K.L.N. COLLEGE OF ENGINEERING

Pottapalayam – 630 612, Sivagangai District

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Estd: 1994

FINAL YEAR CURRICULUM AND SYLLABUS

REGULATIONS 2020

For Under Graduate Program

B.E. – MECHANICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

(For the students admitted from the academic year 2020-2021 onwards)

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)

VISION OF THE INSTITUTION

To become a Centre of Excellence in Technical Education and Research in producing Competent and Ethical professionals to the society.

MISSION OF THE INSTITUTION

To impart Value and Need based curriculum to the students with enriched skill development in the field of Engineering, Technology, Management and Entrepreneurship and to nurture their character with social concern and to pursue their career in the areas of Research and Industry**.**

VISION OF THE DEPARTMENT

To become a Centre of excellence for Education and Research in Mechanical Engineering.

MISSION OF THE DEPARTMENT

- Attaining academic excellence through effective teaching learning process and state of the art infrastructure.
- Providing research culture through academic and applied research.
- Inculcating social consciousness and ethical values through co-curricular and extra-curricular activities.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1 Graduates will have successful career in Mechanical Engineering and service industries.

PEO 2 Graduates will contribute towards technological development through academic research and industrial practices.

PEO 3 Graduates will practice their profession with good communication, leadership, ethics and social responsibility.

PEO 4 Graduates will adapt to evolving technologies through lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1 Derive technical knowledge and skills in the design, develop, analyze and manufacture of mechanical systems with sustainable energy, by the use of modern tools and techniques and applying research based knowledge.

PSO 2 Acquire technical competency to face continuous technological changes in the field of mechanical engineering and provide creative, innovative and sustainable solutions to complex engineering problems.

PSO 3 Attain academic and professional skills for successful career and to serve the society needs in local and global environment.

PO1: Engineering knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication

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

PO11: Project management and finance

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

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.

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)

REGULATIONS 2020

For Under Graduate Program

B.E. – MECHAINCAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

CATEGORY OF COURSES

i. **Humanities and Social Sciences (HS) Courses** include Technical English, Environmental Science and Engineering, Engineering Ethics and human values, Communication Skills and Management courses.

ii. **Basic Sciences (BS**) **Courses** include Mathematics, Physics, and Chemistry.

iii. **Engineering Sciences (ES) Courses** include Engineering practices, Engineering Graphics, Basics of Electrical / Electronics / Mechanical / Computer Engineering / Instrumentation etc.

iv. **Professional Core (PC) Courses** include the core courses relevant to the chosen programme of study.

v. **Professional Elective (PE) Courses** include the elective courses relevant to the chosen programme of study.

vi. **Open Elective (OE) Courses** include courses from other branches which a student can choose from the list specified in the curriculum of the students B.E. / B.Tech. Programmes.

vii. **Employability Enhancement Courses (EEC)** include Project Work and/or Internship, Seminar, Professional Practices, Case Study and Industrial / Practical Training.

viii. **Mandatory Courses (MC)** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM – 630 612

(An Autonomous Institution, Affiliated to Anna University, Chennai)

B.E. MECHANICAL ENGINEERING

REGULATIONS – 2020

CHOICE BASED CREDIT SYSTEM

SEMESTER VII

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	20ME701	Mechatronics	PC	3	3	0	0	3
2	20HS701	Management Concepts and Entrepreneurship	HS	3	3	0	0	3
3		Open Elective – II	OE	3	3	0	0	3
4		Professional Elective – II	PE	3	3	0	0	3
5		Professional Elective – III	PE	3	3	0	0	3
PRACTICAL								
6	20ME7L1	Mechatronics Laboratory	PC	4	0	0	4	2
7	20ME7L2	Technical Seminar	EEC	2	0	0	2	1
TOTAL				**21**	**15**	**0**	**6**	**18**

SEMESTER VIII

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective – IV	PE	3	3	0	0	3
2		Professional Elective – V	PE	3	3	0	0	3
PRACTICAL								
3	20ME8L1	Project Work	EEC	20	0	0	20	10
TOTAL				**26**	**6**	**0**	**20**	**16**

SEMESTER VII ELECTIVE II

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20ME7A1	Data Analytics for Mechanical Engineering	PE	3	3	0	0	3
2	20ME7A2	Computer Integrated Manufacturing Systems	PE	3	3	0	0	3
3	20ME7A3	Additive Manufacturing	PE	3	3	0	0	3
4	20ME7A4	Automobile Engineering	PE	3	3	0	0	3
5	20ME7A5	Computational Fluid Dynamics	PE	3	3	0	0	3
6	20ME7A6	Supply chain and Logistic management	PE	3	3	0	0	3
7	20ME7A7	Maintenance Engineering	PE	3	3	0	0	3

SEMESTER VII ELECTIVE III

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20ME7B1	Product Life Cycle Management	PE	3	3	0	0	3
2	20ME7B2	Design of Jigs, Fixtures and Press Tools	PE	3	3	0	0	3
3	20ME7B3	Process Planning and Cost Estimation	PE	3	3	0	0	3
4	20ME7B4	Power Plant Engineering	PE	3	3	0	0	3
5	20ME7B5	Energy Conservation and Management	PE	3	3	0	0	3
6	20ME7B6	Industrial Robotics	PE	3	3	0	0	3
7	20ME7B7	Engineering Economics and Cost Analysis	PE	3	3	0	0	3

SEMESTER VIII ELECTIVE IV

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20ME8A1	Innovation in design	PE	3	3	0	0	3
2	20ME8A2	Unconventional Machining Processes	PE	3	3	0	0	3
3	20ME8A3	Production Planning and Control	PE	3	3	0	0	3
4	20ME8A4	Battery Technology	PE	3	3	0	0	3
5	20ME8A5	Testing of Materials	PE	3	3	0	0	3
6	20HS6A1	Intellectual Property Rights	PE	3	3	0	0	3

SEMESTER VIII ELECTIVE V

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20ME8B1	Two wheeler and Four wheeler Overhauling	PE	3	3	0	0	3
2	20ME8B2	Industrial Safety Engineering	PE	3	3	0	0	3
3	20ME8B3	Welding Technology	PE	3	3	0	0	3
4	20ME8B4	Composite Material and Mechanics	PE	3	3	0	0	3
5	20ME8B5	Advanced Internal Combustion Engines	PE	3	3	0	0	3
6	20HS7A2	Total Quality Management	PE	3	3	0	0	3

OPEN ELECTIVE II (OE)

SEMESTER VII

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20OE205	Industrial Energy Auditing and Management	OE	3	3	0	0	3
2	20OE305	Fundamentals of Image Processing	OE	3	3	0	0	3
3	20OE405	Fundamentals of Machine Learning	OE	3	3	0	0	3
4	20OE407	Computer Graphics	OE	3	3	0	0	3
5	20OE408	Essentials of Data Analytics	OE	3	3	0	0	3
6	20OE507	Concepts of Ethical Hacking	OE	3	3	0	0	3
7	20OE606	Modern Technologies for Vehicles	OE	3	3	0	0	3
8	20OE607	New Generation Hybrid vehicles	OE	3	3	0	0	3
9	20OE608	Automotive Electrical and Electronics Systems	OE	3	3	0	0	3
10	20OE708	Instrumentation for Agro food industry	OE	3	3	0	0	3

OPEN ELECTIVE – II OFFERED TO OTHER DEPARTMENT

SEMESTER VII

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20OE105	Solar Photovoltaic Fundamentals and Applications	OE	3	3	0	0	3
2	20OE106	Fundamentals of Product Design	OE	3	3	0	0	3
3	20OE107	Autonomous and Electric Vehicles	OE	3	3	0	0	3
4	20OE108	Industrial Safety Practices	OE	3	3	0	0	3

20ME701 **MECHATRONICS**

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the functional key elements of mechatronics system.
- To study the characteristics and applications of various types of sensors and transducers.
- To impart knowledge in basic structure and programming of microprocessor.
- To learn about real-time interfacing system.
- To study the architecture, ladder logic program and applications of PLC.

PREREQUISITE:

Course Code: 20GE203

Course Name: Basic Electrical, Electronics and Instrumentation Engineering

UNIT - I INTRODUCTION TO MECHATRONICS - SENSORS AND TRANSDUCERS 9

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

UNIT – II MICROPROCESSOR AND MICROCONTROLLER 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085- Assembly language programming – Examples. Concepts of 8051 microcontroller – Block diagram– Memory map - Addressing modes, I/O Ports.

UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE 9

Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER AND VIRTUAL INSTRUMENTATION 9

Introduction – Basic structure and Specifications – Input and output processing – PLC hardware components Analog & digital I/O modules, Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC- Applications.

Virtual Instrumentation: Block diagram and architecture of a virtual instrument, data -flow techniques, graphical programming in data flows.

UNIT - V ACTUATORS AND MECHATRONIC SYSTEM DESIGN 9

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

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Bolton, W “Mechatronics”, Pearson Higher Education, 2017.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Prentice Hall, 6th Edition, 2013.
3. Michael B.Histand and Davis G. Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2007.

REFERENCES:

1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2015.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
4. Krishna Kant, “Microprocessors & Microcontrollers”, Prentice Hall of India, 2016.
5. Jovitha Jerome, “Virtual Instrumentation Using LabVIEW”, Kindle Edition, PHI Publishers, 2010.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name: MECHATRONICS		**Course Code: 20ME701**			
CO	**Course Outcomes**	**Unit**	**K –CO**	**POs**	**PSO**
C401.1	Describe the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology.	I	K2	**1,2,3**	**1,2,3**
C401.2	Explain the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes and Programming of Microprocessor and Microcontroller.	II	K2	**1,2,3,4**	**1,2,3**
C401.3	Discuss the Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing.	III	K2	**1,2,3,4,5**	**1,2,3**
C401.4	Describe the architecture, Programming and applications of Programmable Logic Controllers in industries.	IV	K2	**1,2,3,4,5**	**1,2,3**
C401.5	Explain the architecture, data flow techniques and graphical programming of Virtual Instruments.	IV	K2	**1,2,3,4,5**	**1,2,3**
C401.6	Discuss about the various actuators used in mechatronics system using the knowledge and skills acquired through the course.	V	K2	**1,2,3,4,5**	**1,2,3**

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C401.1	2	2	1	-	-	-	-	-	-	-	-	-	2	2	1
C401.2	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1
C401.3	2	2	2	1	1	-	-	-	-	-	-	-	2	2	1
C401.4	2	2	2	1	2	-	-	-	-	-	-	-	2	2	1
C401.5	2	2	2	1	2	-	-	-	-	-	-	-	2	2	1
C401.6	2	2	2	1	1	-	-	-	-	-	-	-	2	2	1

20HS701	MANAGEMENT CONCEPTS AND ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the evolution of Management and various theories of management.
- To know about the functions of management.
- To understand the concepts of management and to learn the application of the concepts in an organization.
- To develop and strengthen entrepreneurial quality and motivation.
- To impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Introduction, Nature and functions of management, Roles of Manager, Managerial Skills, Management as a science, art or profession, Henry Fayol and Taylor approaches, Qualitative, Contingency and Systems approaches. Planning: Nature & importance of planning, Types of plans, Steps in planning process, Planning premises.

UNIT – II ORGANIZING AND STAFFING 9

Organizing: Characteristics and Process of organizing Span of Management, Organization structure, Types of organization chart. Staffing: Introduction, Importance and Functions of staffing, Recruitment, Selection and training process.

UNIT – III DIRECTING AND CONTROLLING 9

Directing: Introduction, Requirements of effective direction, Management by objective (MBO)-Motivation theory – Maslow, Theory X and Y, Leadership styles. Communication: Purpose and Importance of Communication, Communication process, Formal & Informal communication, Barriers to communication. Controlling: System and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in Management control.

UNIT – IV ENTREPRENEURSHIP 9

Entrepreneurship: Introduction, Characteristics and Classification of entrepreneurs, Role of entrepreneur in economic development, Problems faced by entrepreneurs. MSME: Importance, Classification, Incentives, Schemes, Problems, IndustryAssociations. Institutions supporting entrepreneurship.

UNIT - V BUSINESS ENTERPRISE 9

Introduction to Government Policies on Entrepreneurship: Start-up India Schemes. Setting up a small business enterprise: Formalities for setting up of a small business enterprise, Preparation of Business Plan. Types of Registration of companies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Tripathi P.C, Reddy P.N. “Principles of Management”, McGraw Hill, 7th Edition, 2021.
2. Harold Koontz, Heinz Weihrich, “Essentials of Management” McGraw Hill, 11th Edition, 2020.
3. Poornima M. Charantimath, “Entrepreneurship Development – Small Business Enterprises” Pearson Education, 3rd Edition, 2018.

REFERENCES:

1. Robert Lussier, “Management Fundamentals – Concepts, Application, Skill Development”, Thomson, 3rd Edition, 2006.
2. Thomas W Zimmerer, Norman M Scarborough, Doug Wilson, “Essentials of Entrepreneurship and Small Business Management”, PHI, 9th Edition, 2018.
3. Stephen Robbins, “Management”, Pearson Education / PHI, 14th Edition, 2019.
4. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, South-Western College Publishing, 11th Edition, 2019.
5. Khanka. S.S., “Entrepreneurial Development” S.Chand& Co. Ltd., 8th Edition, 2013.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : Management Concepts and Entrepreneurship		**Course Code :20HS701**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C402E5.1	Compare various management approaches, planning strategies.	I	K3	1,2,3,11	1, 2, 3
C402E5.2	Organize the staffing and structure for an organization	II	K3	1,2,3,8,11	1, 2, 3
C402E5.3	Make use of communication methods, leadership styles for building effective control in an organization	III	K3	1,2,3,4,5, 11,12	1, 2, 3
C402E5.4	Develop entrepreneurial ideas	IV	K3	1,2,3,4,5, 7,11	1, 2, 3
C402E5.5	Identify the institutions supporting the small-scale industries	IV	K2	1,2,3,4,11,12	1, 2, 3
C402E5.6	Plan various steps involved in setting up a business enterprise	V	K2	1,2,3,5,11,12	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C402E5.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C402E5.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C402E5.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C402E5.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C402E5.5	3	2	1	-	-	-	-	-	-	-	2	1	2	2	1
C402E5.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20ME7L1	MECHATRONICS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To know the assembly language programming in microprocessor and microcontroller.
- To impart knowledge in the design, modeling & analysis of basic electrical, hydraulic, pneumatic system.
- To understand the working of interfacing circuits for stepper motor, servo motor and traffic light controller.
- To know the programming of LabVIEW and Fluidsim software.
- To understand the circuit connection for PLC based Electro Pneumatic system.

PREREQUISITE:

Course Code: 20GE203
Course Name: Basic Electrical, Electronics and Instrumentation Engineering

LIST OF EXPERIMENTS

1. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
2. Stepper motor interface.
3. Traffic light interface.
4. Speed control of DC motor.
5. Study of various types of optical transducers.
6. Study of hydraulic, pneumatic and electro-pneumatic circuits.
7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using software.
8. Study of PLC based Electro Pneumatic circuit with multiple cylinder sequences.
9. Study of Image processing technique.
10. Real-time temperature data logging system with LabVIEW software and DAQ cards.
11. Study of Process control trainer for controlling pressure and flow rate of the liquid.

TOTAL: 45 PERIODS

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name: MECHATRONICS LABORATORY		Course Code: 20ME7L1			
CO	**Course Outcomes**	**Experiments**	**K –CO**	**POs**	**PSO**
C406.1	Develop the program for arithmetic functions and the program for sorting, code conversion functions.	1	K3	1,2,3,4,5,9	1,2,3
C406.2	Develop the program codes to interface with traffic light controller, stepper motor and DC motor.	2,3,4	K3	1,2,3,4,5,9	1,2,3
C406.3	Determine the performance characteristics of LDR, Photo diode and Photo transistors.	5	K3	1,2,3,4,5,9	1,2,3
C406.4	Construct the hydraulic, pneumatic and electro pneumatic circuits by using simulation software and also interface with PLC.	6,7,8	K3	1,2,3,4,5,9	1,2,3
C406.5	Develop graphical programming language codes for image analysis and temperature data logging system.	9,10	K3	1,2,3,4,5,9	1,2,3
C406.6	Construct the circuit to control the temperature, pressure and flow rate of the liquid in process control trainer kit by using DAQ cards with LabVIEW software.	11	K3	1,2,3,4,5,9	1,2,3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C406.1	3	2	2	1	1	-	-	-	3	-	-	-	3	2	1
C406.2	3	2	2	1	1	-	-	-	3	-	-	-	3	2	1
C406.3	3	2	2	2	1	-	-	-	3	-	-	-	3	2	1
C406.4	3	2	2	1	1	-	-	-	3	-	-	-	3	2	1
C406.5	3	2	2	1	2	-	-	-	3	-	-	-	3	2	1
C406.6	3	2	2	1	1	-	-	-	3	-	-	-	3	2	1

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of The Equipment	Quantity
1.	Basic Pneumatic Trainer Kit with manual and electrical Controls / PLC Control each	1
2.	Basic Hydraulic Trainer Kit	1
3.	Hydraulics and Pneumatics Systems Simulation Software	10
4.	8051 - Microcontroller kit with stepper motor and drive circuit sets	2
5.	8051 – Microcontroller kit with traffic light control and Dc motor control	1
6.	8085 microprocessor with interfacing kit	2
7.	Optical transducer trainer kit (LDR, Photo diode, Photo Transistor)	1
8.	Image processing system with hardware & software	1
9.	LabVIEW software with DAQ cards	2
10.	Process Control trainer kit	1

20ME7L2 **TECHNICAL SEMINAR**

L	T	P	C
0	0	2	1

A student has to present three Technical papers or recent advances in engineering/technology that will be evaluated by a Committee constituted by the Head of the Department.

TOTAL: 30 PERIODS

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : TECHNICAL SEMINAR		**Course Code : 20EI6L3**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C407.1	Function effectively as an individual and Make effective presentation on Engineering/ technology.	-	K4	1-12	1,2
C407.2	Review, prepare and present technological developments in the field of mechanical engineering.	-	K4	1-12	1,2
C407.3	Design documentation and write effective reports on seminar topics	-	K4	1-12	1,2

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C407.1	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C407.2	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C407.3	3	3	2	1	1	1	1	1	1	1	1	1	2	2

20ME8L1 **PROJECT WORK**

L	T	P	C
0	0	20	10

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

TOTAL: 300 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PROJECT WORK		**Course Code : 20ME8L1**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C410.1	Identify and apply the real world and societal importance problems in the mechanical engineering and its allied area	-	K4	1-12	1,2
C410.2	Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies	-	K4	1-12	1,2
C410.3	Apply modern engineering tools for solution	-	K4	1-12	1,2
C410.4	Contribute as an individual or in a team in development of technical projects	-	K4	1-12	1,2
C410.5	Develop effective communication skills for presentation of project related activities	-	K4	1-12	1,2
C410.6	Prepare reports and examination following professional ethics	-	K4	1-12	1,2

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C410.1	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C410.2	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C410.3	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C410.4	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C410.5	3	3	2	1	1	1	1	1	1	1	1	1	2	2
C410.6	3	3	2	1	1	1	1	1	1	1	1	1	2	2

20ME7A1	DATA ANALYTICS FOR MECHANICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the various methods of data collection.
- To gain knowledge about the data processing and data handling methods.
- To know about the streaming of data analytics and data security.
- To apply the concepts of data analytics in manufacturing sector.
- To understand the applications of data analysis in energy management and safety systems.

PREREQUISITE: NIL

UNIT - I DATA COLLECTION 9

Sensing: Sensors, transducers, sensor resolution, types of sensors; Actuation: Actuator, types of actuators; Communication protocols: 802.15.4, ZigBee, 6lowpan, RFID, NFC, Bluetooth, Z-wave; Embedded systems - Arduino, Raspberry Pi.

UNIT – II DATA PROCESSING AND DATA HANDLING 9

Data processing: MQTT, MQTT components and methods;
Data handling: Big data, types of data, flow of data; Cloud computing: Recent trends, service models, managing data in cloud.

UNIT – III DATA ANALYTICS AND DATA SECURITY 9

Data analytics: Types, lifecycle, discovery, preparation, model planning, model building; Data collection, Streaming data analytics: hadoop, hive, hbase; Data security: Data protection, challenges.

UNIT – IV APPLICATIONS IN MANUFACTURING 9

Manufacturing: Machine diagnostics and prognosis, robotics and autonomous vehicles and part tracing; Inventory and logistics: Route generation and scheduling, fleet tracking, shipment monitoring, remote vehicle diagnostics;

UNIT - V APPLICATIONS IN ENERGY, SAFETY 9

Energy: Smart grids, waste management; Safety and security: Indoor air quality monitoring, noise level monitoring, smoke/gas detections, structural health monitoring.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 1st Edition, 2016.
2. Ulrich Sendler, "The Internet of Things: Industrie 4.0 Unleashed", Springer, 1st Edition, 2019.
3. Sabina Jeschke, Christian Brecher, Houbing Song, Dana B. Rawat, "Industrial Internet of Things: Cyber- manufacturing Systems", Springer, 2016.

REFERENCES:

1. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.
2. Adrian McEwen, Hakim Cassimally , "Designing the Internet of Things", John Wiley and Sons Ltd, 2014.
3. Thomas Er, Dr. Zaigham Mahmood, Professor Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", PHI, 2013.
4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, Wiley Publications, 2013.
5. Peter Waher “Learning Internet of Things”,Packt Publishing, 2015.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DATA ANALYTICS FOR MECHANICAL ENGINEERING		Course Code : 20ME7A1			
CO	**Course Outcomes**	**Unit**	**K –CO**	**POs**	**PSO**
C404E1.1	Explain the data collection systems using sensors.	I	K2	1, 2, 3	1, 2, 3
C404E1.2	Describe the data processing and handling methods.	II	K2	1, 2, 3	1, 2, 3
C404E1.3	Explain the data security systems.	III	K2	1, 2, 3	1, 2, 3
C404E1.4	Describe the applications of data analytics in manufacturing sector.	IV	K2	1, 2, 3	1, 2, 3
C404E1.5	Describe the applications of data analytics in inventory and shipment.	IV	K2	1, 2, 3	1, 2, 3
C404E1.6	Describe the applications of data analytics in energy and safety management.	V	K2	1, 2, 3, 12	1, 2, 3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C404E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E1.2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E1.3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E1.4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E1.5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E1.6	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1

20ME7A2	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the application of computers in manufacturing systems.
- To know the concept of cellular manufacturing systems.
- To familiarize about FMS and its applications.
- To comprehend the application of automation and AGVS in industry.
- To know the application of computer for generating process planning of the product.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO CIM AND AUTOMATION 9

Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated manufacturing, computerized elements of a CIM system, CAD/CAM and CIM.

Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in process, numerical problems.

UNIT – II CELLULAR MANUFACTURING SYSTEMS 9

Group technology-Part Families, Features and Optiz of Parts Classification and Coding Systems, Machine Cell Design, Applications Of Group Technology.

Quantitative analysis of Cellular Manufacturing, Grouping of parts and Machines by Rank Order Clustering method - Hollier Method – Simple Problems.

UNIT – III FLEXIBLE MANUFACTURING SYSTEMS 9

FMS- Flexibility – Types of FMS- Components - work stations –FMS layout configurations- Computer control and functions – Applications.

Analysis of flexible manufacturing systems – Bottleneck model – sizing the FMS –simple numerical problems.

UNIT – IV AUTOMATED ASSEMBLY SYSTEMS AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 9

Automation – Basic elements- power - program of instructions – control system – levels of automation. Fundamentals of automated assembly systems – system configurations - parts delivery – applications.

Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT - V COMPUTER AIDED PROCESS PLANNING SYSTEMS 9

Computer aided Process Planning – Variant process planning – Generative process planning– Forward and backward planning, input format.

Totally Integrated process planning systems – Expert process planning-Commercial systems: CAM-I, CAPP, MIPLAN, APPAS, CPPP.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education Limited, 5th Edition, 2019.
2. Radhakrishnan P, Subramanyan S.and Raju V., “CAD/CAM/CIM”, New Age, International (P) Ltd, 4th Edition, 2016.
3. James A. Rehg, and Henry W Kraebber, ‘Computer-Integrated Manufacturing’, Pearson Education Limited, 2nd Edition, 2000.

REFERENCES:

1. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 2003.
2. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach”, Chapman & Hall, 1995.
3. Rao. P, N Tewari &T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill, Publishing Company, 2000.
4. Vollmann, T.E. and Bery, W.E., “Manufacturing Planning and Control Systems, Galgotia Publications, 5th Edition, 2004.
5. Yoram Koren, ‘Computer Control of Manufacturing Systems’, McGraw Hill Education, Indian Edition, 2017.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : COMPUTER INTEGRATED MANUFACTURING SYSTEMS													**Course Code : 20ME7A2**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
C404E2.1	Explain the knowledge about role of computer and automation in manufacturing.												I	K2	1,2,8,10	,2,3
C404E2.2	Explain the concept of group technology and formation of parts – machine cell.												II	K3	1,2,3,8,10	,2,3
C404E2.3	Explain the concept of FMS, and sizing of FMS systems.												III	K2	1,2,8,10	,2,3
C404E2.4	Describe the automation, types of automation and automation strategies.												IV	K2	1,2,8,10	,2,3
C404E2.5	Describe Automated Guided Vehicle System and its application.												IV	K2	1,2,8,10	,2,3
C404E2.6	Describe the application of computer in CAPP, and explore to integrated planning software.												V	K2	1,2,8,10	,2,3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**		**PSO2**	**PSO3**
C404E2.1	2	1	-	-	-	-	-	1	-	1	-	-	2		1	1
C404E2.2	3	2	1	-	-	-	-	1	**2**	1	-	-	2		1	1
C404E2.3	2	1	-	-	-	-	-	1	-	1	-	-	2		1	1
C404E2.4	2	1	-	-	-	-	-	1	-	1	-	-	2		1	1
C404E2.5	2	1	-	-	-	-	-	1	-	1	-	-	2		1	1
C404E2.6	2	1	-	-	-	-	-	1	-	1	-	-	2		1	1

20ME7A3 **ADDITIVE MANUFACTURING**

L	T	P	C
3	0	0	3

OBJECTIVES

- To provide detailed understanding of additive manufacturing processes.
- To understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
- To Know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies.
- To help the students to select the best process among various alternative and to think about the possibility of combining different process to develop more efficient AM process

PREREQUISITE: NIL

UNIT - I INTRODUCTION 8

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.

UNIT – II CAD & REVERSE ENGINEERING 10

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

UNIT – III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 10

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system – Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing

UNIT – IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 10

Selective Laser Sintering (SLS): Principle, process, materials, advantages, limitations, Applications.

Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies

UNIT - V OTHER ADDITIVE MANUFACTURING SYSTEMS 9

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM)

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Andreas Gebhardt and Jan-Steffen Hotter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-156990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN-13: 978-1493921126.
3. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

REFERENCES:

1. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, CRC Press., 1st Edition, 2015.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, 2011.
3. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
4. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007.
5. Majumdar J.D and Manna.I, Laser assisted fabrication of materials, Springer series in material science.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : ADDITIVE MANUFACTURING											**Course Code : 20ME7A3**				
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
C404E3.1	Explain the process of Rapid prototyping, Rapid tooling and Rapid manufacturing and describe the benefits and applications of AM process.										I	K2	1,2,5,8,10		1,2,3
C404E3.2	Explain data processing for Additive Manufacturing Technology.										II	K2	1,2,3,4,5,8, 10		1,2,3
C404E3.3	Differentiate MIMICS and MAGICS software’s used in AM process.										II	K2	1,2,5,8,10		1,2,3
C404E3.4	Explain the principle, Processes, applications of SLA, SGC, FDM and LOM processes.										III	K2	1,2,5,7,8,9, 10		1,2,3
C404E3.5	Explain the principle, Processes, applications of SLS and LENS.										IV	K2	1,2,5,7,8,10		1,2,3
C404E3.6	Explain the principle, Processes, applications of 3D printing and SDM processes										V	K2	1,2,5,7,8,10		1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C404E3.1	2	1	-	-	-	-	-	1	-	1	-	-	3	2	2
C404E3.2	2	1	-	-	-	-	-	1	-	1	-	-	3	2	2
C404E3.3	2	1	-	-	2	-	-	1	-	1	-	-	3	2	2
C404E3.4	2	1	-	-	-	-	-	1	2	1	-	-	3	2	2
C404E3.5	2	1	-	-	-	-	-	1	-	1	-	-	3	2	2
C404E3.6	2	1	-	-	-	-	-	1	-	1	-	-	3	2	2

20ME7A4	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the construction and working principle of various parts of an automobile.
- To acquire the fundamental knowledge of the various systems of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system
- To associate the functions of each system with its design and layout and depict the various systems using simple schematics.
- To understand the emerging trends of electric vehicles and hybrid vehicle.

PREREQUISITE:

Course Code: 20ME403

Course Name: Thermal Engineering

UNIT - I AUTOMOTIVE ENGINE AUXILIARY SYSTEMS 9

Automotive engines – External combustion engines – Internal combustion engines – classification of engines – SI Engines – CI Engines – two stroke engines – four stroke engines – construction and working principles – IC engine components – functions and materials – valve timing – port timing diagram – Injection system – Unit injector system – Rotary distributor type – Electronically controlled injection system for SI engines – CI engines – Ignition system – Electronic ignition system – Transistorized ignition system, capacitive discharge ignition system.

UNIT – II VEHICLE FRAMES AND STEERING SYSTEM 9

Vehicle construction and different Chassis layouts – classifications of chassis – types of frames – frameless chassis construction – articulated vehicles – vehicle body – vehicle aerodynamics – various resistances and its effects – steering system – conventional – sophisticated vehicle – and types of steering gear box – power steering – Steering geometry – condition for true rolling motion – Ackermann's – Devi's steering system – types of stub axle – Types of rear axles.

UNIT – III TRANSMISSION SYSTEMS 9

Clutch – types and construction, gear boxes – manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints – Hotchkiss Drive and Torque Tube Drive – rear axle – Differential – wheels and tyres.

UNIT – IV SUSPENSION AND BRAKES SYSTEMS 9

Suspension systems – conventional suspension systems – independent suspension systems – leaf spring – coil spring – taper lite – eligos spring Types of brakes – Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control. Derive the equation of Forces acting while applying a brake on plain surface – inclined road – gradient.

UNIT - V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles – Engine modifications required – Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels – Electric and Hybrid Vehicles, Fuel Cell. Turbo chargers – Engine emission control by three way catalytic converter system.

Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ganesan V. “Internal Combustion Engines”, Fourth Edition, Tata McGraw-Hill, 2012.
2. Jain K.K. and Asthana R.B., “Automobile Engineering” Tata McGraw Hill Publishers, 2015.
3. Kirpal Singh, “Automobile Engineering”, Vol. 1 & 2, Standard Publishers, 7th Edition, 2020.

REFERENCES:

1. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan, “Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.
2. Joseph Heitner, “Automotive Mechanics Principles & Practices”, East-West Press Pvt. Ltd., 2nd Edition, 2006.
3. M. Ehsani, Y. Gao and A. Emadi, “ Modern Electric, Hybrid electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2nd Edition, 2010
4. R. Stone and J. K. Ball, “Automotive Engineering Fundamentals”, SAE International, 2004.
5. T. K. Garrett, K. Newton and W. Steeds, “The Motor Vehicle”, SAE International, 13th Edition, 2001.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : AUTOMOBILE ENGINEERING		**Course Code : 20ME7A4**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C404E4.1	Explain the various types of engines and components.	I	K2	1, 2, 3	1, 2, 3
C404E4.2	Explain the various types of injection and ignition systems.	I	K2	1, 2, 3	1, 2, 3
C404E4.3	Describe the various types of chassis, frame and steering systems.	II	K2	1, 2, 3	1, 2, 3
C404E4.4	Distinguish between the manual transmissions systems with automatic transmission systems.	III	K2	1, 2, 3	1, 2, 3
C404E4.5	Describe the operation of the brakes and the suspension systems.	IV	K2	1, 2, 3	1, 2, 3
C404E4.6	Describe the importance of alternate fuels for IC engines.	V	K2	1, 2, 3, 12	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C404E4.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E4.2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E4.3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E4.4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E4.5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C404E4.6	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1

20ME7A5	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To apply the fundamentals of CFD, and developing case specific governing equations.
- To perform finite difference and finite volume based analysis for steady and transient diffusion problems.
- To implement various mathematical schemes under finite volume method for convention diffusion.
- To solve complex problems in the field of fluid flow and heat transfer with the support of high speed computers.
- To apply the various discretization methods, solution procedure and the concept of turbulence modeling.

PREREQUISITE:

Course Code: 20BS401, 20ME302, 20ME403

Course Name: Statistics and Numerical Methods for Mechanical Engineers, Fluid Mechanics and Machinery, Thermal Engineering

UNIT - I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations– Continuity, Momentum and Energy equations – boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs - Elliptic, Parabolic and Hyperbolic equations.

UNIT – II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Discretization methods - Finite difference methods: Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Discretization of 1-D unsteady state diffusion problems

UNIT – III FINITE VOLUME METHOD FOR 2–D DIFFUSION 9

Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consistency, Stability, Convergence, Grid independent and time independent study, Stability analysis of parabolic and hyperbolic equations. Finite Volume Discretization of 2-D unsteady State Diffusion type problems

UNIT – IV FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Finite volume discretization of Convection-Diffusion Equations: Schemes. The concept of false diffusion, QUICK scheme. Discretization of Navier Stokes Equations: Discretization of the Momentum Equation, Staggered grid and Collocated grid, pressure-velocity coupling, SIMPLE Algorithm.

UNIT - V TURBULENCE MODELS AND MESH GENERATION 9

Turbulence models, mixing length model, Two equation models (k-Є) – High and low Reynolds number models, Mesh Generation and refinement Techniques-software tools.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Tannehill, J.E., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 2nd edition, 2012
2. Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2007
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill, 1998.

REFERENCES:

1. John. F. Wendt, “Computational Fluid Dynamics – An Introduction”, Springer, 2013.
2. Suhas V, Patankar, “Numerical Heat transfer and Fluid flow”, Taylor & Francis, 2009.
3. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, 2014.
4. Uriel Frisch, Turbulence, Cambridge University Press, 1999.
5. Yogesh Jaluria & Kenneth E. Torrance, “Computational Heat Transfer”, CRC press, 2002.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : COMPUTATIONAL FLUID DYNAMICS		**Course Code : 20ME7A5**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C404E5.1	Apply the fundamentals of CFD to derive governing equations	I	K3	1, 2,3, 4	1, 2, 3
C404E5.2	Discretize 1 D steady and transient diffusion equations using finite difference method.	II	K3	1, 2, 3, 4	1, 2, 3
C404E5.3	Discretize 1 D steady and transient diffusion equations using finite volume method	III	K3	1, 2, 3, 4	1, 2, 3
C404E5.4	Derive finite volume equations for 1 D convention diffusion problem.	IV	K3	1, 2, 3, 4	1, 2, 3
C404E5.5	Explain SIMPLE algorithm.	IV	K2	1, 2, 3, 4	1, 2, 3
C404E5.6	Describe various turbulence models.	V	K2	1, 2, 3, 4	1, 2, 3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C404E5.1	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C404E5.2	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C404E5.3	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C404E5.4	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C404E5.5	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1
C404E5.6	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1

20ME7A6 SUPPLY CHAIN AND LOGISTIC MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the scope of Supply Chain Management and the Drivers of Supply Chain performance.
- To design suitable Supply Chain network for a given situation.
- To solve the issues related to Logistics in Supply Chain Management.
- To understand Sourcing, Coordination and current issues in Supply Chain Management.
- To appraise about the applications of IT in Supply Chain Management and apply Supply Chain Management concepts in selected enterprise.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Role of Logistics and Supply chain Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

UNIT – II SUPPLY CHAIN NETWORK DESIGN 9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for network Decisions.

UNIT – III LOGISTICS IN SUPPLY CHAIN 9

Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation - 3PL- 4PL- Global Logistics - Reverse Logistics; Reasons, Activities and issues.

UNIT – IV SOURCING AND COORDINATION IN SUPPLY CHAIN 9

Role of Sourcing in supply chain - Supplier selection - Contracts - Design Collaboration - Sourcing planning and analysis - Supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

UNIT - V IT AND EMERGING CONCEPTS IN SUPPLY CHAIN 9

The role IT in supply chain-The supply chain IT framework - Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain- Introduction to Warehouse Management, Risks in Supply Chain, Lean supply Chains, Sustainable supply Chains.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning, and Operation", Pearson Education, 6th Edition, 2016.
2. Ravi Ravindran A, Donald P. Warsing, Jr, “Supply Chain Engineering: Models and Applications”, CRC Press, 2012.
3. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management”, PHI, 2010.

REFERENCES:

1. Simchi – Levi Davi, Kaminsky Philip "Designing and Managing the Supply Chain Concepts Strategies and Case Studies", McGraw-Hill Education, 3rd Edition, 2017.
2. Erik Hofmann, Nicola Bosia and Urs Magnus Strewe, "Supply Chain Finance and Blockchain Technology -The Case of Reverse Securitisation", Springer International Publishing AG, 2018.
3. Roberta S Russell, Bernard W Taylor III, "Operations and Supply Chain Management", Wiley India, 10th Edition, 2019.
4. Jay Heizer, Barry Render, Chuck Munson, "Operations Management: Sustainability and Supply Chain Management", Pearson, 12th Edition, 2017.
5. Hsiao Fan Wang, Surendra M Gupta, "Green Supply Chain Management: Product Life Cycle Approach", Mc Graw Hill, 2011.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : SUPPLY CHAIN AND LOGISTIC MANAGEMENT		**Course Code : 20ME7A6**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C404E6.1	Describe the role and drivers of and supply chain management in achieving competitiveness.	I	K3	1,2,3,11	1, 2, 3
C404E6.2	Explain about Supply Chain Network Design.	II	K3	1,2,3,8,11	1, 2, 3
C404E6.3	Illustrate about the issues related to Logistics in Supply Chain.	III	K3	1,2,3,4,5,11 ,12	1, 2, 3
C404E6.4	Appraise about Sourcing and Coordination in Supply Chain.	IV	K3	1,2,3,4,5,7, 11	1, 2, 3
C404E6.5	Explain about the application of Information Technology and Emerging Concepts in Supply Chain.	V	K2	1,2,3,4,5,11 ,12	1, 2, 3
C404E6.6	Describe about warehouse management.	V	K2	1,2,3,5,11,1 2	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C404E6.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C404E6.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C404E6.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C404E6.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C404E6.5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
C404E6.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20ME7A7 MAINTENANCE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the principles, functions of maintenance activities
- To understand the practices adapted in industry for the successful management of maintenance activities.
- To explain the different maintenance categories like Preventive maintenance, condition monitoring.
- To know about the repair methods of machine elements and material handling equipment.
- To illustrate some of the simple instruments used for condition monitoring in industry.

PREREQUISITE: NIL

UNIT - I PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING 9

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

UNIT – II MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE 9

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

UNIT – III CONDITION MONITORING 9

Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

UNIT – IV REPAIR METHODS FOR BASIC MACHINE ELEMENTS 9

Repair methods for beds, slide ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT - V REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT 9

Repair methods for Material handling equipment - Equipment records –Job order systems - Use of computers in maintenance.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Srivastava S.K., “Industrial Maintenance Management”, S. Chand and Co., 2002
2. Venkataraman .K “Maintenance Engineering and Management”, PHI Learning, Pvt. Ltd., 4th Edition, 2010.
3. Bhattacharya S.N., “Installation, Servicing and Maintenance”, S. Chand and Co., 2013.

REFERENCES:

1. Mishra R C and Pathak K., “Maintenance Engineering and Management”, PHI, 2nd Edition, 2012.
2. Andrew K.S. Jardine, Albert H.C. Tsang, “Maintenance, Replacement and Reliability” Taylor and Francis, 2006
3. Bikas Badhury,Basu. S.K., “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2003.
4. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 2000.
5. Davies, “Handbook of Condition Monitoring”, Chapman & Hall, 1996.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : MAINTENANCE ENGINEERING		**Course Code : 20ME7A7**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C404E7.1	Explain the principles, functions of maintenance activities.	I	K3	1,2,3,11	1, 2, 3
C404E7.2	Describe the different maintenance categories.	II	K3	1,2,3,8,11	1, 2, 3
C404E7.3	Describe the principles and methods of lubrication.	II	K3	1,2,3,4,5, 11,12	1, 2, 3
C404E7.4	Explain about condition monitoring and instruments used in industry.	III	K3	1,2,3,4,5,7, 11	1, 2, 3
C404E7.5	Describe the repair methods used for basic machine elements like bed, slide ways.	IV	K3	1,2,3,5,11,1 2	1, 2, 3
C404E7.6	Describe the repair methods used for material handling equipment.	V	K3	1,2,3,5,11,1 2	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C404E7.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C404E7.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C404E7.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C404E7.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C404E7.5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
C404E7.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

SEMESTER VII ELECTIVE III

20ME7B1	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study about the history, concepts and terminology in PLM
- To apply different modules offered in commercial PLM/PDM tools.
- To understand the functions and features of PLM/PDM
- To develop the techniques of PLM/PDM approaches for industrial applications.
- To use PLM/PDM with legacy data bases, CAx & ERP systems.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT – II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT – III DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools – Team center, Windchill, ENOVIA, Aras PLM, SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault.

UNIT – IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

UNIT - V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL : 45 PERIODS

TEXT BOOKS:

1. AnttiSaaksvuori and AnselmiImmonen, “Product Lifecycle Management”, Springer Publisher, 2008.
2. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
3. IvicaCrnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.

REFERENCES:

1. ArieKarniel and Yoram Reich, Managing the Dynamics of New Product Development Processes: A New Product Lifecycle Management Paradigm, Springer, 2011.
2. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
3. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011.
4.Kevin Roebuck, Product Lifecycle Management (PLM): High-impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors, Emereo, 2011.
5.Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PRODUCT LIFE CYCLE MANAGEMENT		**Course Code : 20ME7B1**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C405E1.1	Explain the history, concepts and terminology of PLM	I	K2	1, 2, 3	1, 2, 3
C405E1.1	Describe the functions of PLM/PDM	II	K2	1, 2, 3	1, 2, 3
C405E1.1	Explain the features of PLM/ PDM	III	K2	1, 2, 3	1, 2, 3
C405E1.1	Classify the different modules offered in commercial PLM/PDM tools.	IV	K2	1, 2, 3	1, 2, 3
C405E1.1	Predict PLM/PDM approach techniques for industrial applications.	IV	K2	1, 2, 3	1, 2, 3
C405E1.1	Explain PLM/PDM with legacy data bases, CAx& ERP systems	V	K2	1, 2, 3	1, 2, 3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C405E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E1.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
C405E1.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
C405E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20ME7B2 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

L	T	P	C
3	0	0	3

Use of P S G Design Data Book is permitted.

OBJECTIVES

- To provide knowledge about locating and clamping devices.
- To provide knowledge about functions and design principles of Jigs.
- To provide knowledge about functions and design principles of fixtures
- To provide knowledge about functions and design principles of press tools.
- To provide knowledge about the development of required views of the final design of jigs and fixtures.

PREREQUISITE:

Course Code: 20ME303
Course Name: Manufacturing Processes

UNIT - I LOCATING AND CLAMPING PRINCIPLES 9

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

UNIT – II JIGS AND FIXTURES 9

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

UNIT – III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES 9

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

UNIT – IV BENDING AND DRAWING DIES 9

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

UNIT - V FORMING TECHNIQUES AND EVALUATION 9

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

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Joshi, P.H. “Jigs and Fixtures”, Tata McGraw Hill Publishing Co., 2nd Edition, 2010.
2. Joshi P.H “Press tools – Design and Construction”, wheels publishing, 1996.
3. Venkataraman. K., “Design of Jigs Fixtures and Press Tools”, Tata McGraw Hill, New Delhi, 2005.

REFERENCES:

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold “Tool Design”, Tata McGraw Hill, 5th Edition, 2017.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
5. Kempster, “Jigs and Fixture Design”, Hoddes and Stoughton, 3rd Edition, 1974.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DESIGN OF JIGS, FIXTURES AND PRESS TOOLS		**Course Code : 20ME7B2**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C405E2.1	Summarize the different methods of Locating Jigs and Fixtures and Clamping principles	I	K2	1, 2, 3	1, 2, 3
C405E2.1	Design and develop jigs and fixtures for given component	I	K3	1, 2, 3	1, 2, 3
C405E2.1	Discuss the press working terminologies and elements of cutting dies	II	K2	1, 2, 3	1, 2, 3
C405E2.1	Distinguish between Bending and Drawing dies.	III	K2	1, 2, 3	1, 2, 3
C405E2.1	Discuss the different types of forming techniques	IV	K2	1, 2, 3	1, 2, 3
C405E2.1	Summarize the different methods of Locating Jigs and Fixtures and Clamping principles	V	K3	1, 2, 3	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C405E2.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E2.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
C405E2.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E2.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E2.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E2.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1

20ME7B3	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand about work study concepts.
- To link design and manufacturing.
- To determine the process and sequence of operations to obtain a useful final product.
- To introduce the process planning concepts to make cost estimation for various products after process planning.
- To forecast the expenses and prepare a budget for producing various products.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO WORK STUDY AND PROCESS PLANNING 9

Introduction - Method study – Basic Procedure – Tools and Techniques – Work Measurements – Stop Watch Time study - Methods of process planning - Drawing interpretation - Material evaluation – Steps in process selection - Production equipment and tooling selection.

UNIT – II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixtures Selection of quality assurance methods - Set of documents for process planning-Economics of process planning - case studies

UNIT – III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation – Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost.

UNIT – IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

UNIT - V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Butterworth-Heinemann, 2003.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.
3. M. Adithan, “Process Planning and Cost Estimation”, New Age International (P) Limited, 2015.

REFERENCES:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", Prentice Hall India, 6th Edition, 2011.
2. Ostwalal P.F. and Munoz J., "Manufacturing Processes and systems", John Wiley, 9th Edition, 2008.
3. Russell R.S and Tailor B.W, "Operations Management", Prentice Hall India, 7th Edition, 2010.
4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson, 5th Edition, 2019.
5. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers, 2002.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PROCESS PLANNING AND COST ESTIMATION													**Course Code : 20ME7B3**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
C405E3.1	Explain about method study procedure & its techniques and work measurement.												I	K2	1,2,8,10	,2,3
C405E3.2	Select material, process, production equipment, tooling and process parameters for the given product.												I	K3	1,2,3,8,10	1,2,3
C405E3.3	Prepare a process planning sheet from a design drawing considering various production and design parameters.												II	K3	1,2,3,8,10	1,2,3
C405E3.4	Apply the step by step procedure for estimating the cost of any product.												III	K3	1,2,3,8,10	1,2,3
C405E3.5	Express the different elements of cost of a product and compute the total cost of a given product.												IV	K3	1,2,3,8,10	1,2,3
C405E3.6	Calculate machining time for different lathe operations, drilling, boring, milling, shaping, planning and grinding												V	K3	1,2,3,8,9,10	1,2,3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
C405E3.1	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1	
C405E3.2	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
C405E3.3	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
C405E3.4	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
C405E3.5	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
C405E3.6	3	2	1	-	-	-	-	1	2	1	-	-	2	1	1	

20ME7B4	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide an overview of Power Plants.
- To understand the operation and maintenance of coal based thermal power plants.
- To understand different types of Gas Turbine power plants.
- To understand different types of renewable energy power plants
- To analyze and solve energy and economic related issues in power sectors.

PREREQUISITE:

Course Code: 20ME304, 20ME403

Course Name: Engineering Thermodynamics, Thermal Engineering

UNIT - I COAL BASED THERMAL POWER PLANTS 9

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

UNIT – II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT – III NUCLEAR POWER PLANTS 9

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

UNIT – IV POWER FROM RENEWABLE ENERGY 9

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

UNIT - V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 4th Edition 2018.
2. A.K. Raja, Amit Prakash Srivastava, Manish Dwivedi. Power Plant Engineering, New Age International (P) Ltd., Publishers, 2019.
3. Bedalov, Zark, “Practical power plant engineering : a guide for early career engineers” Wiley, 2020.

REFERENCES:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Black & Veatch, Springer, "Power Plant Engineering", 2021.
3.Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Standard Handbook of McGraw – Hill, 2nd Edition, 2021.
4. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2019.
5. R. K. Hedge, Power Plant Engineering, Pearson Education, 2020.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : POWER PLANT ENGINEERING		**Course Code : 20ME7B4**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C405E4.1	Calculate the efficiency of Rankine cycle.	I	K3	1, 2, 3	1, 2, 3
C405E4.2	Explain the functioning of combined power plants.	II	K2	1, 2, 3	1, 2, 3
C405E4.3	Calculate the efficiency of Various types of gas power cycles	II	K3	1, 2, 3	1, 2, 3
C405E4.4	Explain the working of various types of nuclear power plant	III	K2	1, 2, 3	1, 2, 3
C405E4.5	Explain the working principle of various renewable energy power plants.	IV	K2	1, 2, 3	1, 2, 3
C405E4.6	Explain the different tariff procedures for energy consumption	V	K2	1, 2, 3, 11	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C405E4.1	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
C405E4.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
C405E4.3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
C405E4.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
C405E4.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
C405E4.6	2	1	1	-	-	-	-	-	-	-	1	-	2	2	1

20ME7B5	ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To explain basics of Energy scenario.
- To explain basics of Investment and Financial analysis techniques.
- To explain basics of energy management and audit.
- To explain basics of thermal systems energy efficiency.
- To know in depth of Clean Development Mechanism.

PREREQUISITE:

Course Code: 20ME304, 20HS401

Course Name: Engineering Thermodynamics, Environmental Science and Engineering

UNIT - I ENERGY SCENARIO 9

Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future.

UNIT – II FINANCIAL MANAGEMENT, ENERGY MONITORING AND TARGETING 9

Investment-need, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs).

UNIT – III ENERGY MANAGEMENT & AUDIT 9

Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering.

UNIT – IV ENERGY EFFICIENCY IN THERMAL UTILITIES AND SYSTEMS 9

Boilers: Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Soot blowing and soot deposit reduction, reasons for boiler tube failures, start up, shut down and preservation.

Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery. Forging furnace heat balance, Cupola, non-ferrous melting, Induction furnace, performance evaluation of a furnace.

Waste Heat Recovery: Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential.

UNIT - V ENERGY AND ENVIRONMENT, AIR POLLUTION, CLIMATE CHANGE 9

United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF).

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Amlan Chakrabarti, “Energy Engineering and Management” Prentice Hall India Pvt., Limited, 2019
2. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press, 2016.
3. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press, 2020.

REFERENCES:

1. Rai G. D., Non-conventional Energy Sources, Khanna Publishers, 2016.
2. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Inter science publication,2015.
3. Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation edited by E J Wilson and D Gerard, Blackwell Publishing,2014.
4. Heating and Cooling of Buildings - Design for Efficiency, J. Krieder and A. Rabl, McGraw Hill Publication, 2016.
5. Bureau of Energy Efficiency Reference book: No.1, 2, 3, 4, 2015

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : ENERGY CONSERVATION AND MANAGEMENT		**Course Code : 20ME7B5**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C405E5.1	Summarize the energy conservation scenario, energy and environment, air pollution, climate change, and various acts and policy for the energy conservation	I	K2	1, 2, 3, 4	1, 2, 3
C405E5.2	Infer the concept of financial management, energy monitoring and targeting	II	K2	1, 2, 3, 4, 11, 12	1, 2, 3
C405E5.3	Explain energy audit for the energy management and operation of energy audit instruments.	III	K2	1, 2, 3, 4, 12	1, 2, 3
C405E5.4	Determine energy efficiency in various thermal utilities and systems	IV	K3	1, 2, 3	1, 2, 3
C405E5.5	Explain working of waste hear recovery systems	IV	K2	1, 2, 3	1, 2, 3
C405E5.6	Summarize the Convention on Climate Change and Clean Development Mechanism	V	K2	1, 2, 3, 7, 12	1, 2, 3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C405E5.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E5.2	2	1	1	-	-	-	-	-	-	-	1	1	2	1	1
C405E5.3	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1
C405E5.4	3	2	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E5.5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C405E5.6	2	1	1	-	-	-	1	-	-	-	-	1	2	1	1

20ME7B6 **INDUSTRIAL ROBOTICS**

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the functions of the basic components and coordinate system of a Robot.
- To understand the working principle of various robot drive system.
- To study the use of various types of Sensors and End Effectors.
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot implementation and safety issues.

PREREQUISITE:

Course Code: 20GE203

Course Name: Basic Electrical, Electronics and Instrumentation Engineering

UNIT - I FUNDAMENTALS OF ROBOT AND ROBOT DRIVE SYTEMS 9

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope, Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load-Robot Parts and their Functions-Need for Robots-Different Applications.

Robot Drive Systems - Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives.

UNIT – II SENSORS AND END EFFECTORS 9

Requirements of a sensor, Principles and Applications of the following types of sensors-Pneumatic Position Sensors, Range Sensors, Triangulations Principles, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors.

End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT – III MACHINE VISION 9

Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Serving and Navigation.

UNIT – IV ROBOT KINEMATICS 9

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems.

UNIT - V ROBOT PROGRAMMING AND IMPLEMENTATION 9

Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs. RGV, AGV; Implementation of Robots in Industries - Various Steps; Safety Considerations for Robot Operations.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2010.
2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2017.
3. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2009.

REFERENCES:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 3rd Edition 2014.
2. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.
3. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
4. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
5. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2nd Edition, 2014.
6. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd., 1993.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name: INDUSTRIAL ROBOTICS													**Course Code: 20ME7B6**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
C405E6.1	Explain about the robot parts, specifications, coordinates and robot drive system.												1	K2	1,2	1,2,3
C405E6.2	Discuss the working principle of robot sensors and types of end effectors.												2	K2	1,2	1,2,3
C405E6.3	Explain the Image processing techniques to analyze the real images.												3	K2	1,2,3,4,5	1,2,3
C405E6.4	Explain the forward and reverse kinematics of manipulators with two, three and four degrees of freedom.												4	K2	1,2,3,4,5	1,2,3
C405E6.5	Discuss the commands to control the motion of sensor and end effectors in robot programming languages.												5	K2	1,2,3,4,5	1,2,3
C405E6.6	Describe the steps for implementation of robots in industries and safety considerations for robot operations.												5	K2	1,2,3,4	1,2,3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
C405E6.1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	1	
C405E6.2	2	1	-	-	-	-	-	-	-	-	-	-	2	1	1	
C405E6.3	2	2	2	1	2	-	-	-	-	-	-	-	2	1	1	
C405E6.4	2	2	1	2	1	-	-	-	-	-	-	-	2	1	1	
C405E6.5	2	2	1	1	2	-	-	-	-	-	-	-	2	1	1	
C405E6.6	2	2	1	1	-	-	-	-	-	-	-	-	2	1	1	
C405E6.1	2	2	1	1	1	-	-	-	-	-	-	-	2	1	1	

20ME7B7 ENGINEERING ECONOMICS AND COST ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES

- To gain knowledge about the fundamental economic concepts applicable to engineering.
- To learn the time value of money and calculation of interest.
- To understand the various methods of comparison of alternatives.
- To gain knowledge in replacement policies.
- To understand the importance of cost analysis in economic decision making.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Law of supply and demand, Engineering efficiency, Economic efficiency, Scope of engineering economics. Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Material selection for product Design, Process planning.

UNIT – II VALUE ENGINEERING 9

Reasons for interest, simple interest, compound interest, time-value equivalence, compound interest factors, nominal and effective interest rates, use of interest tables, continuous compounding, calculation of time-value equivalents for single and multiple-payment cash flows involving uniform continuous payment and uniform gradient.

UNIT – III CASH FLOW 9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method

UNIT – IV REPLACEMENT ANALYSIS 9

Items deteriorating with time and items that fail completely, replacement with and without time value of money, replacement policy for new and old machines with infinite horizon, group replacement.

UNIT - V COST ANALYSIS 9

Cost concepts, Determinants of cost, Short-run cost-output Relationship, Long-run cost output relationship, Economies and Diseconomies of scale and Estimating cost-Output Relationship.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. James L Riggs, David D Bedworth, Sabah U Randhawa , "Engineering Economics", Tata McGraw Hill, 4th Edition, 2017.
2. Prasanna Chandra, "Projects Planning and Analysis", Tata McGraw Hill, 9th Edition, 2009.
3. Chan S Park, "Contemporary Engineering Economics", Pearson, 6th Edition, 2015.

REFERENCES:

1. Leland Blank, Anthony Tarquin, "Engineering Economy", Tata McGraw Hill, 7th Edition, 2013.
2. William G Sullivan, Elin M Wicks, Patrick Koelling C, "Engineering Economy", Pearson, 14th Edition, 2011.
3. Gerald Thuesen J, Fabrycky W J, "Engineering Economy", Prentice Hall, 9th Edition, 2002.
4. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, 2001.
5. Zahid A khan, "Engineering Economy", Pearson, 2012

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : ENGINEERING ECONOMICS AND COST ANALYSIS		Course Code : 20ME7B7			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C405E7.1	Determine the break-even point for a given production system.	I	K3	1,2,3,11	1, 2, 3
C405E7.2	Compute time value equivalent for various cash flow.	II	K3	1,2,3,8,11	1, 2, 3
C405E7.3	Describe various methods of comparison of alternatives.	III	K3	1,2,3,4,5,11,12	1, 2, 3
C405E7.4	Choose a suitable replacement policy for items deteriorating with time.	IV	K3	1,2,3,4,5,7,11	1, 2, 3
C405E7.5	Choose a suitable replacement policy for machines with infinite horizon.	IV	K3	1,2,3,5,11,12	1, 2, 3
C405E7.6	Explain various determinants of cost.	V	K3	1,2,3,5,11,12	1, 2, 3

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C405E7.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C405E7.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C405E7.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C405E7.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C405E7.5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
C405E7.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

SEMESTER VIII ELECTIVE IV

20ME8A1	INNOVATION IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know about Design Thinking process.
- To empower with innovative-thinking and a systematic approach to problem-solving.
- To identify opportunity and generate innovative idea.
- To evaluate the idea for problem-solution fit and proceed with effective prototyping.
- To apply design thinking approach with human-centric and sustainable products, services and robust business models.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Seven Concerns, Design Thinking & Collaboration, Challenges to Innovation, Understanding Users, Arriving at Design Insights, Prototyping for User Feedback

UNIT – II CAUSE AND CONTEXT 9

Cause, Crossing the First Pitfall, Trial and Error, User Feedback for Development, New users, new needs to meet, Knowing the Context.

Context, The Basic Need, Ingenious Attempts, Further Insights, Working Rig, Concepts generation, Experiencing the Product, Refinements

UNIT – III COMPREHENSION AND CHECK 9

Comprehension, Understanding Constraints, Positioning the Product, Exploring Possibilities, More Experiments, Understanding the Technology, At the 2nd Valley of Death, Finishing Touch

Check, Cause, Product, Users and the Context, Prototyping, User needs, Crucial Step Missed

UNIT – IV CRAFTING 9

Crafting, Recap, Manufacturing Challenge, User Feedback, Iterative Process.

UNIT - V CONNECTION 9

Connection, Seed for Innovation, Pinnacle for Innovation, Connection - Part B, Innovation Timeline, Innovation Champions, Innovation Domains, Connection - Part C, Innovation Templates, Serial Innovation

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Robert Curedale, Design Thinking Process & Methods 5th Edition, Design Community College Incorporated, 2019
2. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook - Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, Wiley, 2018
3. Stephen Wunker, Jessica Wattman and David Farber, Jobs to Be Done: A Roadmap for Customer-Centered Innovation, AMACOM, 2016

REFERENCES:

1. Michael G. Luchs, Scott Swan, Abbie Griffin, Design Thinking: New Product Development Essentials from the PDMA, Wiley, 2015
2. Alexander Osterwalder, Yves Pigneur, Patricia Papadakos, Gregory Bernarda, Value Proposition Design: How to Create Products and Services Customers Want, Wiley, 2014
3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Bloomsbury Publishing India Private Limited, 2011
4. Jeanne Liedtka and Tim Ogilvie, Designing for Growth: A Design Thinking Tool Kit for Managers, Columbia University Press, 2011
5. Roger Martin, The Design of Business: Why Design Thinking Is the Next Competitive Advantage, Harvard Business Review Press, 2009

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : INNOVATION IN DESIGN		**Course Code : 20ME8A1**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C406E1.1	Explain seven concerns in design thinking.	I	K2	1, 2, 3	1, 2, 3
C406E1.1	Describe new needs to context with example.	II	K3	1, 2, 3	1, 2, 3
C406E1.1	Describe the constraints and technologies for comprehension.	III	K2	1, 2, 3	1, 2, 3
C406E1.1	Identify the crucial steps missed in check	IV	K3	1, 2, 3	1, 2, 3
C406E1.1	Identify the manufacturing challenges in crafting.	V	K3	1, 2, 3	1, 2, 3
C406E1.1	Explain the innovation domains.	V	K2	1, 2, 3	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C406E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C406E1.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
C406E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C406E1.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
C406E1.1	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
C406E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20ME8A2	UNCONVENTIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications and apply the knowledge to remove material by mechanical energy processes.
- To gain knowledge about Thermal and Electrical energy based processes.
- To apply knowledge in Chemical and Electro-chemical energy based processes.
- To know various nono abrasives based unconventional machining processes.
- To gain knowledge about recent trends in non-traditional machining processes.

PREREQUISITE: NIL

UNIT - I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Introduction – Need for non-traditional machining methods - Classification of modern machining processes – considerations in process selection. Materials. Applications and material removal phenomena - Brief overview - merits and demerits.

Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining (AJM, WJM, AWJM and USM). Working principles – equipment used – Process parameters – MRR – Applications and numerical problems

UNIT – II THERMAL AND ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle – equipments – Process Parameters – Surface Finish and MRR – electrode / Tool – Power and control circuits – Tool wear – Dielectric – Flushing – Applications. problems. Laser Beam machining and drilling. (LBM), plasma arc machining (PAM) and Electron Beam Machining (EBM), Principles – Equipment –Types – Beam control techniques – Applications and numerical problems.

UNIT – III CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining and Electro-Chemical machining (CHM and ECM) – Etchants – Maskant – techniques of applying maskants – Process Parameters – Surface finish and MRR –Applications. Principles of ECM – equipments – Surface Roughness and MRR Electrical circuit – Process Parameters – ECG and ECH –Anode shape prediction and tool design for ECM processes Applications and numerical problems.

UNIT – IV ADVANCED NANO FINISHING PROCESSES 9

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheloogical abrasive flow finishing and their working principles, equipments – effect of process parameters, applications, advantages and limitations.

UNIT - V RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES 9

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations, Comparison of non-traditional machining processes.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Vijay.K.Jain"Advanced Machining Processes" Allied Publishers Pvt.Ltd., 1st Edition 2013
2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill,1st Edition 2013
3. Benedict. G.F." Nontraditional Manufacturing Processes", Marcel Dekkerr Inc., 1987

REFERENCES:

1. J. A. Mcgeough, “Advanced Methods of Machining”, Springer, 2011.
2. Paul De Gamo, J.T.Black, and Ronald, A.Kohser, “Material and Processes in Manufacturing” Prentice Hall of India Pvt. Ltd., 8th Edition, New Delhi, 2001.
3. Bhattacherya A, “New Technology”, The Institute for Engineers, 1st Edition, 2000.
4. C. Elanchezhian, B. Vijaya Ramnath, M. Vijayan, “Unconventional Machining processes”, Anuradha Publication, 1st Edition, 2005.
5. M. K. Singh, “Unconventional Machining processes”, New Age International Publishers, 1st Edition, 2010.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : UNCONVENTIONAL MACHINING PROCESSES											**Course Code : 20ME8A2**				
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**		**PSO**
C408E2.1	Explain the need for unconventional machining processes and its classification.										I	K2	1,2,8,10		1,3
C408E2.2	Explain various mechanical energy based unconventional machining processes.										I	K2	1,2,8,10		1,3
C408E2.3	Compare various thermal energy and electrical energy based unconventional machining processes.										II	K2	1,2,8,9,10		1,3
C408E2.4	Summarize various chemical and electro-chemical energy based unconventional machining processes.										III	K2	1,2,8,10		1,3
C408E2.5	Explain various nono abrasives based unconventional machining processes.										IV	K2	1,2,8,10		1,3
C408E2.6	Distinguish various recent trends based unconventional machining processes**.**										V	K2	1,2,8,10		1,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C408E2.1	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
C408E2.2	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
C408E2.3	2	1	-	-	-	-	-	1	2	1	-	-	2	-	1
C408E2.4	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
C408E2.5	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
C408E2.6	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1

20ME8A3	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the various components and functions of production planning and control
- To gain knowledge about method study, motion study and work study,
- To understand the product planning, process planning, production scheduling, Inventory Control.
- To know the recent trends like manufacturing requirement Planning (MRP II)
- To gain knowledge in Enterprise Resource Planning (ERP).

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Production planning and control – Objectives, benefits, Functions. Types of production, Product development and design - Marketing, Functional, Operational, Durability and dependability, aesthetic aspect. Profit consideration- Standardization, Simplification & specialization

UNIT – II WORK STUDY 9

Method study, basic procedure, Selection, Recording of process, Micro motion and memo motion study, work measurement techniques, Time study, Work sampling, Synthesis from standard data, Predetermined motion time standards.

UNIT – III PRODUCT PLANNING AND PROCESS PLANNING 9

Value analysis, Problems in lack of product planning, Process planning and routing-Prerequisites, Steps in process planning, Quantity determination in batch production-Machine capacity, balancing, Analysis of process capabilities in a multi-product system.

UNIT – IV PRODUCTION SCHEDULING 9

Master Scheduling, Scheduling rules, Gantt charts, Basic scheduling problems, Line of balance, Flow and batch production scheduling, Product sequencing, Production Control systems-Periodic batch control, Material requirement planning, kanban. Manufacturing lead time, Techniques for aligning completion times and due dates.

UNIT - V RECENT TRENDS IN PPC 9

Introduction to computer integrated production planning systems, elements of JUST IN TIME SYSTEMS, Fundamentals of MRP II and ERP.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Martand Telsang, “Industrial Engineering and Production Management”, S. Chand and Company, Reprint, 2006.
2. James.B.Dilworth, “Operations management – Design, Planning and Control for manufacturing and services” Mc Graw Hill International edition, 1992.
3. Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corporation,2015

REFERENCES:

1. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, John Wiley and Sons, 8th Edition, 2000.
2. Kanishka Bedi, “Production and Operations management”, Oxford university press, 3rd Edition, 2013.
3. Melynk, Denzler, “Operations management – A value driven approach” Irwin Mcgraw hill, 1995.
4. Norman Gaither, G. Frazier, “Operations Management”, Thomson learning IE, 9th edition, 2007
5. Jain. K.C & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers, 8th Edition, 1999.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PRODUCTION PLANNING AND CONTROL		**Course Code : 20ME8A3**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C408E3.1	Explain various aspects of product development.	I	K3	1,2,3,11	1, 2,3
C408E3.2	Describe work sampling techniques.	II	K3	1,2,3,8,11	1, 2,3
C408E3.3	Determine the quantity in batch production system.	III	K3	1,2,3,4,5,11, 12	1, 2,3
C408E3.4	Explain scheduling rules	IV	K3	1,2,3,4,5,7,11	1, 2,3
C408E3.5	Determine manufacturing lead time for the given production system.	IV	K3	1,2,3,5,11,12	1, 2,3
C408E3.6	Explain MRP and ERP.	V	K3	1,2,3,5,11,12	1, 2,3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C408E3.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C408E3.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C408E3.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C408E3.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C408E3.5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
C408E3.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20ME8A4	BATTERY TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the working principle of automotive batteries.
- To gain knowledge in energy storage systems.
- To understand about the battery performance
- To understand the battery management system
- To understand the requirement of batteries for automotive applications

PREREQUISITE:NIL

UNIT - I INTRODUCTION TO BATTERIES 9

Classification of batteries, Automotive Batteries - Principle, construction and working of lead acid battery, advanced lead-acid batteries horizontal plate Pb-acid batteries for transportation, cylindrical Pb-acid battery vs. flat plate system, maintenance free batteries.

UNIT – II ENERGY STORAGE SYSTEMS 9

Advanced Li-ion batteries - principle of operation, battery components and design, electrode, cell and battery fabrications, Li-polymer batteries and applications, Li-S battery, Li-Air battery, Sodium battery, Magnesium battery, Aluminum battery, Advanced Ni-MH batteries for transportation, future prospects of Ni-MH batteries, super capacitors

UNIT – III BATTERY TESTING AND EVALUATION 9

Battery performance evaluation- Primary battery - Service time- Voltage data- Service life – ohmic load curve- Effect of operating temperature on service life. Secondary batteries- Discharge curves-Terminal voltages- Plateau voltage, Maintenance of batteries.

UNIT – IV BATTERY PACK AND BATTERY MANAGEMENT SYSTEM 9

Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests.

UNIT - V BATTERIES FOR AUTOMOTIVES – FUTURE PROSPECTS 9

Degrees of vehicle electrification – Battery size vs. application -USABC and DOE targets for vehicular energy storage systems – Analysis and Simulation of batteries - Equivalent circuit and life modeling – Environmental concerns in battery production – Disposal and recycling of batteries

TOTAL : 45 PERIODS

TEXT BOOKS:

1. David Linden, Thomas Reddy, Hand book of batteries, MC Graw Hill Professional, Third Edition 2002
2. T.Minami, M.Tatsumisago,M.Wakihara,C. Iwakura,S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009
3. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.

REFERENCES:

1. Masataka Wakihara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance,Wiley–VCH, Verlag GmbH, 2008.
2. Robert A.Huggins, Advanced Batteries – Materials science aspects,Springer, 2009.
3. Ibrahim Dinçer, Halil S. Hamut and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems”, JohnWiley& Sons Ltd., 2016.
4. Albert N. Link, Alan C. O’ Connor and Troy J. Scot, Battery technology for Electric vehicles, Routledge,2015
5. G.Pistoia, J.P. Wiaux, S.P. Wolksy, Used Battery Collection and Recycling, Elsevier, 2001

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : BATTERY TECHNOLOGY													**Course Code : 20ME8A4**		
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
C408E4.1	Describe the construction and working of lead acid batteries.												I	K2	1, 2, 3, 4, 6, 7	1, 2, 3
C408E4.2	Explain the construction and working of lithium ion batteries.												II	K2	1, 2, 3, 4, 6, 7	1, 2, 3
C408E4.3	Discuss about the testing of batteries.												III	K2	1, 2, 3, 4, 6, 7	1, 2, 3
C408E4.4	Explain the battery pack system.												IV	K2	1, 2, 3, 4, 6, 7	1, 2, 3
C408E4.5	Discuss about the battery management system.												IV	K2	1, 2, 3, 4, 6, 7	1, 2, 3
C408E4.6	Discuss the environmental aspects, energy consumption, reuse and recycling of batteries.												V	K2	1, 2, 3, 4, 6, 7, 12	1, 2, 3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
C408E4.1	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
C408E4.2	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
C408E4.3	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
C408E4.4	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
C408E4.5	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
C408E4.6	2	1	1	1	-	1	2	-	-	-	-	1	2	1	1	

20ME8A5	TESTING OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the purpose of testing and its development.
- To understand the different types of Destructive testing methods.
- To study the various Non-Destructive testing methods.
- To study the different material characterization testing techniques and its applications.
- To know the concepts of Thermal and Chemical Testing techniques

PREREQUISITE:

Course Code: 20ME301

Course Name: Strength of Materials

UNIT - I INTRODUCTION TO MATERIALS TESTING 9

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

UNIT – II MECHANICAL TESTING 9

Introduction to mechanical testing, Hardness test – Types and Techniques, Tensile test- Stress-Strain Diagram, Impact test – Types, Principles, Advantages and Limitations, Applications. Bend test, Shear test, Creep test - Principles, Techniques, Methods, Advantages and Limitations, Applications, Fatigue test – S-N Curve

UNIT – III NON DESTRUCTIVE TESTING 9

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT – IV MATERIAL CHARACTERIZATION TESTING 9

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT - V THERMAL AND CHEMICAL TESTING 9

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo-mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
2. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park.
3. Cullity, B. D., “Elements of X-ray diffraction”, Addison-Wesley Company Inc., 3rd Edition, 2000.

REFERENCES:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. P. Field Foster, “The Mechanical Testing of Metals and Alloys” Cousens Press, 7th Edition, 2007.
3. Brandon D.G., “Modern Techniques in Metallography”, Von Nostrand Inc. 1986.
4. A V K Suryanarayana, “Testing of Metallic Materials”, BS Publications, 2018.
5. Vernon John “Testing of Materials”, Macmillan Publisher, 1992

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : TESTING OF MATERIALS										**Course Code : 20ME8A5**				
CO	**Course Outcomes**									**Unit**	**K –CO**	**POs**		**PSO**
C408E5.1	Explain the purpose of testing and its classification.									I	K2	1,2,10		1,3
C408E5.2	Explain different types of testing standards and advantages of testing.									I	K2	1,2,10		1,3
C408E5.3	Explain the working principles of mechanical testing methods									II	K2	1,2,6,8,10		1,3
C408E5.4	Describe the concepts of non-destructive testing and their applications									III	K2	1,2,8,10		1,3
C408E5.5	Explain the working of material characterization testing methods and their applications.									IV	K2	1,2,8,10		1,3
C408E5.6	Explain the concepts of thermal and chemical testing methods.									V	K2	1,2,8,9		1,3
CO-PO Mapping														
CO	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO12**	**PSO1**	**PSO 2**	**PSO 3**
C408E5.1	2	1	-	-	-	-	-	-	-	1	-	-	2	-	1
C408E5.2	2	1	-	-	-	-	-	-	-	1	-	-	2	-	1
C408E5.3	2	1	-	-	-	2	-	1	-	2	-	-	2	-	1
C408E5.4	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
C408E5.5	2	1	-	-	-	-	-	1	-	2	-	-	2	-	1
C408E5.6	2	1	-	-	-	-	-	1	2	-	-	-	2	-	1

20HS6A1	INTELLECTUAL PROPERTY RIGHTS (Common to ECE,EEE, EIE)	L	T	P	C
		3	0	0	3

OBJECTIVES

- To get an adequate knowledge on patent and copyright for their innovative research works.
- To use in their career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations.
- To pave the way to catch up Intellectual Property (IP) as a career option.
    - R & D IP Counsel
    - Government Jobs – Patent Examiner
    - Private Jobs
    - Patent agent and Trademark agent
    - Entrepreneur

UNIT - I OVERVIEW OF INTELLECTUAL PROPERTY 9

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design - Genetic Resources and Traditional Knowledge - Trade Secret - IPR in India: Genesis and development - IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention - 1883, the Berne Convention - 1886, the Universal Copyright Convention - 1952, the WIPO Convention - 1967, the Patent Co-operation Treaty - 1970, the TRIPS Agreement - 1994.

UNIT - II PATENTS 9

Patents - Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), Industrial Application - Non-Patentable Subject Matter - Registration Procedure - Rights and Duties of Patentee - Assignment and license - Restoration of lapsed Patents - Surrender and Revocation of Patents - Infringement - Remedies & Penalties - Patent office and Appellate Board.

UNIT - III COPYRIGHTS 9

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works - cinematograph films and sound recordings - Registration Procedure - Term of protection - Ownership of copyright - Assignment and license of copyright - Infringement - Remedies & Penalties - Related Rights - Distinction between related rights and copyrights.

UNIT - IV TRADEMARKS 9

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.

UNIT - V OTHER FORMS OF IP & REGISTRATION PROCESS 9

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection. Geographical Indication (GI): meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. IPR registration process through government website-modalities and publications. Plant Variety Protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection. Layout Design Protection: meaning – Procedure for registration, effect of registration and term of protection.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. K.V.Nithyananda, “Intellectual Property Rights: Protection and Management”, Cengage Learning India Pvt. Ltd., 2019.
2. P.Neeraj and D.Khusdeep, “Intellectual Property Rights”, PHI Learning Pvt. Ltd., 2014..

REFERENCES:

1. V.K.Ahuja, “Law Relating to Intellectual Property Rights”, Lexis Nexis, Third Edition, 2017.
2. Journal of Intellectual Property Rights (JIPR): NISCAIR
3. Cell for IPR Promotion and Management (http://cipam.gov.in/)
4. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
5. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name: INTELLECTUAL PROPERTY RIGHTS											**Course Code : 20HS6A1**				
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**		**PSO**
C408E6.1	Explain the fundamental aspects of Intellectual property Rights which plays a major role in development and management of innovative projects in industries.										1	K2	1,2,8		1,2
C408E6.2	Describe the patents, patent regime in India and abroad and registration aspects.										2	K2	1,2,8		1,2
C408E6.3	Describe the copyrights and its related rights and registration aspects.										3	K2	1,2,8		1,2
C408E6.4	Explain the trademarks and registration aspects.										4	K2	1,2,8		1,2
C408E6.5	Explain the Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects.										5	K2	1,2,8		1,2
C408E6.6	Analyze the current trends in IPR and Government steps in fostering IPR										5	K3	1,2,3,8		1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C408E6.1	2	1	-	-	-	-	-	1	-	-	-	-	1	1	-
C408E6.2	2	1	-	-	-	-	-	1	-	-	-	-	1	1	-
C408E6.3	2	1	-	-	-	-	-	1	-	-	-	-	1	1	-
C408E6.4	2	1	-	-	-	-	-	1	-	-	-	-	1	1	-
C408E6.5	2	1	-	-	-	-	-	1	-	-	-	-	1	1	-
C408E6.6	2	1	-	-	-	-	-	1	-	-	-	-	1	1	-

SEMESTER VIII ELECTIVE V

20ME8B1 TWO WHEELER AND FOUR WHEELER OVERHAULING	L	T	P	C
	3	0	0	3

OBJECTIVES

- To understand the constructional details operating characteristics and vehicle design aspects.
- To understand the various subsystems of two and four wheeler.
- To develop the skills of the students in the operating principles.
- To understand the knowledge about recent development of two and four wheelers.
- To understand the cooling and lubrication systems.

PREREQUISITE:

Course Code: 20ME403

Course Name: Thermal Engineering

UNIT - I POWER UNIT 9

Two stroke and four stroke SI & CI engine Construction and Working, merits and demerits, Symmetrical and unsymmetrical valve & port timing diagrams. Scavenging process.

UNIT – II FUEL AND IGNITION SYSTEMS 9

Fuel system – Different circuits in two wheeler fuel systems, fuel injection system. Ignition systems - Magneto coil and battery coil spark ignition system, Electronic ignition System, Starting system - Kick starter system – Self-starter system. Recent technologies.

UNIT – III CHASSIS AND SUSPENSION SYSTEMS 9

Main frame for two and four wheelers, its types, Chassis and different drive systems for two wheelers, Single, multiple plates and centrifugal clutches, Gear box and its and various gear controls in two wheelers. Two wheeler suspension systems, Front and rear suspension systems. Shock absorbers. Four wheeler suspension systems, conventional suspension systems, independent suspension systems, leaf spring, coil spring.

UNIT – IV BRAKES AND WHEELS 9

Two wheeler Brake system - Drum brakes & Disc brakes Construction and Working and its Types, Front and Rear brake links layouts for two wheeler. Brake actuation mechanism. Four wheeler brake system – Pneumatic and Hydraulic braking systems, Antilock braking system (ABS), Steering geometry, Construction and working of four wheeler power steering. Spoked wheel, cast wheel, Disc wheel & its merits and demerits. Tyres and tubes Construction & its Types.

UNIT - V COOLING AND LUBRICATIONS SYSTEMS 9

Need for cooling, types of cooling systems, air and liquid cooling systems. Thermo syphon and forced circulation and pressurized cooling systems, properties of coolants, Requirements of lubrication systems, types – mist, pressure feed, dry and wet sump systems, properties of lubricants.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Kirpal singh, “Automobile Engineering”, Vol. 1 & 2, Standard Publishers Distributors, 2020.
2. R. K. Rajput, “A text book of Automobile Engineering”, Laxmi Publications, 2015.
3. Irving, P.E.," Motor cycle Engineering", Temple Press Book, London, 1992.

REFERENCES:

1. K. K. Ramalingam, “Automobile Engineering”, Scitech publication, Chennai, 2014.
2. James E Duffy, “Modern Automotive Technology”, Goodheart-Willcox Pub; Work book edition, 2016.
3. Ganesan V. “Internal Combustion Engines”, Tata McGraw-Hill, 3rd Edition, 2007
4. Roland Brown, The Encyclopedia of Motor cycles, Lorenz Books, 2016.
5. Ramalingam. K. K., "Two Wheelers", Scitech publications, Chennai,2009

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : TWO WHEELER AND FOUR WHEELER OVERHAULING		**Course Code : 20ME8B1**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C409E1.1	Explain two stroke and four stroke SI and CI engines and valve & port timing diagrams.	I	K2	1, 2, 3	1, 2, 3
C409E1.2	Explain the different circuits in two wheeler fuel systems and ignition system.	II	K2	1, 2, 3	1, 2, 3
C409E1.3	Describe the main frame for two and four wheelers, chassis and drive systems for two wheelers.	III	K2	1, 2, 3	1, 2, 3
C409E1.4	Describe the different types of clutches, gear box and suspension systems.	III	K2	1, 2, 3	1, 2, 3
C409E1.5	Describe the different types of brake system for two wheeler and four wheeler, wheels and tyres.	IV	K2	1, 2, 3	1, 2, 3
C409E1.6	Explain the different types of cooling systems and lubrication systems.	V	K2	1, 2, 3	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C409E1.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E1.2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E1.3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E1.4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E1.5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E1.6	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20ME8B2 INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

- To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
- To provide the knowledge of safety in welding and gas cutting.
- To expose the students to the basics of safety in cold and hot working processes.
- To understand the safety in finishing operations and testing of boilers.
- To understand the engineering and administrative controls in safety.

PREREQUISITE: NIL

UNIT - I SAFETY IN METAL WORKING AND WOOD WORKING MACHINES 9

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, safety principles, electrical guards, work area, material handling, inspection.

UNIT – II SAFETY IN WELDING AND GAS CUTTING 9

common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing, explosive welding, safety in generation, distribution and handling of industrial gases, colour coding, leak detection, pipe line safety, storage and handling of gas cylinders.

UNIT – III SAFETY IN COLD FORMING AND HOT WORKING OF METALS 9

Power presses - point of operation safe guarding, auxiliary mechanisms, power press electric controls, inspection and maintenance. Hot working safety in forging, hot rolling, hot bending of pipes, hazards and control measures. Safety in Furnace Operation, Foundry Health Hazards.

UNIT – IV SAFETY IN FINISHING, INSPECTION AND TESTING 9

Safety In Electro Plating, Paint Shops, Sand And Shot Blasting, Safety In Inspection And Testing of Boilers. Safety In Radiography, Personal Monitoring Devices, Radiation Hazards.

UNIT - V INDUSTRIAL SAFETY 9

Advances in Industrial Ergonomics and safety, Work and protective clothing, Industrial Noise and Vibration, Engineering And Administrative Controls.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly, “Accident Prevention Manual” NSC, 14th Edition, 2015.
2. Charles D. Reese, “Occupational Health and Safety Management”, CRC Press, 3rd Edition, 2015.
3. John V. Grimaldi and Rollin H. Simonds “Safety Management” All India Travelers Book seller, 4th Edition, 1989.

REFERENCES:

1. John Davies, Alastair Ross, Brendan Wallace, “Safety Management: A Qualitative Systems Approach”, CRC Press, 2003.
2. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
3. Anil Mital “Advances in Industrial Ergonomics and Safety” Taylor and Francis Ltd, London, 1989.
4. Safety Manual, “EDEL Engineering Consultancy”, 2000.
5. David L.Goetsch, “Occupational Safety and Health for Technologists, Engineers and Managers”, 5th Edition, Pearson Education Ltd., 2005.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : INDUSTRIAL SAFETY ENGINEERING		**Course Code : 20ME8B2**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C409E2.1	Illustrate the importance of safety of employees while working with machineries.	I	K3	1,2,3,11	1, 2, 3
C409E2.2	Illustrate the importance of safety of employees while working with welding and gas cutting processes	II	K3	1,2,3,8,11	1, 2, 3
C409E2.3	Understand the importance of safety principles in hot and cold working of metals	III	K3	1,2,3,4,5,11 ,12	1, 2, 3
C409E2.4	Explain the concept of inspection and testing in boilers	IV	K3	1,2,3,4,5,7, 11	1, 2, 3
C409E2.5	Explain the radiation hazards	IV	K3	1,2,3,5,11,1 2	1, 2, 3
C409E2.6	Describe the hazards caused by industrial noise.	V	K3	1,2,3,5,11,1 2	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C409E2.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C409E2.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C409E2.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C409E2.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C409E2.5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
C409E2.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20ME8B3	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know the basics of gas and arc welding processes.
- To understand the different types of resistance welding processes.
- To study about the various welding parameters influencing the solid state welding processes.
- To study the different special welding processes and its applications.
- To understand the various weld joint designs and weldability of different materials.

PREREQUISITE:

Course Code: 20ME303

Course Name: Manufacturing Processes

UNIT - I CONVENTIONAL WELDING PROCESSES 9

Fundamentals of welding, Gas welding – Principle, types and technique - Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications.

UNIT – II RESISTANCE WELDING PROCESSES 9

Resistance Spot welding – Principle, Features and Process parameters, Seam welding, Projection welding, Resistance Butt welding - Flash and Upset Butt welding, Percussion welding, Stud welding and High frequency resistance welding processes - advantages, limitations and applications.

UNIT – III SOLID STATE WELDING PROCESSES 9

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.

UNIT – IV SPECIAL WELDING PROCESSES 9

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding - Process parameters, Under Water welding – Risks and Classification, Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT - V WELD DESIGN, WELDABILITY AND TESTING 9

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non destructive testing of weldments.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Parmer R.S., “Welding Engineering and Technology”, Khanna Publishers, 2nd Edition, 2013.
2. Khanna O.P, “A Textbook of Welding Technology”, Dhanpat Rai Publishing Co Pvt Ltd, 2011.
3. Davis A.C., “The Science and Practice of Welding”, Cambridge University Press, 10th Edition,1993.

REFERENCES:

1. Schwartz M.M. “Metals Joining Manual”, New York: McGraw Hill, 1979.
2. Tylecote R.F. “The Solid Phase Welding of Metals”. Edward Arnold Publishers Ltd. London, 1968.
3. Annette O'Brien, “Welding Hand Book: Welding Processes”, Volume 2, American Welding Society, 9th Edition, 2004.
4. Nadkarni S.V. “Modern Arc Welding Technology”, Oxford IBH Publishers, 8th Edition, 2008.
5. Christopher Davis. “Laser Welding- Practical Guide”, Jaico Publishing House, 1994.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : WELDING TECHNOLOGY												**Course Code : 20ME8B3**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSO**
C409E3.1	Explain the basics of welding.											I	K2	1,2,10	1,3
C409E3.2	Compare different types of gas and arc welding processes.											I	K2	1,2,10	1,3
C409E3.3	Explain the working principle of resistance welding processes and various process parameters influence on their performance.											II	K2	1,2,10	1,3
C409E3.4	Describe the working of various types of solid state welding processes.											III	K2	1,2,10	1,3
C409E3.5	Explain the working principle of special welding processes and their applications.											IV	K2	1,2,9,12	1,3
C409E3.6	Explain the various welding defects, weldability and testing methods.											V	K2	1,2,10	1,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C409E3.1	2	1	-	-	-	-	-	-	-	3	-	-	2	-	1
C409E3.2	2	1	-	-	-	-	-	-	-	3	-	-	2	-	1
C409E3.3	2	1	-	-	-	-	-	-	-	2	-	-	2	-	1
C409E3.4	2	1	-	-	-	-	-	-	-	2	-	-	2	-	1
C409E3.5	2	1	-	-	-	-	-	-	2	-	-	1	2	-	1
C409E3.6	2	1	-	-	-	-	-	-	-	2	-	-	2	-	1

20ME8B4	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge about composite materials and its applications.
- To provide knowledge about different types of processing techniques of polymer composites.
- To provide knowledge about different types of processing techniques of metal matrix composites.
- To know about the constitutive equations for polymer composites.
- To provide knowledge about bending and buckling analysis of polymer composites

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO COMPOSITES 9

Fundamentals of composites – need for composites – enhancement of properties – classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers

UNIT – II POLYMER MATRIX COMPOSITES 9

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – roving's – woven fabrics – non woven random mats – various types of fibres. PMC processes – hand layup processes – spray up processes – compression moulding – reinforced reaction injection moulding – resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. -applications of PMC in aerospace, automotive industries

UNIT – III METAL MATRIX COMPOSITES 9

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries

UNIT – IV LAMINA CONSTITUTIVE EQUATIONS FOR POLYMER COMPOSITES 9

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness.

UNIT - V ANALYSIS OF LAMINATED FLAT PLATES 9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 1994.
2. Chawla K. K., "Composite materials", 2nd Edition, Springer – Verlag, 1998.
3. Kaw.K., "Mechanics of Composite Materials", 2nd Edition, CRC publication,2005.

REFERENCES:

1. Clyne, T. W. and Withers, P. J., “Introduction to Metal Matrix Composites”, Cambridge University Press, 1993.
2. Strong, A.B., “Fundamentals of Composite Manufacturing”, SME, 1989.
3. Sharma, S.C., “Composite materials”, Narosa Publications, 2000.
4. Broutman, L.J. and Krock,R.M., “ Modern Composite Materials”, Addison-Wesley, 1967.
5. ASM Hand Book, “Composites”, Vol.21, ASM International, 2001

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : COMPOSITE MATERIALS AND MECHANICS		**Course Code : 20ME8B4**			
CO	**Course Outcomes**	**Unit**	**K –CO**	**POs**	**PSO**
C409E4.1	Explain the different types of the composite materials and its applications.	I	K2	1,2,8,10	1,2,3
C409E4.2	Explain the various processing techniques for polymer composites manufacturing.	II	K2	1,2,8,10	1,2,3
C409E4.3	Explain the different types of processing techniques for metal matrix composites manufacturing.	III	K2	1,2,8,9,10	1,2,3
C409E4.4	Determine the stress strain and strain displacement relationship matrix for polymer composites.	IV	K3	1,2,3,8,10	1,2,3
C409E4.5	Determine the buckling, and bending behaviours of polymer composites.	V	K3	1,2,3,8,10	1,2,3
C409E4.6	Determine the natural frequency of polymer composites.	V	K3	1,2,3,8,10	1,2,3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C409E4.1	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
C409E4.2	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
C409E4.3	2	1	-	-	-	-	-	1	2	1	-	-	2	1	1
C409E4.4	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1
C409E4.5	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1
C409E4.6	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1

20ME8B5	ADVANCED INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the underlying principles of operation of different IC Engines and components.
- To compare the operations of different IC Engine and components.
- To understand the various alternative fuels.
- To provide knowledge on pollutant formation, control, alternate fuel etc.
- To provide knowledge on Hybrid Electric Vehicles.

PREREQUISITE:

Course Code: 20ME304

Course Name: Engineering Thermodynamics

UNIT - I SPARK IGNITION ENGINES 9

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

UNIT – II COMPRESSION IGNITION ENGINES 9

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbo charging.

UNIT – III POLLUTANT FORMATION AND CONTROL 9

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

UNIT – IV ALTERNATIVE FUELS 9

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

UNIT - V RECENT TRENDS 9

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – Nox Adsorbers - Onboard Diagnostics.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2018.
2. H.N. Gupta, Fundamentals of Internal Combustion Engines, Prentice-Hall of India Pvt. Ltd, 2020.
3. Ganesan. V, Internal combustion engines, McGraw-Hill Education, 2017.

REFERENCES:

1. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons 2010.
2. Auto fuel and emission control systems : technology, South Holland, Ill. : Goodheart-Willcox ,2018
3. Eric Chowenitz, "Automobile Electronics", SAE Publications, 2019
4, K.A. Subramanian , Bio-fuelled Reciprocating Internal Combustion Engines, CRC Press, 2018
5. S.K.Gupta "A Text book of Automobile Engineering", S Chand and Company Limited 2020.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : ADVANCED INTERNAL COMBUSTION ENGINES		**Course Code : 20ME8B5**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C409E5.1	Explain fuel injection systems in SI engine, types of combustion chamber and combustion process.	I	K2	1, 2, 3	1, 2, 3
C409E5.2	Explain different types of fuel injection system and combustion chambers of CI engine.	I	K2	1, 2, 3	1, 2, 3
C409E5.3	Explain different types of air motion, and Turbo charging of IC Engine.	II	K2	1, 2, 3	1, 2, 3
C409E5.4	Explain the mechanism of pollution formation and the evolution of emission norms.	III	K2	1, 2, 3	1, 2, 3
C409E5.5	Describe the properties of various alternative fuels, engine modification required and emission characteristic of alternative fuels.	IV	K2	1, 2, 3	1, 2, 3
C409E5.6	Discuss various ignition methods used in I.C engine and electronic engine management system	V	K2	1, 2, 3	1, 2, 3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C409E5.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E5.2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E5.3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E5.4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E5.5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
C409E5.6	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20HS7A2	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand TQM concepts.
- To know about TQM principles.
- To understand Six Sigma, Traditional tools, New tools, Benchmarking and FMEA.
- To understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
- To apply QMS and EMS in any organization.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Quality – Need, Evolution, Definitions, Dimensions of product and service quality. TQM - Basic concepts, Framework, Contributions of Deming, Juran and Crosby, Barriers. Quality statements, Customer satisfaction, Customer complaints, Customer retention, Costs of quality.

UNIT – II TQM PRINCIPLES 9

Strategic quality planning, Quality Councils, Employee involvement, Motivation, Empowerment, Teamwork, Quality circles, Recognition and Reward, Performance appraisal, Continuous process improvement - PDCA cycle, 5S, Kaizen, Supplier partnership, Supplier selection, Supplier Rating.

UNIT – III TQM TOOLS AND TECHNIQUES I 9

Traditional tools of quality, New management tools. Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT, Bench marking, Reason to bench mark, Bench marking process, FMEA - Stages, Types.

UNIT – IV TQM TOOLS AND TECHNIQUES II 9

Control Charts, Process Capability, Quality Function Development (QFD), Taguchi quality loss function, TPM - Concepts, improvement needs, Performance measures.

UNIT - V QUALITY SYSTEMS 9

Need for ISO 9000, ISO 9001-2008 Quality System, Elements, Documentation, Quality Auditing, QS 9000 - ISO 14000, Concepts, Requirements and Benefits, TQM Implementation in manufacturing and service sectors.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, 5th Edition, 2018.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", Cengage Learning, 8th Edition, 2012.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2nd Edition, 2006.

REFERENCES:

1. Joel.E. Ross, “Total Quality Management – Text and Cases”, CRC Press, 5th Edition, 2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 1st Edition, 2016.
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2012.
4. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 1st Edition, 2006.
5. Brue G, "Six Sigma for Managers”, Tata-McGraw Hill, 2nd Edition, 2002.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : TOTAL QUALITY MANAGEMENT				**Course Code : 20HS7A2**		
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**	
C409E6.1	Explain basic concepts, TQM framework, Barriers and Benefits of TQM.	I	K3	1,2,3,11	1, 2, 3	
C409E6.2	Explain the TQM Principles for application.	II	K3	1,2,3,8,11	1, 2, 3	
C409E6.3	Define the basics of Six Sigma and Traditional tools, New tools, Benchmarking and FMEA.	III	K3	1,2,3,4,5,11, 12	1, 2, 3	
C409E6.4	Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.	IV	K3	1,2,3,4,5,7,11	1, 2, 3	
C409E6.5	Ilustrate and apply QMS and EMS in any organization.	IV	K3	1,2,3,4,11,12	1, 2, 3	
C409E6.6	Explain the process of implementation of ISO 9000/9001-2008/14000 for given manufacturing, service sector.	V	K3	1,2,3,5,11,12	1, 2, 3	

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C409E6.1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
C409E6.2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
C409E6.3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
C409E6.4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
C409E6.5	3	2	1	-	-	-	-	-	-	-	2	1	2	2	1
C409E6.6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20OE105	SOLAR PHOTOVOLTAIC FUNDAMENTALS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To explain basics of solar photovoltaic.
- To explain basics of PV Systems.
- To explain basics of PV System grid connections.
- To explain basics of Hybrid systems
- To know in depth of its types and design of various PV-interconnected systems

PREREQUISITE: NIL

UNIT - I PHOTOVOLTAIC BASICS 9

Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells – Cell properties and design - PV Cell Interconnection and Module Fabrication – PV Modules and arrays - Basics of Load Estimation.

UNIT – II STAND ALONE PV SYSTEMS 9

Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc.

UNIT – III GRID CONNECTED PV SYSTEMS 9

Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings.

UNIT – IV HYBRID SYSTEMS 9

Solar, Biomass, Wind, Diesel Hybrid systems - Comparison and selection criteria for a given application.

UNIT - V DESIGN OF PV SYSTEMS 9

Radiation and load data - Design of System Components for different PV Applications – Sizing and Reliability - Simple Case Studies

TOTAL : 45 PERIODS

TEXT BOOKS:

1. CS Solanki: Solar Photovotaics – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2015.
2. Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications Prentice- Hall, 2008
3. Nelson, J the Physics of Solar Cells. Imperial College Press, 2017.

REFERENCES:

1. Thomas Markvart, Solar Electricit, John Wiley and Sons, 2015.
2. Stuart R. Wenham, Martin A. Green, Muriel E. Watt, Richard Corkish (Editors), Applied Photovoltaics, Earthscan, 2014.
3. Michael Boxwell, the Solar Electricity Handbook, Code Green Publishing, UK, 2015.
4. Rik DeGunther, Solar Power Your Home for Dummies, Wiley Publishing Inc, 2016.
5. Chetan Singh Solanki, Renewable Energy Technologies; A Practical Guide for Beginners, PHI School Books, 2014.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : SOLAR PHOTOVOLTAIC FUNDAMENTALS AND APPLICATIONS		**Course Code : 20OE105**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
	Summarize the basics of Photovoltaic systems.	I	K2	1, 2, 3	1, 2, 3
	Explain the component of stand- alone photovoltaic systems	II	K2	1, 2, 3	1, 2, 3
	Explain the component of grid connected photovoltaic systems	III	K2	1, 2, 3	1, 2, 3
	Summarize the basics of Hybrid systems.	IV	K2	1, 2, 3	1, 2, 3
	Explain the selection criteria for a given Photovoltaic application.	V	K2	1, 2, 3	1, 2, 3
	Design of various components of solar PV systems.	V	K3	1, 2, 3	1, 2, 3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1

20OE106	FUNDAMENTALS OF PRODUCT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES

- To Understand various global trends and identify the scope of a new product design
- To translate conceptual idea into detailed design
- To understand the concept of new product design.
- To understand various Quality Concepts in product design
- To impart knowledge on various industrial design process

PREREQUISITE: NIL

UNIT - I PRODUCT PLANNING 9

Product Planning Process - Identify Opportunities - Evaluating and Prioritizing Projects - Allocating Resources and Timing - Identifying Customer Needs - Raw Data from Customers - Interpreting Raw Data in Terms of Customer Needs - Organizing the Needs into a Hierarchy - Establishing the Relative Importance of the Needs - Case study for motor driven nailer - Reflecting on the Results and the Process

UNIT – II CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT – III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance –manufacturability – product development management – establishing the architecture – creation –clustering – geometric layout development – fundamental and incidental interactions – related system level design issues.

UNIT – IV QUALITY CONCEPTS 9

Design For Quality - Quality Function Deployment - Design Of Experiments - Failure Modes & Effect Analysis - TQM - Design For Six Sigma - Brain Storming Techniques - Design For Manufacturing - Design Ethics - Safety and Environmental Considerations in Product Design

UNIT - V INDUSTRIAL DESIGN 9

Integrate process design – Managing costs – Robust design – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process– conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Tata McGraw Hill Education, 4th Edition, 2009.
2. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education
3. George E Dieter, Linda C Schmidt, “Engineering Design”, Mc-Graw Hill International Edition, 5th Edition, 2012

REFERENCES:

1. David G.Ullman, “The Mechanical Design Process”, Tata McGraw Hill , 2011
2. Stephen Rosenthal, Effective Product Design and Development, Business One Orwin, 1992,
3. Staurt Pugh, Tool Design -Integrated Methods for Successful Product Engineering, Addison Wesley Publishing, 1991.
4. Chitale A K and Gupta R C, “Product Design and Manufacturing”, PHI 2007.
5. Yousef Haik, T. M. M. Shahin, “Engineering Design Process”, Cengage Learning, 2nd Edition Reprint, 2010.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : FUNDAMENTALS OF PRODUCT DESIGN											**Course Code : 20OE106**				
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**	**PSOs**	
	Explain the basic concepts of product design										I	K3	1,2,3,6, 9,10	1,2,3	
	Describe the basic concepts of concurrent Engineering										I	K3	1,2,3,6, 9,10	1,2,3	
	Generate various concepts for a product design and to select the best concept										II	K3	1,2,3,4, 6,9,10	1,2,3	
	Discuss the concepts and importance of product architecture										III	K3	1,2,3,6, 9,10	1,2,3	
	Apply the quality concepts to develop robust product										IV	K3	1,2,3,6, 9,10	1,2,3	
	Illustrate the importance of industrial design in view of aesthetics factors and ergonomic factors										V	K3	1,2,3,4, 6,9,10	1,2,3	
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1
	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1

20OE107	AUTONOMOUS AND ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To Understand the technologies used in autonomous system
- To understand the perception, prediction and routing of autonomous driving
- To understand the planning and control of autonomous driving
- To understand the architecture of electric vehicle and energy storage device
- To understand the architecture of hybrid electric vehicle

PREREQUISITE: NIL

UNIT - I AUTONOMOUS DRIVING TECHNOLOGIES 9

Autonomous driving Technologies overview- Autonomous driving algorithms-Autonomous driving client system- Autonomous driving cloud platform

UNIT – II PERCEPTION, PREDICTION AND ROUTING 9

Perception in Autonomous Driving – Detection – Segmentation – Stereo, optical flow and scene flow – Tracking. Prediction and Routing – Planning and control – Traffic Prediction-Lane level Routing.

UNIT – III DECISION AND PLANNING 9

Decision, planning and control – Behavioral Decisions – Motion Planning – Feedback control.

UNIT – IV ELECTRIC VEHICLE AND ENERGY STORAGE 9

Basics of Vehicle mechanisms, history of Electric vehicles (EV), Electric vehicle Architecture: Major components of electric vehicle. Energy storage-Battery, fuel cell and ultra capacitor.

UNIT - V HYBRID ELECTRIC VEHICLE 9

Introduction to hybrid electric vehicle, Types- series, parallel and complex configuration-Architecture of hybrid electric vehicle-drive train-sizing of components.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Shaoshan Liu; Liyun Li; Jie Tang; Shuang Wu; Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems”, Morgan & Claypool, 2018.
2. A. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.
3. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, CRC Press, New York, 2003.

REFERENCES:

1. Danil Prokhorov, “Computational Intelligence in Automotive Applications”, Studies in Computational Intelligence book series, Springer, 2008.
2. H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin:Springer, 2011.
3. Andreas Herrmann, Walter Brenner, Rupert Stadler, Autonomous Driving: How the Driverless Revolution will Change the World Emerald Publishing, 2018
4. Michael E. McGrath, Autonomous Vehicles: Opportunities, Strategies, and Disruptions, Amazon, 2018.
5. Tom Denton, Electric and Hybrid Vehicles,1st edition, Routledge Publishers,2017

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : AUTONOMOUS AND ELECTRIC VEHICLE										**Course Code : 20OE107**				
CO	**Course Outcomes**									**Unit**	**K-CO**	**POs**	**PSOs**	
	Discuss the latest technologies in the design of autonomous systems.									I	K2	1, 2, 3, 4, 5, 6, 7	1, 2, 3	
	Explain the perception of autonomous system.									II	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
	Explain the prediction and routing of autonomous system.									II	K2	1., 2, 3, 4, 6, 7	1, 2, 3	
	Explain the planning and control of autonomous driving.									III	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
	Explain the importance of electric vehicle and energy storage system.									IV	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
	Discuss about the hybrid electric vehicles.									V	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
	2	1	1	1	1	1	2	-	-	-	-	-	2	1	1
	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1

20OE108	INDUSTRIAL SAFETY PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on safety engineering fundamentals.
- To gain knowledge on safety management practices.
- To understand about the chemical, fire, mechanical hazards.
- To understand about noise and vibration control.
- To gain knowledge in Factories Act.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT – II CHEMICAL HAZARDS 9

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

UNIT - III ENVIRONMENTAL CONTROL 9

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

UNIT – IV HAZARD ANALYSIS 9

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

UNIT - V SAFETY REGULATIONS 9

Explosions – Disaster management – catastrophe control, hazard control, Factories Act, Safety regulations, Product safety – case studies.

TEXT BOOKS:

1. John V.Grimaldi, “Safety Management”, AITB S Publishers, 2003.
2. David L. Goetsch, “Occupational Safety and Health for Technologists”, Engineers and Managers, Pearson Education Ltd. 5th Edition, 2005.
3. Deshmukh L M, “Industrial Safety Management”, Tata McGraw-Hill Publishing Company Ltd.,2005

REFERENCES:

1. Safety Manual, “EDEL Engineering Consultancy”, 2000.
2. Charles D. Reese, “Occupational Health and Safety Management”, CRC Press, 2003.
3. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly, “Accident Prevention Manual – NSC”, Chicago, 2009.
4. John Davies, Alastair Ross, Brendan Wallace, “Safety Management: A Qualitative Systems Approach”, CRC Press, 2003.
5. Anil Mital, “Advances in Industrial Ergonomics and Safety”, Taylor and Francis Ltd, London, 1989

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : INDUSTRIAL SAFETY PRACTICES												**Course Code : 20OE103**			
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
CO	**Course Outcomes**											I	K3	1,2,3,4,6, 10,12	1,2
	Identify and prevent chemical, environmental mechanical, fire hazard.											II	K3	1,2,3,4,6, 10,12	1,2
	Collect, analyze and interpret the accidents data based on various safety techniques.											III	K3	1,2,3,4,5, 6,10,12	1,2
	Apply proper safety techniques on safety engineering and management.											IV	K3	1,2,3,4,5, 6,10,12	1,2
	Perform hazard analysis.											V	K3	1,2,3,4,5, 6,10,12	1,2
	Design the system with environmental consciousness by implementing safety regulation.											V	K3	1,2,3,4,6, 10,12	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-
	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-
	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-
	3	3	1	1	1	2	-	-	-	1	-	1	2	1	-
	3	3	1	1	1	2	-	-	-	1	-	1	2	1	-
	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-