyright law

Tutorial Exercises (2 hours per week)

1. Drafting exercises on assignment and licensing of copyright.

TEXT BOOKS & REFERENCES:

1. B.L. Wadhera, Law Relating to Intellectual Property, Universal Publishing Company, 5th Edition.

2. Alka Chawla, Copyright and Related Rights: National and International Perspectives (Macmillan India Ltd., Delhi, 2007).

3. N.S. Gopalakrishnan & T.G. Ajitha, Principles of Intellectual Property, Eastern Book Company,2nd Edition , 2014.

Course Title/ Code	CYBER LAWS (LWS323)
Course Type:	ELECTIVE
Course Nature:	SOFT
L-T-P-O Structure	(1-0-2-0)

SECTION A

Introduction: Overview of Computer and Web Technology, Need for Cyber Law, Cyber Jurisprudence at International and Indian Level

SECTION B

Cyber Crimes & Legal Framework: Cyber Crimes against Individuals, Institution and State, Hacking: Digital Forgery, Cyber Stalking/Harassment, Cyber Pornography, Identity Theft & Fraud Cyber Terrorism, Different offences under IT Act, 2000

SECTION C

Digital signature and Electronic Signature and Data Protection **,** Concept of public key and private key, Certification authorities and their role**,** Creation and authentication of digital signature, Concept of electronic signature certificates, electronic records and electronic signatures.

SECTION D

E Contracting: Salient features of E-contract, Formation of E-contract and types: E-mail Contracting**,** Indian Approach on E-contracts**,** E-commerce: Salient Features and advantages, Models of E-commerce.

TEXT BOOKS & REFERENCES:

1. Vishwanathan Suresh T., "The Indian Cyber Law" Second Edition 2001:- Bharat Law House.
2. Prasad T.V.R. Satya, : "Law Relating to Information Technology (Cyber Laws)" 1st edition 2001:- Asia Law House.
3. Syed Shakil Ahmed and Reheja Rajiv, " A Guide to Information Technology" (Cyber Laws & Ecommerce) Edition 2001:- Capital Law House.

Course Title/Code	**DESIGN SOFTWARE-I (MEW324)**
Course Type	**Domain Core**
Course Nature	**Workshop**
L-T-P-O Structure	**0-0-3-0**
Prerequisite	**NIL**

SECTION A

Junction: Block ,Associate Entities to the Geometry , Move the Vertices , Apply Mesh Parameters Generate the Initial Mesh, Adjust the Edge Distribution and Refine the Mesh,Match the Edges,Verify and Save the Mesh and Blocking

SECTION B

Hexa Mesh Generation for a 2D Car:Start a New Project and Initiate Replay Control, Create and Split the Blocking to Resemble the Geometry Associate and Fit the Blocking to the Geometry, Align the Vertices, Set Mesh Parameters and Generate the Initial Mesh, Create an O-grid, Refine the Mesh using Edge Parameters, Save the Replay File and Use it for Design Iteration, Create Output Data for a Solver.

SECTION C

Hexa Mesh Generation for a 3D Pipe Junction: ,Creating a Material Point , Blocking the Geometry, Projecting the Edges to the Curves, Moving the Vertices , Generating the Mesh ,Checking the Mesh Quality ,Creating an O-Grid in the Blocking ,Verifying and Saving the Mesh

Hexa Mesh Generation for a radial flow pump impeller**:** Creating Parts, Blocking the Geometry, Projecting the Edges to the Curves, Moving the Vertices , Generating the Mesh, Checking the Mesh Quality, Creating an O-Grid in the Blocking, Verifying and Saving the Mesh

SECTION D

Mesh Generation for an Aerofoil: Creating Parts, Blocking the Geometry, Projecting the Edges to the Curves, Moving the Vertices, Generating the Mesh, Checking the Mesh Quality, Creating an O-Grid in the Blocking,Verifying and Saving the Mesh

Mesh Generation for a Diffuser**:** Blocking the Geometry, Projecting the Edges to the Curves, Moving the Vertices, Generating the Mesh, Checking the Mesh Quality ,Creating an O-Grid in the Blocking, Verifying and Saving the Mesh

TEXT BOOKS & REFERENCES:

1. Introduction to the Finite Element Method – Evgeny Barkanov

2. Finite Element Method: A Practical Course by S. S. Quek, G.R. Liu**.**

Course Title/Code	DESIGN SOFTWARE-II (MEW325)
Course Type	Domain Core
Course Nature	Workshop
L-T-P-O Structure	0-0-3-0
Prerequisite	NIL

SECTION A

Introduction to ANSYS, Introduction to CFD, Boundary, Conditions and Cell Zones, Set up the most appropriate CFD model (in terms of boundary conditions, material properties, solution control parameters, solution monitor, etc.) for the problem in hand.

SECTION B

Solver Settings, Turbulence Modelling , Heat Transfer Modelling , Set up the most appropriate turbulence model for their particular applications, Explain how to conduct both Steady state and Transient (time dependent) fluid flow simulations.

SECTION C

User-Defined Functions, Advanced Physics, Transient Flow Modelling, Explain how to solve for both isothermal and non-isothermal thermo-fluid applications, by including all the necessary modes of heat transfer i.e. conduction, convection and radiation, in their CFD model set up.

Explain how to solve for both Incompressible and Compressible fluid flow applications. Explain how to solve for fluid flow through porous media and through rotating machinery.

SECTION D

Post-processing with FLUENT and CFD-Post, Mini projects on flow over Aerofoil, Mini Projects on flow Through diffuser, Problems on Heat Sink, Describe how and extract the required results and plots from the wealth of information available at the solution stage.

TEXT BOOKS & REFERENCES:

1.http://orange.engr.ucdavis.edu/ICEM11_Tutorial/itut110.pdf

2.http://home.cc.umanitoba.ca/~engsjo/teaching/Tutorials/ICEM-CFD-tutorial-simple-duct-v1p01.pdf

3. www.cfd-online.com https://intranet.birmingham.ac.uk/collaboration/hpc-research/documents/public/cfd/CFD-intro-course-notes.pdf

Semester 6 (Total credit – 25.5)

<table>
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Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2) /
NTCC Course (0-0-0-1)
Name (Offering Department)</td><td>Workshop (0-0-3)
name (Offering Department)</td></tr>
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<tr><td>Allied Core</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Domain Elective</td><td rowspan="5">E2-
-Machine Design-II
-Solar Energy Engineering
-Mechanical Vibration

E3-
-Mechanics of materials-II
-Power Plant Engineering
-Production Management</td><td></td><td>Analysis Software-I</td></tr>
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<tr><td rowspan="6">Allied Elective</td><td rowspan="6">E4

-Control Systems (ECE)
-Micro Electric Mechanical Systems (ECE)
-Microprocessors & interfacing (ECE)

Artificial Intelligence & Intelligence Systems(CSE)

*A student can pick only one subject from Allied Electives</td><td></td><td></td></tr>
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<tr><td>NTCC</td><td></td><td>Professional Competency Enhancement-IV</td><td></td></tr>
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Course Title/ Code	HEAT TRANSFER (MEH326)
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Introduction and Basic Concepts**:** Application areas of heat transfer, Modes and Laws of heat transfer, three dimensional heat conduction equations in Cartesian coordinates.

One dimensional steady state heat conduction without heat generation: Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance and conductance, three dimensional heat conduction equations in cylindrical and spherical coordinates and its reduction to one dimensional form, critical radius of insulation for cylinders and spheres,

Transient Conduction**:** lumped system analysis, Biot and Fourier number, Time constant and response of thermocouple, Introduction to transient heat analysis using charts

SECTION B

Heat transfer through extended surface: Types of fins, Governing Equation for constant cross sectional area fins, solution (with derivation) for infinitely long & adequately long (with insulated end) fins and short fins (without derivation), efficiency & effectiveness.Fundamentals of convection: Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers. Forced Convection: Dimensionless numbers and their physical significance, empirical correlations for external & internal flow for both laminar and turbulent. Natural convection: Introduction, dimensionless numbers and their physical significance, empirical correlations for natural convection.

SECTION C

Heat exchangers**:** Classification and applications, heat exchanger analysis – LMTD for parallel and counter flow heat exchanger, effectiveness– NTU method for parallel and counter flow heat exchanger, introduction to cross flow heat exchanger, LMTD correction factor, design criteria for heat exchanger, introduction to heat pipe.

Condensation and Boiling: Boiling heat transfer, types of boiling, pool boiling curve and forced boiling phenomenon, condensation heat transfer, film wise and drop wise condensation (No numerical treatment).

SECTION D

Thermal Radiation**:** Fundamental concepts of radiation, different laws of radiation, Radiation shape factor, Heat exchange by radiation between two black and diffuse gray surfaces, Radiation shields.

TEXT BOOKS & REFERENCES:

1. Heat Transfer A Practical Approach- By Yunus A Cengel , Mcgraw-Hill

2. Heat Transfer- By J.P.Holman, Tata Mcgraw Hill Education Private Limited

LIST OF EXPERIMENTS:

1. To analyze the Heat Transfer from a Pin-Fin Apparatus
2. To analyze the Heat Transfer through Composite Wall
3. To determine the Critical Heat Flux

4. To measure the emissivity using Emissivity Measurement Apparatus
5. To analyze the Heat Transfer through the Lagged Pipe
6. To determine the Thermal Conductivity of Insulating Powder.
7. To determine the Thermal Conductivity of Metal Rod
8. To analyze the Heat Transfer in Natural Convection
9. To explain the Parallel Flow / Counter Flow Heat Exchanger
10. To determine the Heat Transfer in Forced Convection.

Course Title / Code	MACHINE DESIGN-II
Code	MEH327
Course Type	Hard Course
Course Nature	Elective
L-T-P-O Structure	(3-1-2-0)
Prerequisite	Machine Design

SECTION A

Introduction: Problems in Engineering Design, Division of Design Project, testing models, patents and agreements. Modeling of concurrent engineering design, real time constraints checking in design process, life design cycle.
Introduction to creep, Mechanisms of Creep Deformation, Deformation Mechanism Maps Creep Fracture, Material Design Against Creep.

SECTION B

Bearings & Lubrication: Types and laws of friction, Types of Lubrication Hydrodynamic and Hydrostatic bearings, Ball and Roller bearings, Method of load estimation and Selection of bearings. Concept of Air bearing

SECTION C

Springs: Design of helical springs subjected to static and dynamic loads, design of torsion and leaf springs, elementary idea of rubber springs.
Pressure vessel classification, Design of thick, thin & compound cylindrical shell, and design of head covers.

SECTION D

Power Transmission with Toothed Gears: Selection of Gears and Gear Materials, Tooth Forces, Design of Spur Gear, Design of Helical, Bevel and Worm Gears.

TEXT BOOKS & REFERENCES:

1. Sharma & Aggarwal; Machine Design, Kataria Publications.
2. V. B Bhandari: Design of Machine Elements, McGraw Hill

LIST OF EXPERIMENTS:

1. To Design of Simple and eccentrically loaded welded connections.
2. To Design of different type of bearings
3. To Design of rolling contact bearing
4. To Design of hydrostatic & elasto-hydrodynamic bearing
5. To Design of different type of springs
6. To Design of torsion and leaf springs
7. To Design of Spur Gear
8. To Design of Helical, Bevel and Worm Gears
9. To Design against creep.

Course Title / Code	MECHANICAL VIBRATIONS (MEH328)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Vibration: Scope of vibration, important terminology and classification, Degrees of freedom one dimensional longitudinal, transverse and torsional vibrations with and without damping using Newton's second law, D' Alembert's principle and Principle of conservation of energy.

Free and Damped Force Vibration Damped vibrations of single degree of freedom systems. Viscous damping; under damped, critically damped and over damped systems, Logarithmic decrement. Vibration characteristics of Coulomb damped and Hysteretic damped systems.

SECTION B

Undamped Force Vibration**:** System with two degrees of freedom; principle mode of vibration. Undamped forced vibrations of two degrees of freedom system with harmonic excitation. Vibration Absorber; Undamped dynamic vibration absorber and centrifugal pendulum absorber.

Forced Vibration**:** Forced vibrations of single degree of freedom systems. Forced vibration with constant harmonic excitation. Frequency response curves and phase angle plot. Forced vibration due to excitation of support. Vibration Isolation and transmissibility; Force transmissibility, Motion transmissibility. Forced vibration with rotating and reciprocating unbalance. Materials used in vibration isolation.

SECTION C

Two Degrees of Freedom Systems **:** Introduction to Multi-Degree of Freedom Systems, Normal Mode Vibrations, Coordinate Coupling, Principal Coordinates, Free Vibrations in Terms of Initial Conditions, Forced Harmonic Vibrations, Vibration Absorber, Centrifugal Vibration Absorber, Vibration Damper.

Multi degrees of Freedom Systems and Numerical Methods Introduction**:** Influence Coefficients, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes, Orthogonality of Normal Modes, Many degrees of freedom systems: approximate methods; Rayleigh's, Dunkerley's, Stodola's and Holzer's methods. Geared and Branched Systems, Beams, computer programmes for solutions.

SECTION-D

Normal Mode Vibration of Continuous System (Closed form solutions): Vibrating String, Longitudinal and Torsional Vibrations of Rod, Transverse vibration of beams: equations of motion and boundary conditions, Transverse vibration of beams: natural frequencies and mode shapes

Normal Mode Vibration of Continuous System (Approximate solutions): Rayleigh's energy method, Rayleigh-Ritz method, Assumed modes and Galerkin's method.

TEXT BOOKS & REFERENCES:

1. Mechanical Vibration : G.K. Grover and S.P. Nigam, Nem Chand and Sons
2. Mechanical Vibration: V.P.Singh, Dhanpatrai Publishers

LIST OF EXPERIMENTS:

1. Determination of the time period of a thread pendulum having different lengths and material.
2. Determination of the time period of a Rod pendulum with a length of 800mm.
3. Determination of the time period of a rod and thread pendulum with same centre of gravity distance.

4. Determination of the reduced pendulum length of a reversible pendulum.
5. Determination of the time period of a pendulum with bifilar suspension, having different suspended mass.
6. Determination of spring constants.
7. Determination of Natural Frequencies of Free Un-Damped Oscillations.
8. Determination of Natural Frequencies of Free Damped Oscillations.
9. Determination of the Amplitude of Forced Un-Damped Oscillations.
10. Determination of the Amplitude of Forced Damped Oscillations.

Course Title/ Code	SOLAR ENERGY ENGINEERING (MEH329)
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	3-1-2-0
Prerequisite	NIL

SECTION-A

Solar Radiation: Introduction to solar system – sun, earth and earth-sun angles, solar time, derived solar angles, estimation of solar radiation (direct and diffuse), measurement systems – Pyranometer, phyrheliometers, Sunshine recorder and other devices.

Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces, periodic heat transfer through walls and roofs by conduction, convection and radiation.

SECTION-B

Solar Collector and types: Flat plate and concentrating solar collectors, advanced solar collectors and solar concentrator – comparative study, design and materials, efficiency, selective coatings

Solar Thermal systems: Solar distillation, thermal storages, solar ponds, solar cookers, solar drying.

SECTION-C

Solar cooling Systems: Continuous and Intermittent vapour absorption systems for cooling applications, passive cooling methods, refrigerant –absorbent combination

SECTION-D

Solar Photovoltaic System: Photovoltaics, solar cells, solar lighting systems, solar Inverter, solar lanterns, Solar PV pumps, Solar Refrigeration, satellite solar power systems.

Effects on Environment, ozone layer depletion, greenhouse effect, global warming, Remedial measures by international bodies.

TEXT BOOKS & REFERENCES:

1. Solar Energy – S P Sukhatme, Tata McGraw Hill

2. Solar Energy –Fundamentals, Design, Modelling and Applications – G.N. Tiwari, Narosa Publishing House

LIST OF EXPERIMENTS:

1. To carry out experimental studies of direct/Indirect type solar dryer.
2. To carry out experimental studies of solar photovoltaic dryer.
3. To carry out experimental studies of solar water heating system.
4. To evaluate energy performance of solar water heater.
5. To carry out experimental studies of solar cooker.
6. To evaluate the performance of passive solar still.
7. To evaluate the electrical efficiency for a temperature dependent solar cell.
8. To evaluate the fill factor and electrical performance of solar cell.

Course Title/ Code	MECHANICS OF MATERIALS-II (MEH330)
Course Type	Domain Elective
Course Nature	Hard Course
L-T-P-O Structure	3-1-2-0
Prerequisite	Mechanics of Materials-I

SECTION A

Riveted Joints: Types & terminology, failure, efficiency, thickness of cover plate, diamond revit, relation between d & t, determination of pitch

Welded Joints: Advantages and disadvantages of welded joints, types of welded joints, strength of bolts

SECTION B

Unsymmetrical Bending: Properties of beam cross section, product of inertia, ellipse of inertia, slope of the neutral axis, stresses & deflections, shear center and the flexural axis Numerical.

Thin Walled Vessels: Hoop & Longitudinal stresses & strains in cylindrical & spherical vessels & their derivations under internal pressure, wire would cylinders, Numerical.

SECTION C

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castigliano's theorem stresses in simple chain link, deflection of simple chain links, Theories of Failures. Numerical

SECTION D

Thick Cylinders & Spheres: Derivation of Lame's equations, radial & hoop stresses and strains in thick, and compound cylinders and spherical shells subjected to internal fluid pressure only, wire wound cylinders, hub shrunk on solid shaft, Numerical.

Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength

Stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders

TEXT BOOKS & REFERENCES:

1. Strength of Materials- GH Ryder

2. Vibration and Control- SS Rao

LIST OF EXPERIMENTS:

1. To determine the stresses in Plastic material and plot stress strain graph.
2. To determine the Stresses in visco elastic materials and plot stress strain graph.
3. To determine the strength of welded joint and study the failure conditions
4. To determine the strength of riveted joint and study the failure conditions.
5. To determine the deflection and slope in asymmetrical beams.
6. To determine the stresses in curved bars.

Course Title/Code	**PRODUCTION MANAGEMENT (MEH331)**
Course Type	**Core**
Course Nature	**Hard**
L-T-P-O structure	**3-1-2-0**
Prerequisites	**NIL**

SECTION A

Engineering Economy and Costing**:** Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements.

Facility Design**:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; assembly line balancing; materials handling systems.

Production Planning and Inventory Control**:** Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; concept of JIT manufacturing system;

SECTION B

Inventory: functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.

Linear programming: problem formulation, simplex method, duality and sensitivity analysis;

SECTION C

Transportation and assignment models; network flow models, simple queuing models; dynamic programming; simulation – manufacturing applications; PERT and CPM, time-cost trade-off, resource leveling.

SECTION D

Quality Management**:** Quality – concept and costs, quality circles, quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management; ISO 9000; design of experiments – Taguchi method.

Management Information System**:** Value of information; information storage and retrieval system database and data structures; knowledge based systems.

TEXT BOOK & REFERENCES:

1. Production Systems: Planning, Analysis and Control by J.L. Riggs

2. Production, Planning and Inventory Control by S. Narasimhan, D. W. McLeavey, and P. J. Billington

3. Operation Research by D.S.Heera, S. Chand Publication

LIST OF EXPERIMENTS:

1. To prepare a case study for producing a product on shop floor covering areas of PPC, design, Methods Engineering, Operations and Quality Control.

2. To prepare a project report for calculating the total cost (direct and indirect cost) of a product being developed for manufacturing.

3, To prepare a flow chart identifying main steps to be followed by methods engineering in manufacturing a product.

4. To prepare a bar chart for producing a generator/turbine identifying the main sub assemblies along with their completion schedule.

5. To prepare a document for quality policy, quality systems and procedures required to be followed in the manufacture of a turbine/generator.

Course Title/Code	POWER PLANT ENGINEERING (MEH332)
Course Type	Domain Elective
Course Nature	Hard
L-T-P-O Structure	3-1-2-0
Prerequisite	NIL

SECTION-A

Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.

Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

SECTION-B

Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, coal preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.

Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariff-methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input output curves, efficiency, heat rate, economic load sharing, Problems.

SECTION-C

Combined Cycles: Constant pressure gas turbine power plants, Arrangement of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles, Problems.

Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.

SECTION-D

Non-Conventional Power Generation: Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.

Direct Energy Conversion Systems: Fuel cell, MHD power generation-principle, open & closed cycles systems, thermoelectric power generation, thermionic power generation.

TEXT BOOKS & REFERENCES:

1. Power Plant Engineering: P.K. Nag Tata McGraw Hill second Edition 2001.
2. Power Plant Engineering: Dr.P.C. Sharma, S.K.Kataria & Sons
3. A Text book of Power Plant Engineering: R.K Rajput, Laxmi Publications

LIST OF EXPERIMENTS:

Visit to Hydro-Power plant site and study of general layout of hydro Electric Power Plant.

1. Measurement of Rain-Fall & run-off in lab.

Visit to Steam Turbine Power Plant

2. To explain of general layout of Steam Turbine Power Plant.

3. To get acquainted with the functioning of coal –handling system.
4. To explain coal handling plant
5. To get acquainted with the operation of coal pulverizing system (Mills).
6. To explain rate of coal consumption.
7. To explain coal firing system in the furnace.
8. To explain steam generation in boiler and functioning of mounting and accessories.
9. To explain operation aspect of a steam turbine.
10. To operate and explain construction and operation of different system, accessories od steam turbine such as condenser, LPH & HPH, Toil and Seal oil system etc.
11. To explain operational functioning of BFP, super heated and reheated system.
12. To explain construction and working of Economizer.
13. To explain construction and operational of Ash handling system and ESP.

Course Title/ Code	CONTROL SYSTEMS (ECH327)
Course Type:	Domain Elective
Course Nature:	CORE
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Control System Modelling**:** Basic elements of control system – Open loop and closed loop systems, Differential equation–Transfer function, Modeling of electric systems, Translational and rotational mechanical systems, Block diagram reduction techniques,Signal flow graphs, Effect of feedback on sensitivity (to parameter variations), Stability, External disturbance (noise), Overall gain etc.

SECTION B

Time Response Analysis**:** Typical test signals, Time response of first order systems to various standard inputs, Impulse and step response analysis of second order systems, Time domain specifications of a general and an underdamped 2nd order system, Steady state and dynamic errors and error constants.Techniques for stability analysisin time domain:Stability, Routh-Hurwitz criterion, Relative stability, Root Locus technique, Construction of Root Locus, Stability,Dominant poles, Application of Root Locus diagram, Relative stability.

SECTION-C

Frequency Response Analysis**:** Relationship between time and frequency response, Bode plot, Stability in frequency domain, Minimum and non minimum phase systems, All-pass systems, Polar plot, Nyquist plot, Nyquist stability criteria. Performance specification in frequency domain, Compensation and their realization in time and frequency domain,; Lead, Lag and Lead Lag compensators.

SECTION-D

Basic Modes of Feedback Control**:** Proportional, Integral and Derivative PID Controllers.Hardware:**C**ontrol hardware and their model, Synchros, AC and DC tacho-generators, Servomotors, Stepper motors, & their applications, Magnetic amplifier, State Variable Analysis**:** State space representation of continuous time system, State equations, Transfer function from state variable representation, Solutions of the state equations, Concepts of controllability and observability.

TEXT BOOKS & REFERENCES:

1. K. Ogata, Modern Control Engineering, Prentice Hall India.
2. Norman S. Nise, Control Systems Engineering, Wiley Publications**.**

LIST OF EXPERIMENTS:

1. Implement basic MATLAB programs
   i. Introduction to control system toolbox
   ii.Find the location of poles and zeros and plot poles and zeros of given transfer function.
2. To solve problems based on block diagram reduction using MATLAB.
3. To plot transient response of first order and second order system and find its specifications using MATLAB.
4. To analyze the stability of a system using Routh's Hurwitz criterion and Root Locus Technique.
5. To plot Bode plot and Nyquist plot for stability analysis of a system using MATLAB.
6. To design PID Controllers using MATLAB Simulink.

7. Determination of transfer function of a DC servomotor and its speed control.
8. To study speed torque characteristics of AC Servomotor and find out the Eb constant.
9. To study the performance of analog PID controller with model process as temperature control system, analyze the effect of various controllers.
10. To study the lead, lag, lead-lag compensators and to draw their magnitude and phase plots and also find specifications of closed loop response.
11. To study the magnetic amplifier and to plot its load vs control current characteristics for:
    Positive feedback mode
    Negative feedback mode
12. Project

Course Title/ Code	MICRO ELECTRICAL MECHANICAL SYSTEM (ECH435)
Course Type:	Domain Elective
Course Nature:	CORE
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Introduction to MEMS and Micro Fabrication: History of MEMS development, Characteristics of MEMS, Miniaturization, Micro electronics integration, Mass fabrication with precision. Sensors and Actuators: Energy domain. Sensors, Actuators, Multidisciplinary nature of MEMS. Micro fabrication: microelectronics fabrication process, Silicon based MEMS processes, New material and fabrication processing, Points of consideration for processing. Anisotropic wet etching, Isotropic wet etching, Dry etching of silicon, Deep reactive ion etching (DRIE), and surface micromachining process, Structural and sacrificial material, The LIGA Process.

SECTION B

Electrical and Mechanical Concepts of MEMS: Conductivity of semiconductors, crystal plane and orientation, Stress and strain – definition, Relationship between tensile stress and strain, Mechanical properties of Silicon and thin films, Flexural beam bending analysis under single loading condition, Types of beam, Longitudinal strain under pure bending, Deflection of beam, Spring constant**,** Torsional deflection, Intrinsic stress, Resonance and quality factor.

SECTION C

Working Principle of Microsystems: Working Principle of Micro sensors, Micro actuators, Micro accelerometers, Micro fluidics. Electrostatic sensing and actuation: Parallel plate capacitor, Pressure and tactile sensor, Parallel plate actuator- comb drive, Application of electrostatic sensing and actuators, Thermal sensing and Actuations:Thermal sensors, Actuators, Applications Inertial, flow and infrared sensors, Applications of thermal sensors and actuators. Piezoresistive sensors: Piezoresistive sensor material, Stress in flexural cantilever and membrane, Pressure, Piezoelectric sensing and actuation, Applications of piezoresistive sensors, Piezoelectric material properties, Quartz, PZT, PVDF, ZnO, Gyroscopes, Microfluidic Components and Devices, Microfluidics: Valves, Pumps and Mixers.

SECTION D

Polymer and Optical MEMS**:** Polymers in MEMS, Polymide, SU-8, Liquid crystal polymer(LCP), PDMS, PMMA, Parylene, Flurocarbon, Optical MEMS: passive MEMS optical components-lenses, mirrors, Actuation for active optical MEMS, New trends in Engineering and Science: Introduction to NEMS

TEXT BOOKS & REFERENCES:

1. Chang Liu, Foundations of MEMS, Pearson Indian Print, 1st Edition, 2012.
2. Tai – Ran Hsu, MEMS & Microsystems Design and Manufacturing, Tata McGraw Hill Edition, 2006. 3. James D. Plummer, Michael D.Deal, Peter B. Griffin, Silicon VLSI Technology, Pearson Education.

LIST OF EXPERIMENTS:

1. Introduction to Software and creating a 2D model.
Case Study 1: Piezoresistive pressure sensor
2. Designing of different types of Diaphragm for different types materials used in MEMS.

3. Measurement of Stress and Strain on the Different types of Diaphragm.
4. Calculation of suitable pressure range for the appropriate diaphragm.
5. Placement of Piezoresistors on Diaphragm.
6. Calculation of pressure range for linear range of operation of pressure senor and temperature effects on the pressure sensor.

Case Study 2: Thermal Actuator

7. Designing of Electothermal actuator of poysilicon material.
8. Designing of Electothermal actuator of poysilicon material.
9. Thermal analysis of electrothermal actuator for stability.
10. Measurement of temperature range for the linear operation of actuator.
11. Report and Presentations on case studies.

Course Title/ Code	MICROPROCESSORS & INTERFACING (ECH326)
Course Type:	Domain Elective
Course Nature:	CORE
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION - A

Architecture of 8-Bit Microprocessor**:** General architecture of microprocessors, Introduction to Intel 8085 microprocessor, Pin description and internal architecture. Instruction Set: Addressing modes, Instruction set of 8085: Data transfer, Arithmetic, Logical, branch, stack and machine control groups of instruction set, Unspecified flags and instructions, Assembly language programming.

SECTION-B

History and Evolution**:** Background history of microprocessors, Introduction to basic features, Memory & I/O systems &interfacing: RAM, ROM, and EPROM. I/O systems, I/O mapped I/O, Memory mapped I/O, Memory mapping. Interrupts: Interrupt structure of 8085A microprocessor, Processing of vectored and non-vectored interrupts, Latency time and response time, Handling multiple interrupts, Operation and control of microprocessor**:** Timing and control unit, Op-code fetch machine cycle, Memory read/write machine cycles, I/O read/write machine cycles, Interrupt acknowledge machine cycle, State transition diagram.

SECTION-C

Intel 8086 Microprocessor**:** Pin Functions, Architecture, Characteristics and basic features of family, Segmented memory, Directives and macros, MIN/MAX Modes of 8086, Clock generator 8284, Interrupt structure of 8086.DMA Controller: Direct memory access operation, Programmable DMA controller 8257: Features of 8257, Internal block diagram of 8257 programmable DMA controller, Interfacing of 8257 with 8085, Control word register of 8257, Status word register, Types of DMA cycles, Types of DMA transfer, 8237: Functional description, DMA operation, IDLE cycle, Active cycle, Transfer types, Register description, Programming. Programmable keyboard and display controller: Functional diagram and PIN diagram of 8279, Block and signal description of Intel 8279, Interfacing of 8279 with 8085, operating modes of 8279, Status word of 8279.

SECTION-D

Programmable Peripheral Interface**:** Intel 8255, Pin configuration, internal structure of each port bit, Modes of operation, Bit SET/RESET feature. Programmable Interval Timer: Intel 8253, Pin configuration, Internal block diagram of counter and modes of operation, Counter read methods, Programming, READ-BACK command of Intel 8254.Universal Synchronous and Asynchronous Receiver and Transmitter Intel 8251: Introduction, Data transmission signals, Method of communication-serial vs parallel, Types of serial data transfer, Modes of communication, Data communication terminology, Modems, Format of serial data transfer, Universal synchronous and asynchronous receiver and transmitter (USART) Intel 8251, Operating features of 8251, Detailed operation description.

TEXT BOOKS & REFERENCES:

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming & Applications with 8085, Wiley Eastern Ltd.
2. Brey, The Intel Microprocessors 8086- Pentium processor, PHI

LIST OF EXPERIMENTS:

1. Demonstration of 8085 kit, interfacing kits and simulators.
2. Problems related to data transfer instructions of 8085 microprocessor.
3. Problems related to data transfer instructions of 8085 microprocessor.
4. Problems related to arithmetic instructions of 8085 microprocessor.
5. Problems related to arithmetic instructions of 8085 microprocessor.
6. Problems related to logical instructions of 8085 microprocessor.
7. Problems related to logical instructions of 8085 microprocessor.
8. Problems related to branch instructions of 8085 microprocessor.
9. Problems related to branch instructions of 8085 microprocessor.
10. Write a program to control the operation of stepper motor using 8085and 8255 PPI.
11. Write a program to control the traffic light system using 8085and 8255 PPI.
12. Write a program to control the operation of ADC/DAC using 8085 and 8255 PPI.
13. Demonstration of 8086 kit.

Course Title/ Code	**ARTIFICIAL INTELLIGENCE AND INTELLIGENCE SYSTEM (CSH316)**
Course Type:	**Domain Elective**
Course Nature:	**CORE**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION-A

Intelligent agents and AI Problems**:** Introduction to AI, Foundation and History of AI, Turing Test, Intelligent Agents: Architectures, Types: reactive, deliberative, goal-driven, utility-driven, and learning agents, Applications and Current Trends of AI.

Problem Representation in AI, State Space Representation and Problem Reduction, Production Systems: Inference Engine, Working Memory, Knowledgebase and Control Strategy using Water Jug Problem and n-Queens Problem.

SECTION-B

Search Strategies and Knowledge Representation: Search Strategies: Uninformed Search Strategies, Informed Search strategies (Heuristic Search): Generate and Test, Hill Climbing, Best First Search, A*algorithm, AO*Algorithm, Constraint Satisfaction, Means End Analysis. Game Playing: Minmax Strategy, Alpha-beta Pruning. Introduction to Knowledge, Types of Knowledge, Issues in Knowledge Representation, Approaches to Knowledge Representation: Logic, Semantic Nets, Partitioned Semantic Nets, Frames and its types, Conceptual Dependency.

SECTION-C

Reasoning, Planning and Learning**:** Logical agents: Propositional logic, Inferences, First-order Predicate Logic, Inferences in First-order Predicate Logic, Forward Chaining, Backward chaining, Unification, Resolution.

Reasoning under Uncertainty: Monotonic and Non-Monotonic Reasoning, Statistical Reasoning: Review of probability: Axioms of probability, Probabilistic inference, Probabilistic Reasoning(Bayes Theorem), Bayesian Networks, Inferences in Bayesian networks, Temporal and Spatial Reasoning, Dempster-Shafer Theory, Fuzzy Reasoning, Hidden Markov models. Planning with state-space search, partial-order planning, planning graphs.

Learning from observation, Inductive learning, Deductive learning, Decision trees, Explanation based learning, Statistical Learning methods, Machine Learning and its types: Supervised, Unsupervised and Reinforcement Learning, Natural Language Understanding.

SECTION-D

Advanced Topics and Applications of AI**:** Expert Systems: Architecture, Characteristics, Types, Advantages and Drawbacks, Knowledge Acquisition Principles, Study of MYCIN and DENDRAL, Overview of Knowledge Discovery from Databases, Web Intelligence, Robotics. Semantic Webs, Natural Language Processing, Neural Networks, Genetic Algorithms.

TEXT BOOKS & REFERENCES:

1. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivashankar B. Nair, Third Edition, TMH.
2. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education**.**

LIST OF EXPERIMENTS:

1. Study of PROLOG.
2. Implementation of facts and rules with family tree.
3. Representing and solving AI problem by performing exercises on lists using PROLOG.

4. Representing and solving AI problem by performing exercises on Arithmetic and Relational operations using PROLOG.
5. Representing and solving AI problem by performing exercises on Strings using standard String Predicates in PROLOG.
6. Representing and solving AI/Gaming problem using searching algorithm in PROLOG.
7. Representing and solving AI problem by using sorting techniques in PROLOG.
8. Write a program to solve the problem of Tower of Hanoi.
9. Write a program to implement Water Jug problem.
10. Write a program to solve 8 queens problem.
11. Solve traveling salesman problem.
12. Solve monkey banana problem
13. Solve the classical Missionary Cannibals problem of AI.
14. Write a program to implement an Expert System.

Course Title/ Code	ANALYSIS SOFTWARE-I (MEW333)
Course Type:	Domain Elective
Course Nature:	Workshop
L-T-P-O Structure	(0-0-3-0)
Prerequisite	NIL

SECTION-A

Introduction to Preprocessing: Introduction to Ansys workbench, Solid modeling fundamentals design in Ansys Design Modeler and revision of modeling commands, modeling techniques.

Introduction to the concept of meshing, preprocessing, Types of Meshing, Types of Nodes, governing equations, boundary conditions, general post processing.

SECTION-B

1D and 2D Stress Analysis and Simulation: Introduction to plane stress and strain, One dimensional and two dimensional stress analysis, Application of loads and Couples, modal analysis, hands on experience with beams and trusses.

SECTION-C

3D Stress Analysis and Simulation: Introduction to volumetric stresses and Strain, introduction of Stress and Strain tensor, Three dimensional stress analysis and application of three dimensional nodes in meshing, hands on experience with Cylinders, pressure vessel and other 3 D designs, Simulations.

SECTION-D

Thermal Stresses and Combined Loading Problem:

Combination of stresses and introduction to thermal stresses problem, hands on experience on problems on combined loading and complex designs.

TEXT BOOKS & REFERENCES:

1. http://orange.engr.ucdavis.edu/ICEM11_Tutorial/itut110.pdf

2. http://home.cc.umanitoba.ca/~engsjo/teaching/Tutorials/ICEM-CFD-tutorial-simple-duct-v1p01.pdf

3. www.cfd-online.com https://intranet.birmingham.ac.uk/collaboration/hpc-research/documents/public/cfd/CFD-intro-course-notes.pdf

Course Title/Code	ANALLYSIS SOFTWARE-II (MEW334)
Course Type	Domain Core
Course Nature	Workshop
L-T-P-O Structure	0-0-3-0
Prerequisite	NIL

SECTION-A

Preprocessing: Introduction to Finite Element Analysis (FEA), Types of Analysis, FEA Software i.e. Hypermesh, Hyper View and Radioss, Introduction to Meshing, 1-D Meshing, 2-D Meshing, 3-D Meshing, Specification of Material, Boundary Conditions, Loading Conditions, Specification of Material to the Elements. Exercises.

SECTION-B

Solver and Post processing: Selection of Types of Analysis, Run the Analysis using Radioss Software and View the result in Hyper View Software. Exercises.

SECTION-C

1D and 2D Structure Analysis and Simulation: 1D analysis of I-Section, Square Section, Rectangular Section, Circular Section, Hollow Section, Exercises, 2D analysis of Sheet Metal Component, Exercises.

SECTION-D

3D Structure Analysis and Simulation: Combination of stresses and hands on experience on problems on combined loading and complex designs Exercises.

SEMESTER 7 (Total credit - 14)

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<tr><td>Nature of the course/
Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2)
Name (Offering Department)</td><td>NTCC (0-0-0-N) name</td></tr>
<tr><td rowspan="2">Domain Core</td><td>Refrigeration and Air Conditioning (ME)</td><td></td><td></td></tr>
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-Finite Element Method
-Alternate Fuels, Pollution and Control
-Quality Engineering
-Automobile Engineering</td><td></td><td></td></tr>
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<tr><td>Total Credits</td><td colspan="3">14</td></tr>
<tr><td>Total no of Hours</td><td colspan="3">16</td></tr>
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Course Title/ Code	REFRIGERATION & AIR CONDITIONING (MEH436)
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	Elements of Mechanical Engineering

SECTION A

Introduction: Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP),Refrigeration effect, cooling capacity and COP of a refrigerator; heating effects, heating capacity and COP as heat pump; Fundamentals of air-conditioning system; Cryogenics.

Refrigerants: Classification, Desirable Properties like thermodynamics, physical and chemical. Comparison among commonly used refrigerants, Selection of Refrigerants, Effect on ozone depletion and global warming, Alternative Refrigerants.

Gas cycle Refrigeration: Carnot cycle, Reversed Carnot cycle, Temperature. Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane, Air cycles for aircrafts (Descriptive Treatment), Comparison of different systems, problems.

SECTION B

Vapour Compression Refrigeration Cycle**:** Vapour compression cycle on P-V,P-H and T-S diagram; Derivation of actual cycle from theoretical cycle; Compressor capacity and volumetric efficiency, Analysis of theoretical and actual vapour compression cycles; Effect of suction pressure, discharge pressure, sub cooling, super heating and pressure drop in valves on performance and cooling capacity.

Vapour Compression Refrigeration with Multiple Evaporators and Compressors**:** Compound compression with single and multiple expansion valves, water intercooling and flash intercooling; multiple load systems with single and multiple expansion valves.

Vapour Absorption Systems: Introduction, simple vapour absorption systems, practical vapour absorption system, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Comparison between VCC and VAC. Electrolux and Steam Jet Refrigeration system.

SECTION C

Psychometry: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychometric chart; Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning. Problems.

Psychometry Process**:** Sensible heating and cooling, cooling with dehumidification; Heating with dehumidification; by-pass factor; chemical dehumidification; adiabatic mixing, air washer.

SECTION D

Load Calculation and supply of Air Conditioning: Source of heat load; sensible and latent heat factor; apparatus dew point temperature; Rate and state of supply air. Load analysis RSHF,GSHF,ESHF, Enumeration and brief explanation of the factors forming the load on refrigeration and air conditioning system.

Refrigeration and Air Conditioning Equipment: Brief description of compressors, condensers and expansion devices; Cooling towers; Ducts; dampers; grills; air filters; fans; room air conditioners; split units; Package and central air conditioning plants.

TEXT BOOKS & REFERENCES

1. Refrigeration & Air conditioning –C.P. Arora, TMH, New Delhi.
2. A course in Refrigeration & Air Conditioning – Arora & Domkundwar, DhanpatRai & Sons.
3. Refrigeration & Air conditioning -W.F. Stocker and J.W. Jones, TMH, New Delhi.

LIST OF EXPERIMENTS:

1. To study the vapour compression Refrigeration System and determine its C.O.P. and draw P-H and T-S diagrams.
2. To Study the Mechanical heat pump and find its C.O.P.
3.To study the Air and Water heat pump and find its C.O.P.
4. To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor
5. To study the various controls used in Refrigerating & Air Conditioning systems.
6. To study the Ice- plant, its working cycle and determine its C.O.P and capacity.
7. To study the humidification, heating, cooling and dehumidification processes and plot them on Psychrometric charts.
8. To determine the By-pass factor of Heating & Cooling coils and plot them on Psychometric Charts on different inlet condition.
9. To determine sensible heat factor of Air on re-circulated air-conditioning set up.

Course Title / Code	FINITE ELEMENTS METHOD (MEH437)
Course Type	Elective
Course Nature	Hard Course
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Basic concept of finite element method, approximate solution; Basic principle of structural dynamics, boundary, initial and Eigen value problems, Integral relations, functional, the variation symbols; Weak formulation of boundary value problems; Rayleigh-Ritzmethod, Galerkin's method and method of weighted residuals.

SECTION B

Finite element analysis of one dimensional problems-second order boundary value problems, basic steps of finite element analysis e.g. modeling of boundary value problems, Discretisation of domain, derivation of element equations, connectivity of elements, imposition of boundary conditions, solution of equations; Application of finite element analysis to heat transfer, fluid mechanics and solid mechanics.

SECTION C

Introduction to bending of beams: Finite element error analysis, approximation errors, various measures of errors, conversions of solutions, accuracy of solutions, problems based on error analysis, Eigen value and time dependant problems. Interpolation functions, numerical integration and modeling considerations.

SECTION D

Isoperimetric formulations and numerical integration, natural coordinates approximation of geometry, Pre-processor, calculation of element matrices, assembly of element equations, imposition of boundary conditions, solution of equations and post-processing. Finite element analysis of two dimensional problems.Application of finite element 2-D analysis to heat transfer, fluid mechanics and solid mechanics.

TEXT BOOKS & REFERENCES:

1. Tripathi R. Chandrupatla & Ashoke D. Belegundu; Introduction to Finite Element in Engineering, Prentice Hall of India, Pvt. Ltd.

2. J.N. Reddy; An introduction to Finite Element Methods 2nd Edition

List of Experiments:

1. Structural Analysis

a) Cantilever beam subjected to point at free end

b) Truss subjected to transverse load

c) Plate with hole subjected to axial load

d) Shaft subjected to torque

2. Modal Analysis

a) Plate with hole and without hole

3. Thermal Analysis

a) Heat dissipation in Pin –Fin of Microprocessor cooling fan.

Course Title/ Code	ALTERNATIVE FUELS & POLLUTION CONTROL (MEH438)
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Introduction**:** Estimation of petroleum reserve - World Energy Scenario - Energy Survey of India – Oil industry background and history – survey of oil consumption - Availability of petroleum products – types – uses - air craft fuels – alternate fuels – list of alternate fuels - Need for alternate fuel – Availability of alternate fuels. Alcohols**:** Introduction - properties of alcohol as fuel uses of alcohol fuels – alcohol availability – alcohol production – methanol – ethanol – impact of incremental vehicle cost – vehicle technology and vehicle emission – use of low level blends – vehicle emission – dedicated vehicles – fuel flexible vehicle – variable fuelled vehicle – air quality benefits of alcohol fuels – methanol vehicles – fuel characteristics – fuel additives – handling of methanol – methanol health and safety.

SECTION B

Natural Gas, Lpg, Hydrogen and Biogas**:** Availability of CNG - automotive gasoline – composition – types – properties – additives – effect of emissions - modification required in engines – performance and emission characteristics of CNG and LPG in SI & CI engines. Performance and emission for LPG – Hydrogen – Storage and handling, performance and safety aspects.

Bio-Diesel: Various vegetable oils for engines ,Karanji oil, Neem oil, Rice bran oil, Linseed oil, Sunflower oil, properties, transesterification – Performance in engines – and emission characteristics, diesel & vegetable oil blends. Electric and solar powered vehicles**:** Advantage and limitations – Specifications – System component, Brief on Electronic control system – High energy and power density batteries – Hybrid vehicle – Solar powered vehicles. Fuel cell vehicles.

SECTION C

Pollutant formation in SI engines**:** Pollutant formation in SI Engines, mechanism of HC and CO formation in four stroke and two stroke SI engines, NOx formation in SI engines, control of evaporative emission. Two stroke engine pollution. Pollutant formation in CI engines: Pollutant formation in CI engines, smoke and particulate emissions in CI engines, effects of design and operating variables on CI engine emissions. Nox formation and control. Noise pollution from automobiles, measurement and standards.

SECTION D

Control of emissions from SI and CI engines**:** Design of engine, optimum selection of operating variables for control of emissions, secondary air injection, catalytic converters, catalysts, fuel modifications, fuel cells, Two stroke engine pollution control.

TEXT BOOKS & REFERENCES:

1. The properties and performance of modern alternate fuels – SAE Paper No.841210.
2. Automobile pollution, Dr. Satykush, IVY Publishing House, Delhi – 110095**.**
3. John B. Heyhood, "Internal Combustion Engines Fundamentals", McGraw Hill

LIST OF EXPERIMENTS:

1. To analyze the FFA content of the different feedstock used for the production of biodiesel

2. Transesterification of the given feedstock for the production of biodiesel
3. Determine the Kinematic Viscosity, Flash & fire point of given fuel.
4. Compare the density, Specific gravity, Kinematic Viscosity, Flash & fire point & calorific values of given fuels
5. Determine the efficiency of given alternative fuel on IC engine and compare its performance with diesel engine
6. Emission Measurements of SI Engine using Orsat Apparatus.
7. Emission Measurements of CI Engine using Orsat Apparatus.

Course Title/Code	**QUALITY ENGINEERING (MEH439)**
Course Type	**Elective**
Course Nature	**Hard**
L-T-P-O structure	**3-1-2-0**
Prerequisites	**Manufacturing Technology-I**

SECTION A

Basic Concept Quality Costs**:** Fitness for Use, Quality Characteristics, Parameters of Fitness for use, Definition of quality and its meaning and importance in industry, Control and Quality control, Quality Tasks, Quality functions, The system Concept, Quality systems, quality assurance and ISO 9000 quality system standards, Quality costs concept, Quality cost categories, Examples of Quality cost studies, Securing the Cost figures, Pareto Analysis, Cost reduction Programs and economics of quality

SECTION B

Control charts**:** Statistical Tools in Quality control, The concept of variation, Tabular Summarization of Data, Frequency distribution, Graphical Summarization of Data: The Histogram, Quantitative methods of summarizing data: Numerical Indices, Probability distributions : General, The normal Probability distribution, The normal curve and Histogram Analysis, The causes of variation, statistical aspect of control charting, concept of rational sub-grouping and detecting patterns on the control charts, for variables and attributes: X and R, X and S, p, np, c and u charts; specification and tolerances, natural tolerance limits, specification limits, process capability ratio analysis and narrow limit gauging

SECTION C

Basic statistical concepts**:** Descriptions of Binomial, Poisson and Normal distribution with practical examples basics of sampling distribution. Acceptance Sampling: Principle of acceptance sampling, Acceptance sampling by attributes: single multiple and sequential sampling plans, lot quality protection and average outgoing quality protection, Acceptance sampling by variables sampling plans of process parameters.

SECTION D

Total quality Management**:** Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Modern Quality Management Techniques: TQM tools: Benchmarking, QFD, Taguchi quality loss function TPM, FMEA. Lean Manufacturing continuous improvement techniques, JIT systems, Pareto diagrams, cause and effect diagrams, scatter diagram, run charts, affinity diagrams, inter-relationship diagram, process decision program charts.

LIST OF EXPERIMENTS:

1. For given data Draw Pareto diagrams, its cause and effect diagrams.
2. To draw the Normal curve and Histogram Analysis for normal Probability distribution for given data.
3. To determine whether the data is controlled or not by reading of X and R chart drawn with the help of given data
4. To determine process stability for given data sheet by drawing X and S chart.
5. To construct an “np” chart for given data for determining process stability.
6. Construct c-u chart for given baseline data for a particular process and report the results about stability of the system.
7. To study the Taguchi quality loss function.
8. Prepare Process decision program charts to understand the decision program.
9. To find an appropriate plan to meet particular conditions for given baseline data.
10. To draw an operating characteristics for single sampling plans using attributes.

TEXT BOOKS & REFERENCES:

1. Quality planning and Analysis, Juran and Gryna, TMH, New Delhi
2. Quality Management, Kanishka Bed, Oxford University Press, New Delhi
3. Introduction to SQC, Montgomery DC, 3e, Wiley, New Delhi

Course Title/ Code	AUTOMOBILE ENGINEERING (MEH440)
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Introduction: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles.

Power Plant: Classification, Engine Terminology, Types of Cycles, working principle of an IC engine, advanced classification of Engines- Multi cylinder engines, Engine balance, firing order.

Fuel System and Ignition System and Electrical system: spark Ignition engines- Fuel tank, fuel filter, fuel pump, air cleaner/filter, carburetor, direct injection of petrol engines. Compression Ignition engines, Fuel Injection System- air & solid injection system, Pressure charging of engines, super charging and turbo charging, Components of Ignition systems, battery ignition system, magneto ignition system, electronic ignition and ignition timing. Main electrical circuits, generating & stating circuit, lighting system, indicating devices, warning lights, speedometer.

SECTION B

Lubricating system and cooling systems: Functions & properties of lubricants, methods of lubrication-splash type, pressure type, dry sump, and wet sump & mist lubrication. Oil filters, oil pumps, oil coolers. Characteristics of an effective cooling system, types of cooling system, radiator, thermostat, air cooling & water cooling.

Chassis: Systems in an automobile, body, chassis frame, parts of the automobile body, terminology, automobile frames, functions, constructions, sub frames, materials and defects in frames.

SECTION C

Transmission, axles, clutches, propeller shafts and differential: Types of gear boxes, automatic transmission, electronic transmission control, functions and types of front and rear axles, types and functions of the clutches, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control.

Steering System: functions of steering mechanism, steering gear box types, wheel geometry.

SECTION D

Breaking and suspension system: functions and types of brakes, operation and principle of brakes, constructional and operational classification and parking brake. Types of springs shock observers, objectives and types of suspension system, rear axles suspension, electronic control and proactive suspension system.

Automotive air conditioning: ventilation, heating, air condition, refrigerant, compressor and evaporator.

Wheels and tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications. Automotive electrical, electronics and auxiliaries.

LIST OF EXPERIMENTS:

1. To prepare report on the construction details, working principles and operation of the Following automotive clutches**:**

a. Coil-spring clutch

b. Diaphragm spring clutch

C.Double Disk Clutch

2. To prepare report on the construction details, working principles and operation of the Following automotive transmission systems**:**

a. Synchromesh- four speed range

b. Transaxle with dual speed range
c. Four wheel drive and transfer case
d. Steering column and floor shift- lever

3. To prepare report on the construction details, working principles and operation of the Following automotive tyres & wheels
a. Various types of bias and radial pliestyres
b. Various types of wheels

4. To prepare report on the construction details, working principles and operation of the Following automotive steering systems:
a. Manual steering system, e.g pitman arm steering, rack and pinion steering
b. Power steering system, e.g rack& pinion power steering systems
c. Steering wheels & column e.g. tilt and telescopic steering wheels, collapsible steering Columns.

5. To prepare report on the construction details, working principles and operation of the Following automotive brake systems**:**
a. Hydraulic and Pneumatic brake system
b. Drum brake System
c. Disk brake system
d. Antilock brake system

6. To prepare report on the construction details, working principles and operation of the following automotive suspension systems:
a. Front suspension system
b. Rear suspension system

7. To prepare report on the construction details, working principles and operation of the following automotive drive lines and differentials**:**
a. Rear wheel driveline
b. Front wheel driveline
c. Differential, drive axle and four wheel drive line

8. To prepare report on the construction details, working principles and operation of the following automotive emission and pollution control systems.

9. To prepare report on the construction details, working principles and operation of the following automotive fuel supply systems**:**
a. Carburetor
b. Diesel fuel injection system
c. Gasoline fuel injection system

10. To prepare report on the construction details, working principles and operation of the Following automotive engine systems and sub systems:
a. Multi Cylinder : Diesel and petrol Engine
b. Engine Cooling and lubricating systems
c. Engine Starting systems
d. Contact point and electronic ignition systems

TEXT BOOKS & REFERENCES:

1. Automobile Engineering, Dr. Kirpal Singh, Standard Publishers Distributers
2. Automobile Engineering, R.K Rajput , Laxmi Publishers

Semester 8 (Total credit - 18)

<table>
<tr><td>Nature of the course/
Type of the course</td><td>Hard Course (3-1-2-0)
Name (Offering Department)</td><td>Soft Course (1-0-2)
Name (Offering Department)</td><td>Project (0-0-0-8)</td></tr>
<tr><td>Domain Core</td><td></td><td></td><td>Major Project</td></tr>
<tr><td>Allied Core</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Domain Elective</td><td rowspan="6">E6-
-Heating Ventilation and Air Conditioning
-Product Design and Development
-Project Management
E7-
-Computational Fluid Dynamics
-Mechatronics
-Automation in Manufacturing</td><td></td><td></td></tr>
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<tr><td>Credits</td><td>10</td><td></td><td>8</td></tr>
<tr><td>Total Credits</td><td colspan="3">18</td></tr>
<tr><td>Total No of Hours</td><td colspan="3">20</td></tr>
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Course Title/ Code	**HEATING VENTILATION AND AIR CONDITIONING (MEH443)**
Course Type:	**Domain Elective**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Pre-Requisite	**Refrigeration & Air-Conditioning**

SECTION A

Introduction: Purpose, applications, definition and components of air conditioning - Need and methods of ventilation - Course outline. Psychometric: Evolution of air properties and psychometric chart - Basic processes such as sensible heating/cooling, humidification/dehumidification and their combinations, steam and adiabatic humidification, adiabatic mixing, etc. - Bypass factor and Sensible heat ratio. Method of heat load calculation. Summer and Winter AC: Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP - Precision AC - Winter AC.

SECTION B

Human Comfort: Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality. AC Equipments - Filters, types, efficiency - Fans basic equations, parallel and series configurations - Air washer, adiabatic, heated and cooled - Cooling tower, enthalpy potential, types, tower efficiency, NTU and characteristics, sizing and off design performance - Cooling and dehumidifying coil, dry and wet, sizing, performance.

Sound Control - Definitions of various terms like level, pitch, attenuation, frequency, sources of noise in air conditioning plants, design procedure for noise prevention, noise and vibration study and elimination techniques (description only).

SECTION C

Heat Transfer - Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor. Direct and Indirect Evaporative Cooling: Basic psychometric of evaporative cooling, types of evaporative coolers, design calculations, indirect evaporative cooling for tropical countries. Cooling Load Estimation: Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, equipments - Ventilation, air quantity, loads - Load estimation methods

SECTION D

Heating load estimation: Vapour transfer in wall, vapour barrier, load estimation basics. Air Distribution - Ducts, types, fittings, air flow, friction chart, methods of sizing, balancing. Air Diffusion - Isothermal jet, throw, drop, types of outlets, ADPI, outlet/inlet selection. Basics of Ventilation - Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings.Methods of Ventilation - Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation Industrial Ventilation - Steel plants, car parks, plant rooms, mines, etc

Ventilation System Design - Exhaust ducts, filters, blowers, hoods, chimney, etc.

TEXT BOOKS & REFERENCES:

1. Arora, C.P., Refrigeration and Air Conditioning, Tata-McGraw- Hill, New Delhi, 2003.
2. Hainer R. W., Control System for Heating, Ventilation and Air conditioning, Van Nastrand Reinhold Co., New York, 1984.

LIST OF EXPERIMENTS:

1. To use the Psychometrics chart and human comfort chart and calculation of air velocity/distribution to best conditions.
2. To do the energy audit of building and heat load calculations of non-insulated and insulated building.
3. To explain the chilling plant and its working cycle.
4. To calculate the performance factor of split A.C and commercial air conditioning units
5. To design of duct system for a load calculated building.
6. To calculate noise and study the elimination techniques in air conditioning system.
7. To explain different types of cooling system in air conditioning system.
8. To explain different insulating materials in buildings.

Course Title/Code	PRODUCT DESIGN AND DEVELOPMENT (MEH444)
Course Type	Elective
Course Nature	Hard
L-T-P-O structure	3-1-2-0
Prerequisites	Machine Drawing and Manufacturing Technology

SECTION A

Introduction to Engineering Design**:** Importance of Design, Design Philosophy, History of Design, Design Paradigm, the Design Process, Good Design, Engineering Analysis, Design phases, Product and Process Cycle, Product Realization Process, Concurrent Engineering.

Need Identification and Problem Definition: Identifying customer needs Benchmarking, Quality Function Deployment, and Engineering Design Specification.

SECTION B

Concept Design :Creativity and Problem Solving, Functional requirements, Product Component Decomposition, Product Function Decomposition, Conceptual Decomposition, Generating Design Concepts, Evaluating alternative Concepts, Theory of Inventive Problem Solving, Axiomatic Design, Evaluation Methods, Decision Making.

Embodiment Design**:** Introduction, Product Architecture, Configuration Design, Parametric Design, Best Practices, Industrial Design, Human Factors Design, Design For X (DFX) – Function, Assembly, Manufacture, Environment, Robustness, Reliability, Recyclability, etc., Computer Aided Design, Computer Aided Engineering, Computer Visualization.

SECTION C

Materials Selection**:** Performance Characteristics of Materials, the Material Selection Process, Economics of Materials, Material Selection Methods. Selection of Manufacturing Processes: Manufacturing Processes, Costs of Manufacturing, Process Selection. Building and Testing Prototypes: Building Traditional Prototypes, Building Rapid Prototypes, Testing Prototypes.

SECTION D

Design for Failure, Safety and Tolerance**:** Failure Modes and Effects Analysis, Design for Safety, Tolerance Design. Human Factors/Ergonomics**:** Sensory input limitations – Sight, Hearing, Touch, Kinesthetic, Vestibular, Human Decision Making Limitations, Physical Size Limitations, Workspace Consideration.

Detail Design**:** Making Detail Design Decisions, Detail Drawings, Bill of Materials, Communicating Design and manufacturing Information, Product Data Management, and Final Design Review.

TEXT BOOKS & REFERENCES:

1. Dieter, George E. and Schmidt, Linda C., Engineering Design, Fourth Edition, McGraw Hill.
2. Eggert, Rudolph J., Engineering Design, First Edition, Prentice Hall.

LIST OF EXPERIMENTS:

1. To design sheet metal component with 3D Model and 2D drawing.
2. To develop sheet metal component as per experiment no. 1 with process sheet.
3. To design machining component with 3D Model and 2D drawing.
4. To develop machining component as per experiment no. 3 with process sheet for conventional machining.
5. To design casting component with 3D Model and 2D drawing.
6. To develop casting component as per experiment no. 5 with process sheet.
7. To design plastic component with 3D Model and 2D drawing.

8. To develop plastic component as per experiment no. 7 with process sheet by the method of molding.
9. To design carbon fiber component with 3D Model and 2D drawing.
10. To develop carbon fiber component as per experiment no. 9 with process sheet.

Course Title/Code	PROJECT MANAGEMENT (MEH445)
Course Type	ELECTIVE
Course Nature	HARD
L-T-P-O	(3-1-2-0)
Prerequisite	Production Management

SECTION A

Project Management: Need – goals – evolution – different forms – project management in manufacturing, service and government sectors; systems development cycle – project life cycle – conception phase : proposal, contracting – definition phase – execution phase: production/build, implementation - operation phase – case study. Systems And Procedures: Tools for project planning – work break down structure, responsibility matrix, events and milestones, Gantt charts.

SECTION B

Network Scheduling: Network diagram – critical path – late times – slack – float - calendar scheduling. Pert Network: Time estimates – probability of finishing by target completion date – meeting the target – simulating PERT network – criticisms of PERT ; CPM – time-cost relationship – reducing project duration – shortest duration – total project cost – scheduling with resource constraints – resource loading and leveling – constrained resources; Introduction to GERT Network, Case studies in PERT/CPM.

SECTION C

Project Cost Estimation**:** Process – classification – expert opinion, analogy, parametric estimate; cost engineering – example; contingency amount ; elements of budgets and estimates – direct labor, direct non-labor, overhead, general and administrative expenses, profit and total billing; project cost accounting and management information systems – cost summaries , cost schedules and forecasts – case study.

Project Control**:** Cost accounting systems – project control process ; project control emphasis – scope, change control, quality control, schedule control, time buffers; performance analysis – cost, schedule , work package analysis, performance indices, updating time estimates, technical performance measurement; performance index monitoring – variance limits, controlling changes, contract administration, control problems, case study.

SECTION D

Project Management Information Systems (PMIS): Functions – computer based PMI systems – web-based project management. Project Evaluation**:** Review meetings, reporting, terminating, termination responsibilities, closing the contract, project extensions, project summary evaluation.

TEXT BOOKS & REFERENCES:

1. Information Technology Project Management, Jack T. Marchewka, 3rd edition, Wiley India, 2009.
2. S. J. Mantel, J. R. Meredith and etl.. "Project Management" 1st edition, Wiley India, 2009**.**

LIST OF EXPERIMENTS

1. Project and System's Management
2. Feasibility study document
3. Project Proposal
4. Project Planning
5. Activity Planning
6. Analyzing the project network diagram
7. Cost estimation and budgeting
8. Risk management

9. Performance analysis of project
10. Project evaluation and closure

Course Title/Code	COMPUTATIONAL FLUID DYNAMICS (MEH446)
Course Type	Elective
Course Nature	Hard
L-T-P-O	(3-1-2-0)
Prerequisite	NIL

SECTION A

Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description. Review of the equations of motion for fluid flow and heat and mass transfer. Reduced forms of the equations: inviscid, irrotational, potential and fully developed flow. Turbulent flow: Reynolds averaging and the need for closure approximations; the k-epsilon turbulence model; boundary conditions and wall functions. Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods

SECTION B

Finite Difference Technique: different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of f.d. method.

Finite Volume Technique: different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem. Relevance (heat and mass transfer, fluid flow, fully developed laminar flow, potential flow etc.); solution strategy; discretisation by the finite volume method; conservation, choice of computational molecule, flux approximations, boundary conditions, properties of resultant coefficient matrix; solution algorithms for discrete equations (explicit, implicit, iterative, direct, factored); convection term discretisation - the extremum principle, boundedness, upwind, QUICK and TVD schemes.

SECTION C

Finite Element Methods: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.

Methods of Solution: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.

Time integration Methods: Single and multilevel methods; predictor corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems.

SECTION D

Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping.

Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods.

Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

TEXT BOOKS & REFERENCES:

1. Numerical heat Transfer and Fluid Flow-by Suhas.V.Patankar, Hemisphere Publishing Corporation
2. Versteeg, H.K. and Malalasekara, W., An Introduction to Computational Fluid Dynamics, Pearson Education, 2010.

LIST OF EXPERIMENTS:

1. Hexa Mesh Generation for a 2D Pipe Junction.
2. Hexa Mesh Generation for a 2D Car.
3. Hexa Mesh Generation for a radial flow pumps impeller.
4. Mesh Generation for an Elbow Part.
5. Mesh Generation for an Aerofoil.
6. Mesh Generation for a Diffuser.
7. Analysis of flow through Diffuser.
8. Analysis of flow over Aerofoil.

Course Title/Code	MECHATRONICS (MEH447)
Course Type	ELECTIVE
Course Nature	Hard
L-T-P-O Structure	3-1-2-0
Prerequisite	NIL

SECTION A

Introduction and Basics: What is Mechatronics?; A Measurement System with its constituent elements; Open and Closed Loop Systems; Sequential Controllers; Micro-processor Based Controllers; The Mechatronic Approach.
.Hardware of Measurement Systems; A review of Displacement, Position Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors / along with Performance Terminology; Selection of Sensors; Input Data by Switches; Signal Conditioning; Brief Review of Operational Amplifier; Protection; Filtering; Wheat Stone Bridge; Digital Signals; Multiplexers; Data Acqusition; Digital Signal Processing; Pulse Modulation; Data Presentation Systems – Displays; Data Presentation Elements; Magnetic Recording; Data Acquisition Systems; Testing & Calibration; Problems.

SECTION B

Pneumatic, Hydraulic, Mechanical and Electrical Actuation Systems: Pneumatic and Hydraulic Systems; Directional Control Valves; Valve Symbols; Pressure Control Valves; Cylinder Sequencing; Process Control Valves; Rotary Actuators; Mechanical Systems – Types of Motion, Kinematic Chains, Cams, Gear Trains, Ratchet & Pawl, Belt & Chain Drives, Bearings, Mechanical Aspect of Motor Selection; Electrical Systems; Mechanical & Solid State Switches; Solenoids; D.C. & A.C. Motors; Stepper Motors; Problems.
System Modeling and Performance: Engg. Systems; Rotational – Translational Systems; Electro-mechanical Systems; Hydraulic – Mechanical Systems; A review of modeling of First and Second Order Systems and Performance Measures; Transfer Functions for first order System, Second Order System, Systems in series & Systems with Feedback Loops; Frequency Response of First Order and Second Order Systems; Bode Plots: Performance Specifications: Stability; Problems.

SECTION C

Closed Loop Controllers: Continuous and Discrete Processes – Lag, Steady State Error; Control Modes; Two- step Mode; Proportional Mode – Electronic Proportional Controllers; Derivative Control – Proportional plus Derivative Control; Integral Control - Proportional plus Integral Control; PID Controller – Operational Amplifier PID Circuits; Digital Controllers – Implementing Control Modes; Control System Performance; Controller Tuning – Process Reaction Method & Ultimate Cycle Method; Velocity Control; Adaptative Control; Problems. Digital Logic and Programmable Logic Controllers : A Review of Number Systems & Logic Gates; Boolean Algebra; Kanaugh Maps; Sequential Logic; Basic Structure of Programmable Logic Controllers; Input/ Output Processing; Programming; Timers, Internal Relays and Counters; Master & Jump Controls; Data Handling; Analogue Input/ Output; Selection of a PLC; Problems.

SECTION D

Microprocessors and Input/Output Systems: Control; Microcomputer Structure; Micro- controllers; Applications; Programming Languages; Instruction Sets; Assembly Language Programs; Subroutines; Why C Language ? A review of Program Structure, Branches, Loops, Arrays, Pointer; Examples of Programs; Interfacing; Input/ Output; Interface Requirements; Peripheral Interface Adaptors; Serial Communication Interface; Examples of Interfacing;

Problems. Design and Mechatronics: Design Process; Traditional and Mechatronics Design; Possible Mechatronics design solutions for Timed Switch, Wind Screen Wiper Motion, Bath Room Scale, A Pick & Place Robot, Automatic Camera, Engine Management System & Bar Code Recorder.

LIST OF EXPERIMENTS

1. To verify truth table of various gates such as AND, OR, NOR, NOT, etc.
2. To realize a logic equation Y=AB+CD.
3. Selection of sensor for a particular application from Catalogue/Internet.
4. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values
5. To study the hardwares and softwares of mechatronics kit.
6. To move a table in X-direction within the range of proximity sensors using Control-X software.
7. To rotate a table using DAC system.
8. To move a table in Y-direction within the range of proximity sensors using Control-X software.
9. To run a motor with PLC.
10. To study the movement of actuating cylinders and sensors.

TEXT BOOKS & REFERENCES:

1. Mechatronics by W. Bolton, Published by Addition Wesley**.**
2. Mechatronics System Design – Devdas Shetty and Richard A. Kolx Brooks/ Cole 1997

Course Title/Code	AUTOMATION IN MANUFACTURING (MEH448)
Course Type	Elective
Course Nature	Hard
L-T-P-O	3-1-2-0
Prerequisites	Computer Aided Design

SECTION A

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

Material handling systems**:** Overview of Material Handling Systems- Rotary feeders, oscillating force feeder, vibratory feeder, elevator type and Centrifugal type feeders, Principles and Design Consideration, Material Transport Systems, Storage Systems.

SECTION B

Automated Manufacturing Systems**:** Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation, Flow lines & Transfer Mechanisms, Fundamentals and Analysis of Transfer Lines, product design for automatic assembly.

Control Technologies in Automation**:** Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Sensors, Actuators and other Control System Components.

SECTION C

Evaluation of automatic production**:** product manufacturability, orientation devices- active and passive, devices, parts orientation and Rocapement.

Pneumatic and hydraulic components and circuits**:** Boolean algebra, pneumatic sensors and amplifiers, jet destruction devices, logic devices, schimit triggering devices, developing pneumatic circuits for automatic die casting machine.

SECTION D

Modeling and Simulation for manufacturing Plant Automation**:** Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.

TEXT BOOKS & REFERENCES:

1. M.P. Grover Automation, Production Systems, and Computer Integrated Manufacturing, Prentice Hall, 2008.

2. Manufacturing and Automation Technology, 3rd Edition, R. Thomas Wright and Micheal Berkeihiser.

LIST OF EXPERIMENTS:

1. To explain the hardware of a retrofit and CNC machine tools.
2. Selection of various equipments required with the specifications from Internet/Catalogue: To convert a manual machine tool/system into an automatic machine tool/system.
3. To write programme with G code and M code for a component.
4. To simulate machining of component using PRO/E.

5. Explain the applications of Hydraulic software.
6. Explain the applications of Pneumatic software.
7. Explain the applications of Robotic software.
8. Explain the applications of PLC software.
9. To design an automated part feeder.
10. Developing pneumatic circuits for machines and systems.