K.L.N. COLLEGE OF ENGINEERING

Pottapalayam - 630612, 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 in the academic year 2022-2023)

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.

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

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 life-long 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 andtechniques 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 societyneeds in local and global environment.

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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.

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REGULATIONS 2020

For Under Graduate Program

B.E. MECHANICAL 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 departments 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 (MC) Courses** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc

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SEMESTER VII

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	20ME701	Mechatronics	PC	3	3	0	0	3
2		Open Elective – II	OE	3	3	0	0	3
3		Professional Elective – IV	PE	3	3	0	0	3
4		Professional Elective – V	PE	3	3	0	0	3
5		Professional Elective – VI	PE	3	3	0	0	3
PRACTICAL								
6	20ME7L1	Mechatronics Laboratory	PC	4	0	0	4	2
7	20ME7L3	Technical Seminar	EEC	4	0	0	4	2
TOTAL				**23**	**15**	**0**	**8**	**19**

SEMESTER VIII

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	20MC801	Disaster Management	MC	2	2	0	0	-
PRACTICAL								
2	20ME8L1	Project Work	EEC	20	0	0	20	10
TOTAL				**22**	**2**	**0**	**20**	**10**

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Professional Elective Courses – Verticals

Vertical 1	Vertical 2	Vertical 3	Vertical 4	Vertical 5	Vertical 6
Design and Development	**Modern Manufacturing**	**Clean Energy Technologies**	**Robotics and Automation**	**Industrial Engineering**	**Modern Mobility Systems**
Product Design and Development	Unconventional Machining Processes	Compressible Flow and Turbomachinery	Applied Hydraulics and Pneumatics	Statistical Quality and Control	Automobile Engineering
Product Life Cycle Management	Computer Integrated Manufacturing Systems	Power Plant Engineering	Industrial Robotics	Process Planning and Cost Estimation	Advanced Internal Combustion Engines
Design of Jigs, Fixtures and Press Tools	Composite Material and Mechanics	Engine Pollution and Control	Sensors and Actuators	Production Planning and Control	Two wheeler and Four wheeler Overhauling
Piping Design Engineering	Additive Manufacturing	Energy Conservation and Management	Automation in Manufacturing	Supply chain and Logistic management	Battery Technology
Computational Fluid Dynamics	Testing of Materials	Renewable energy sources	Virtual Instrumentation	Engineering Economics and Cost Analysis	Alternative fuels for IC engines
Innovation in design	Digital Manufacturing	Fundamentals of HVAC Systems	Data Analytics for Mechanical Engineering	Maintenance Engineering	Intelligent Transportation systems
		Energy efficient Buildings	Micro Electro Mechanical Systems	Operations Research	

Vertical 1: Design and Development

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20MEV11	Product Design and Development	PE	3	3	0	0	3
2	20MEV21	Product Life Cycle Management	PE	3	3	0	0	3
3	20MEV31	Design of Jigs, Fixtures and Press Tools	PE	3	3	0	0	3
4	20MEV41	Piping Design Engineering	PE	3	3	0	0	3
5	20MEV51	Computational Fluid Dynamics	PE	3	3	0	0	3
6	20MEV61	Innovation in design	PE	3	3	0	0	3

Vertical 2: Modern Manufacturing

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20MEV12	Unconventional Machining Processes	PE	3	3	0	0	3
2	20MEV22	Computer Integrated Manufacturing Systems	PE	3	3	0	0	3
3	20MEV32	Composite Material and Mechanics	PE	3	3	0	0	3
4	20MEV42	Additive Manufacturing	PE	3	3	0	0	3
5	20MEV52	Testing of Materials	PE	3	3	0	0	3
6	20MEV62	Digital Manufacturing	PE	3	3	0	0	3

Vertical 3: Clean Energy Technologies

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20MEV13	Compressible Flow and Turbomachinery	PE	3	3	0	0	3
2	20MEV23	Power Plant Engineering	PE	3	3	0	0	3
3	20MEV33	Engine Pollution and Control	PE	3	3	0	0	3
4	20MEV43	Energy Conservation and Management	PE	3	3	0	0	3
5	20MEV53	Renewable energy sources	PE	3	3	0	0	3
6	20MEV63	Fundamentals of HVAC Systems	PE	3	3	0	0	3
7	20MEV73	Energy efficient Buildings	PE	3	3	0	0	3

Vertical 4: Robotics and Automation

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20MEV14	Applied Hydraulics and Pneumatics	PE	3	3	0	0	3
2	20MEV24	Industrial Robotics	PE	3	3	0	0	3
3	20MEV34	Sensors and Actuators	PE	3	3	0	0	3
4	20MEV44	Automation in Manufacturing	PE	3	3	0	0	3
5	20MEV54	Virtual Instrumentation	PE	3	3	0	0	3
6	20MEV64	Data Analytics for Mechanical Engineering	PE	3	3	0	0	3
7	20MEV74	Micro Electro Mechanical Systems	PE	3	3	0	0	3

Vertical 5: Industrial Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20MEV15	Statistical Quality and Control	PE	3	3	0	0	3
2	20MEV25	Process Planning and Cost Estimation	PE	3	3	0	0	3
3	20MEV35	Production Planning and Control	PE	3	3	0	0	3
4	20MEV45	Supply chain and Logistic management	PE	3	3	0	0	3
5	20MEV55	Engineering Economics and Cost Analysis	PE	3	3	0	0	3
6	20MEV65	Maintenance Engineering	PE	3	3	0	0	3
7	20MEV75	Operations Research	PE	3	3	0	0	3

Vertical 6: Modern Mobility Systems

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20MEV16	Automobile Engineering	PE	3	3	0	0	3
2	20MEV26	Advanced Internal Combustion Engines	PE	3	3	0	0	3
3	20MEV36	Two wheeler and Four wheeler Overhauling	PE	3	3	0	0	3
4	20MEV46	Battery Technology	PE	3	3	0	0	3
5	20MEV56	Alternative fuels for IC engines	PE	3	3	0	0	3
6	20MEV66	Intelligent Transportation systems	PE	3	3	0	0	3

OPEN ELECTIVE – II (VIII SEMESTER)

S.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 Electronic Systems	OE	3	3	0	0	3
10	20OE708	Instrumentation for Agro food industry	OE	3	3	0	0	3

OPEN ELECTIVE – II (VII SEMESTER) offered to other Department

S.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	

		L	T	P	C
20ME7L1	**MECHATRONICS LABORATORY**	0	0	4	2

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: 60 PERIODS

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

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

20ME7L3 **TECHNICAL SEMINAR**

L	T	P	C
0	0	4	2

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: 60 PERIODS

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

Course Name : TECHNICAL SEMINAR		**Course Code : 20ME7L3**			
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

20MC801	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	--

OBJECTIVES:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

UNIT – I INTRODUCTION 6

Disaster: Definition, Factors and Significance, Difference between Hazard and Disaster.

Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT – II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches.

Man-made Disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Out breaks of Disease and Epidemics, War and Conflicts.

UNIT – III DISASTER PRONE AREAS IN INDIA 6

Disaster Prone are as in India: Study of Seismic Zones, Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post – Disaster Diseases and Epidemics.

UNIT – IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard.

Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies.

Media Reports: Governmental and Community Preparedness.

UNIT - V RISK ASSESSMENT 6

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co - Operation In Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

TOTAL: 30 PERIODS

REFERENCES:

1. Nishith Rai and A.K. Singh, "Disaster Management in India: Perspectives, Issues and Strategies", New Royal Book Company, 2007.
2. Pardeep Sahni, Alka Dhameja and Uma Medury, "Disaster Mitigation: Experiences and Reflections", Prentice Hall India Learning Private Limited, 2001.
3. S.L.Goel,"Disaster Administration and Management: Text and Case Studies",Deep & Deep Publication Pvt.Ltd., 2007

Vertical 1: Design and Development

		L	T	P	C
20MEV11	PRODUCT DESIGN AND DEVELOPEMENT	3	0	0	3

OBJECTIVES

- To understand various global trends and identify the scope of a new product development.
- To translate conceptual idea into detailed design.
- To understand the concept of product development.
- To impart knowledge on various industrial design process.
- To create prototype to demonstrate the product.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Strategic importance of Product development – Modern Product development process – Examples of Product development process - Understanding customer needs – Types of Customer needs - Gathering Customer needs – Benchmarking and Establishing Engineering Specifications – A benchmarking Approach - Examples.

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 DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs– Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes

UNIT - V INDUSTRIAL DESIGN 9

Integrated 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.Kemnneth Crow, Concurrent Engg./Integrated Product Development, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2.Stephen Rosenthal, Effective Product Design and Development, Business One Orwin, Homewood, 1992.
3.Staurt Pugh, Tool Design -Integrated Methods for Successful Product Engineering, Addison Wesley Publishing, New york.
4.Reddy G B, "Intellectual Property Rights and the Law", Gogia Law Agency, 7th Edition Reprint, 2009
5. Chiu-Shui Chan, "Style and creativity in design" Springer, 2015.

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

Course Name : PRODUCT DESIGN AND DEVELOPEMENT											**Course Code : 20MEV11**				
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**		**PSOs**		
CO1	Explain the basic concepts of product design and development								I	K2	1,2,3,6,9,10		1,2,3		
CO2	Describe the basic concepts of concurrent Engineering								I	K2	1,2,3,6,9,10		1,2,3		
CO3	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		
CO4	Discuss the concepts and importance of product architecture								III	K2	1,2,3,6,9,10		1,2,3		
CO5	Illustrate the importance of industrial design in view of aesthetics factors and ergonomic factors								IV	K2	1,2,3,6,9,10		1,2,3		
CO6	Apply design for manufacture guidelines for reducing manufacturing cost without compromising quality								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**
CO1	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO2	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO3	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1
CO4	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO5	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO6	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1

20MEV21	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 : 20MEV21**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the history, concepts and terminology of PLM	I	K2	1, 2, 3	1, 2, 3
CO2	Describe the functions of PLM/PDM	II	K2	1, 2, 3	1, 2, 3
CO3	Explain the features of PLM/ PDM	III	K2	1, 2, 3	1, 2, 3
CO4	Classify the different modules offered in commercial PLM/PDM tools.	IV	K2	1, 2, 3	1, 2, 3
CO5	Predict PLM/PDM approach techniques for industrial applications.	IV	K2	1, 2, 3	1, 2, 3
CO6	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**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO6	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20MEV31 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: 20ME303 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 : 20MEV31			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Summarize the different methods of Locating Jigs and Fixtures and Clamping principles	I	K2	1, 2, 3	1, 2, 3
CO2	Design and develop jigs and fixtures for given component	I	K3	1, 2, 3	1, 2, 3
CO3	Discuss the press working terminologies and elements of cutting dies	II	K2	1, 2, 3	1, 2, 3
CO4	Distinguish between Bending and Drawing dies.	III	K2	1, 2, 3	1, 2, 3
CO5	Discuss the different types of forming techniques	IV	K2	1, 2, 3	1, 2, 3
CO6	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
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1

20MEV41	PIPING DESIGN ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on piping processes
- To understand the piping layout and stresses acting on it.
- To evaluate the geometry and dimensions of piping design
- To identify and correct the design errors and create the safe working environment
- To learn the concept of piping layout and the stresses acting on it.

PREREQUISITE:

Course Code: 20GE201, 20BS202,20ME301, 20ME302

Course Name: Engineering Graphics, Applied Physics, Strength of Materials, Fluid mechanics and Machinery

UNIT - I INTRODUCTION TO PIPING 9

Introduction to Piping, Piping components- Fittings- Flanges, Valves , Gaskets ,Bolting and piping special items, Piping Codes and Standards used in power and process industries, Types of equipment's, Types of instruments, Process diagrams – PFD, UFD, P and IDs and line list etc.,

UNIT – II PIPING MATERIALS 9

Basics of metallurgy, Piping commodity's material grades, Influence of corrosion piping design, preparation of piping material specifications, piping wall thickness calculations, Branch reinforcement calculations, and Valve material specification.

UNIT - III DESIGN OF LAYOUT 9

Preparation of plot plan preparation of equipment layouts, Preparation of piping general arrangement drawings, preparation of cross sectional drawings, piping isometric drawings, Introduction to piping software tools.

UNIT – IV JUNCTION STRESSES, OPENINGS AND REINFORCEMENTS 9

Stresses in piping systems-discontinuity stresses-thermal stresses-methods of determination stresses-stress concentration in plate having circular hole due to bi-axial loading-Theory of reinforced opening and reinforcement elements.

UNIT - V INTRODUCTION TO STRESS ANALYSIS 9

Types of stresses-Significance of forces and moments in piping system-Expansion loop and bellows-pipe supports-types of supports-support selection-Support location-Support Span Calculation.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mohinder L Nayyar, "Piping Handbook", McGraw Hill Handbook, 7th Edition, 2000.
2. George A Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair", CRC Press, 2003.
3. Roy A. Parisher, Rhea, "Pipe Drafting and Design", Gulf Professional Publishing, 2012.

REFERENCES:

1. Samkannapan,Introduction to Pipe stress analysis"Abi Enterprises Inc.,2008
2. Peter Smith, Fundamentals of piping design",Gulf publishing Company,2007
3. "Power and Process Piping Standards" ASME B 31.1 & B 31.3, 2012.
4. Kellogg M W, "Design of Piping Systems", John Wiley & Sons, 2019.
5. Liang-ChuanPeng and Tsen-LoongPeng, "Pipe Stress Engineering", ASME Press, New York, 2009.
6. Dennis R, Moss, "Pressure Vessel Design Manual", Elsevier Publications, 2004.

OUTCOMES:

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

Course Name : PIPING DESIGN ENGINEERING													**Course Code : 20MEV41**		
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the various piping components and process diagrams											1	K2	1,2,3,8,9,10,12	2
CO2	Apply various codes and standards for piping systems											1	K3	1,2,3,8,9,10	1
CO3	Calculate the piping wall thickness and branch reinforcement											2	K3	1,2,3,9	1
CO4	Draw the layout for piping systems and equipment											3	K2	1,2,3,8	1
CO5	Determine the stresses induced in the pipes under various loadings											4	K3	1,2,3,8,9,10	1
CO6	Explain the concept of piping layout and stresses acting on it.											5	K2	1,2,3,8,9,10	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	-	-	1	**1**	1	-	1	-	1	-
CO2	3	2	1	-	-	-	-	2	2	1	-	-	1	-	-
CO3	3	2	1	-	3	-	-	1	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	1	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	1	1	1	-	-	1	-	-
CO6	3	2	1	-	-	-	-	2	2	1	-	-	1	-	-

20MEV51	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:

20BS401Statistics and Numerical Methods for Mechanical Engineers
20ME302 Fluid Mechanics and Machinery
20ME403 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 : COMPRESSIBLE FLOW AND TURBOMACHINERY													**Course Code : 20MEV51**		
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
CO1	Apply the concepts of compressible flow behaviour in isentropic flow in variable area ducts.										I	K3	1,2,3,4		1,2
CO2	Apply the concepts of compressible flow behaviour in constant area ducts with and without heat transfer.										II	K3	1,2,3,4		1,2
CO3	Calculate the changes in physical properties when a normal shock occurs in One-dimensional constant area or variable area ducts.										III	K3	1,2,3,4		1,2
CO4	Determine the performance of steam turbine.										IV	K3	1,2,3,4		1,2
CO5	Determine the performance of gas turbine										IV	K3	1,2,3,4		1,2
CO6	Explain the working and performance of Rotary compressor.										V	K2	1,2,3,4		1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO6	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3

20MEV61	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 : 20MEV61**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain seven concerns in design thinking.	I	K2	1, 2, 3	1, 2, 3
CO2	Describe new needs to context with example.	II	K3	1, 2, 3	1, 2, 3
CO3	Describe the constraints and technologies for comprehension.	III	K2	1, 2, 3	1, 2, 3
CO4	Identify the crucial steps missed in check	IV	K3	1, 2, 3	1, 2, 3
CO5	Identify the manufacturing challenges in crafting.	V	K3	1, 2, 3	1, 2, 3
CO6	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**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO6	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

VERTICAL 2: MODERN MANUFACTURING

		L	T	P	C
20MEV12	**UNCONVENTIONAL MACHINING PROCESSES**	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. VijayaRamnath, 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 : 20MEV12**			
CO	**Course Outcomes**	**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain the need for unconventional machining processes and its classification.	I	K2	1,2,8,10	1,3
CO2	Explain various mechanical energy based unconventional machining processes.	I	K2	1,2,8,10	1,3
CO3	Compare various thermal energy and electrical energy based unconventional machining processes.	II	K2	1,2,8,9,10	1,3
CO4	Summarize various chemical and electro-chemical energy based unconventional machining processes.	III	K2	1,2,8,10	1,3
CO5	Explain various nono abrasives based unconventional machining processes.	IV	K2	1,2,8,10	1,3
CO6	Distinguish various recent trends based unconventional machining processes**.**	V	K2	1,2,8,10	1,3

CO-PO Mapping

CO	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
CO3	2	1	-	-	-	-	-	1	2	1	-	-	2	-	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1
CO6	2	1	-	-	-	-	-	1	-	1	-	-	2	-	1

20MEV22	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, SubramanyanS.andRaju 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. YoramKoren, ‘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 : 20MEV22**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain the knowledge about role of computer and automation in manufacturing.											I	K2	1,2,8,10	1,2,3
CO2	Explain the concept of group technology and formation of parts – machine cell.											II	K3	1,2,3,8,10	1,2,3
CO3	Explain the concept of FMS, and sizing of FMS systems.											III	K2	1,2,8,10	1,2,3
CO4	Describe the automation, types of automation and automation strategies.											IV	K2	1,2,8,10	1,2,3
CO5	Describe Automated Guided Vehicle System and its application.											IV	K2	1,2,8,10	1,2,3
CO6	Describe the application of computer in CAPP, and explore to integrated planning software.											V	K2	1,2,8,10	1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO2	3	2	1	-	-	-	-	1	**2**	1	-	-	2	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO6	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1

20MEV32	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 : 20MEV32**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain the different types of the composite materials and its applications.												I	K2	1,2,8,10	1,2,3
CO2	Explain the various processing techniques for polymer composites manufacturing.												II	K2	1,2,8,10	1,2,3
CO3	Explain the different types of processing techniques for metal matrix composites manufacturing.												III	K2	1,2,8,9,10	1,2,3
CO4	Determine the stress strain and strain displacement relationship matrix for polymer composites.												IV	K3	1,2,3,8,10	1,2,3
CO5	Determine the buckling, and bending behaviours of polymer composites.												V	K3	1,2,3,8,10	1,2,3
CO6	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**
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO3	2	1	-	-	-	-	-	1	2	1	-	-	2	1	1
CO4	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1
CO5	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1
CO6	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1

20MEV42	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. AmitBandyopadhyay 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 : 20MEV42**		
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
CO1	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
CO2	Explain data processing for Additive Manufacturing Technology.												II	K2	1,2,3,4,5,8, 10	1,2,3
CO3	Differentiate MIMICS and MAGICS software's used in AM process.												II	K2	1,2,5,8,10	1,2,3
CO4	Explain the principle, Processes, applications of SLA, SGC, FDM and LOM processes.												III	K2	1,2,5,7,8,9, 10	1,2,3
CO5	Explain the principle, Processes, applications of SLS and LENS.												IV	K2	1,2,5,7,8,10	1,2,3
CO6	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**
CO1	2	1	-	-	-	-	-	1	-	1	-	-	3		2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	3		2	2
CO3	2	1	-	-	2	-	-	1	-	1	-	-	3		2	2
CO4	2	1	-	-	-	-	-	1	2	1	-	-	3		2	2
CO5	2	1	-	-	-	-	-	1	-	1	-	-	3		2	2
CO6	2	1	-	-	-	-	-	1	-	1	-	-	3		2	2

20MEV52	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: 20ME301 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 : 20MEV52			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain the purpose of testing and its classification.											I	K2	1,2,10	1,3
CO2	Explain different types of testing standards and advantages of testing.											I	K2	1,2,10	1,3
CO3	Explain the working principles of mechanical testing methods											II	K2	1,2,6,8,10	1,3
CO4	Describe the concepts of non-destructive testing and their applications											III	K2	1,2,8,10	1,3
CO5	Explain the working of material characterization testing methods and their applications.											IV	K2	1,2,8,10	1,3
CO6	Explain the concepts of thermal and chemical testing methods.											V	K2	1,2,8,9	1,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	-	-	-	-	-	1	-	-		2	-	1
CO2	2	1	-	-	-	-	-	-	-	1	-	-		2	-	1
CO3	2	1	-	-	-	2	-	1	-	2	-	-		2	-	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-		2	-	1
CO5	2	1	-	-	-	-	-	1	-	2	-	-		2	-	1
CO6	2	1	-	-	-	-	-	1	2	-	-	-		2	-	1

20MEV62	DIGITAL MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the technological advancements in industrial production.
- To learn about the product life cycle management.
- To understand about the digital thread and digital twin.
- To learn about Big data and cloud computing.
- To understand about machine learning and artificial intelligence.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO DIGITAL MANUFACTURING 9

Definition-Components of DM- Introduction to 4th industrial revolution-cyber physical systems-Introduction to Digital thread and Digital twin- Introduction to product life cycle management (PLM),

UNIT – II DIGITAL THREAD 9

Digital thread components-Data Sharing Strategies- Interoperability and Data Formats-semantic data-Technical data packages-Strategic issues in implementing the digital thread-Cyber infrastructure Components of the Digital Thread –Digital Thread and the Manufacturing Enterprise. Case study on smart factory using Digital thread.

UNIT - III DIGITAL TWIN 9

Types of Digital Twin -Product twin – Process Twin – Performance Twin-Virtual commissioning of Digital Twin– Data mapping – Simulation of Digital Twin – Data collection and visualization-Case study on smart factory using Digital twin.

UNIT – IV ADVANCED MANUFACTURING PROCESS ANALYSIS 9

Data analysis-Manufacturing Settings and Data Collection-Traditional Data Sets vs Big Data-Data Storage and Organization-Data preprocessing- computational techniques and platform-Components, Categories and Capabilities-high performance and cloud computing

UNIT - V INTELLIGENT MANUFACTURING 9

Concepts and features of intelligent Manufacturing –Intelligent Multi Information Sensing and Fusion in the Manufacturing Process -Intelligent machining components- sensors and sensing techniques-machine learning and artificial intelligence in sensing techniques.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Zudezhou ,"Fundamentals of Digital Manufacturing Science",Springer,2012
2. Mark J. Barrenechea, Tom Jenkins, "Digital manufacturing", open text corpn,2018
3. KEN English, "Specialization course in Digital Manufacturing Design and Technology", Coursera.

REFERENCES:

1. Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018
2. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2016), Pearson Education.
3. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.
4. Elvis Hozdić, "Smart factory for Industry 4.0" International Journal of Modern Manufacturing Technologies ISSN 2067–3604, Vol. VII, No. 1 / 2015
5. Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013.

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

Course Name : DIGITAL MANUFACTURING												Course Code : 20MEV62			
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**			**PSOs**	
CO1	Describe the basic components of Digital manufacturing								I	K2	1,2			1,2	
CO2	Implement digital thread components in Manufacturing enterprise								II	K3	1,2,3,5			1,2	
CO3	Perform virtual commissioning of Digital Twin in Smart Factory								III	K3	1,2,3,5			1,2	
CO4	Perform advanced manufacturing process analysis in digital manufacturing enterprise								IV	K3	1,2,3,5,7,10			1,2	
CO5	Design intelligent manufacturing operations in manufacturing enterprise.								V	K3	1,2,3,5,11,12			1,2	
CO6	Formulate business models for advanced manufacturing process								V	K3	1,2,3,12			1,2	
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-
CO2	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
CO3	3	2	1	-	3	-	-	-	-	-	-	-	2	1	-
CO4	3	2	1	-	1	-	2	-	-	2	-	-	2	1	-
CO5	3	2	1	-	1	-	-	-	-	-	3	2	2	1	-
CO6	3	2	1	-	-	-	-	-	-	-	-	2	2	1	-

VERTICAL 3: CLEAN ENERGY TECHNOLOGIES

		L	T	P	C
20MEV13	**COMPRESSIBLE FLOW AND TURBO-MACHINERY**	3	0	0	3

(Use of approved gas tables, standard Steam Tables, Mollier diagram and Psychrometric chart permitted)

OBJECTIVES

- To understand the basic difference between incompressible and compressible flow.
- To understand the Flows through constant area ducts with and without Heat transfer.
- To understand the phenomenon of shock waves and its effect of flow on variable area of ducts.
- To understand the basic concepts of steam turbine and different types of gas turbines.
- To understanding the basic concepts and operating principles of Rotary compressors.

PREREQUISITE:

Course Code: 20ME302, 20ME304

Course Name: Fluid Mechanics and Machinery, Engineering Thermodynamics

UNIT - I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers.

UNIT – II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties.

UNIT - III NORMAL AND OBLIQUE SHOCKS 9

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations.

UNIT – IV STEAM TURBINES AND GAS TURBINES 9

Impulse and reaction principles, Velocity diagrams for simple impulse turbine, Work done and efficiency – optimal operating conditions. Compounding and governing.

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations.

UNIT - V ROTARY COMPRESSOR 9

Classifications, Root blower, Vane type compressor, Centrifugal and Axial flow compressor Construction and working, velocity triangle, degree of reaction, polytropic efficiency, coefficients, losses and Characteristic curve of axial flow compressor.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Yahya S M, 'Fundamentals of Compressible Flow with Aircraft and Rocket Propulsions, New Age International Publishers, 5th Edition (2016).

2. Kothandaraman.C.P., Domkundwar. S, Domkundwar. A.V., "A course in thermal Engineering", 5th Edition, "Dhanpat Rai & sons, 2016.

3. Oosthuizen, P.H. and Carscallen, W.E., Compressible Fluid Flow, McGraw-Hill, 1997.

REFERENCES:

1. Anderson, J.D., "Modern Compressible flow", 4th Edition, McGraw Hill, 2021.
2. Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 2010.
3. Yahya, S.M., 'Turbines, Compressor and Fans', McGraw Hill Education Publishing Company, 4th edition, 2017.
4. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", Pergamon Press, 2014.
5. Gopalakrishnan .G and Prithvi Raj .D, "A Treatise on Turbo machines", Scifech Publications (India) Pvt. Ltd., 2010.

OUTCOMES:

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

Course Name : COMPRESSIBLE FLOW AND TURBOMACHINERY													**Course Code : 20MEV13**		
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
CO1	Apply the concepts of compressible flow behaviour in isentropic flow in variable area ducts.										I	K3	1,2,3,4		1,2
CO2	Apply the concepts of compressible flow behaviour in constant area ducts with and without heat transfer.										II	K3	1,2,3,4		1,2
CO3	Calculate the changes in physical properties when a normal shock occurs in One-dimensional constant area or variable area										III	K3	1,2,3,4		1,2
CO4	Determine the performance of steam turbine.										IV	K3	1,2,3,4		1,2
CO5	Determine the performance of gas turbine										IV	K3	1,2,3,4		1,2
CO6	Explain the working and performance of Rotary compressor.										V	K2	1,2,3,4		1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
CO6	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3

20MEV23	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:

20ME304 Engineering Thermodynamics
20ME403 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, AmitPrakashSrivastava, 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 : 20MEV23			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Calculate the efficiency of Rankine cycle.	I	K3	1, 2, 3	1, 2, 3
CO2	Explain the functioning of combined power plants.	II	K2	1, 2, 3	1, 2, 3
CO3	Calculate the efficiency of Various types of gas power cycles	II	K3	1, 2, 3	1, 2, 3
CO4	Explain the working of various types of nuclear power plant	III	K2	1, 2, 3	1, 2, 3
CO5	Explain the working principle of various renewable energy power plants.	IV	K2	1, 2, 3	1, 2, 3
CO6	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
CO1	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
CO6	2	1	1	-	-	-	-	-	-	-	1	-	2	2	1

20MEV33	ENGINE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide an insight about effect of engine out emissions on human health and environment
- To impart the knowledge on various pollutant species formations in SI and CI engine
- To divulge about various emission measurement techniques in engines and its significance
- To provide a discernment about various emission control methods
- To impart the knowledge about international and national driving cycles and emission standards

PREREQUISITE: NIL

UNIT - I AIR POLLUTION – ENGINES 8

Atmospheric pollution from automotive, stationary engines and gas turbines, Global warming – Green-house effect, Effects of engine pollution on human health and environment

UNIT – II POLLUTANT FORMATION 9

Formation of Oxides of nitrogen, Carbon monoxide, Hydrocarbon, Aldehydes, Smoke and Particulate matter emissions. Effects of Engine design and operating variables on emission formation, Noise pollution.

UNIT - III EMISSION MEASUREMENT TECHNIQUES 9

CO, CO2 - Non dispersive infrared gas analyzer, NOx - Chemiluminescent analyzer, HC - Flame ionization detector, Smoke – Opacity and filter paper measurements, Particulate Matter – Full flow and Partial flow dilution tunnel, Gas chromatography, Noise measurement.

UNIT – IV EMISSION CONTROL TECHNIQUES 10

Engine design modifications, Fuel modification, Evaporative emission control, EGR, Air injection, Thermal reactors, Water injection, Common rail direct injection and Gasoline direct injection system, After treatment systems - Catalytic converters, Diesel oxidation catalyst, Particulate traps, De-NOx catalysts, SCR systems. Low temperature combustion concepts

UNIT - V DRIVING CYCLES AND EMISSION STANDARDS 9

Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ganesan V., “Internal Combustion Engines”, V Edition, Tata McGraw Hill, 2012.
2. John. B. Heywood, “Internal Combustion engine fundamentals” McGraw – Hill, 1988.
3. Amba Prasad Rao .G, KarthikeyaSharma.T, “Engine Emission Control Technologies Design Modifications and Pollution Mitigation Techniques” Apple Academic Press, 2021

REFERENCES:

1. Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 2012.
2. George Springer and Donald J Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 2012.
3. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 3rd Edition, 2020.
4. Pundir B. P., “IC Engines Combustion and Emission” Narosa publishing house, 2010.
5. Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill, 1971

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

Course Name : ENGINE POLLUTION AND CONTROL		Course Code : 20MEV33			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the impact of pollution from engines on human health and environment.	I	K2	1,2,3,8	1,2,3
CO2	Describe the formation of different pollutants	II	K2	1,2,3	1,2,3
CO3	Discuss the effect of engine design and operating variables on emission formation.	II	K2	1,2,3,5	1,2,3
CO4	Explain the various measurement techniques used for the measurement of pollutants in engine emissions.	III	K2	1,2,3,7	1,2,3
CO5	Describe the various techniques used in IC engine to control the engine emissions	IV	K2	1,2,3,7	1,2,3
CO6	Discuss the international and national driving cycles and emission standards	V	K2	1,2,3,6,7	1,2,3

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	1	-	-	-	-	3	2	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	1
CO3	3	2	1	-	1	-	-	-	-	-	-	-	3	2	1
CO4	2	1	1	-	-	-	1	-	-	-	-	-	2	2	1
CO5	2	1	1	-	-	-	1	-	-	-	-	-	2	2	1
CO6	2	1	1	-	-	-	1	-	-	-	1	-	2	2	1

20MEV43	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:

20ME304 Engineering Thermodynamics
20HS401 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. AmlanChakrabarti, “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 : 20MEV43**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	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
CO2	Infer the concept of financial management, energy monitoring and targeting	II	K2	1, 2, 3, 4, 11, 12	1, 2, 3
CO3	Explain energy audit for the energy management and operation of energy audit instruments.	III	K2	1, 2, 3, 4, 12	1, 2, 3
CO4	Determine energy efficiency in various thermal utilities and systems	IV	K3	1, 2, 3	1, 2, 3
CO5	Explain working of waste hear recovery systems	IV	K2	1, 2, 3	1, 2, 3
CO6	Summarize the Convention on Climate Change and Clean Development Mechanism	V	K2	1, 2, 3, 7, 12	1, 2, 3

CO-PO Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	1	1	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	2	1	1	-	-	-	1	-	-	-	-	1	2	1	1

20MEV53	RENEWABLE SOURCES OF ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the importance of renewable energy
- To understand the functioning of solar power plant
- To understand the functioning of wind power plant
- To understand the mechanism of conversion of biomass into power
- To understand the principle of producing power from wave, tidal and fuel cells

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamilnadu, Present renewable energy status in India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT – II SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Solar thermal energy storage -Fundamentals of Solar Photo Voltaic Conversion – Solar Cells -– Solar PV Power Generation – Solar PV Applications

UNIT - III WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental issues - Applications

UNIT – IV BIO - ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Carbonization – Pyrolysis -Biomass Applications

UNIT - V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen production and Storage - Transport and utilization - Safety issues. Fuel Cell Systems – Hybrid Systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1.Rai. G.D., "Non Conventional Energy Sources", 6th edition, Khanna Publishers, New Delhi, 2017.

2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", 3rd edition, EFN Spon Ltd., UK, 2015.

3. Qiuye Sun, “Energy Internet and We energy”, Springer Nature Singapore Pvt. Ltd., 2018

REFERENCES:

1. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.
2. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017
3. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
4. S. Rao& Dr. B.B.Parulekar. "Energy Technology Nonconventional, Renewable & Conventional", Khanna Publishers, New Delhi , 2015
5. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.

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

Course Name : RENEWABLE ENERGY SOURCES													Course Code : 20MEV53		
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the importance and Economics of renewable Energy												I	K2	1,2,3,4,6,711	1,2,3
CO2	Explain the method of power generation from Solar Energy												II	K2	1,2,3,4,6,7	1,2,3
CO3	Explain the method of power generation from Wind Energy												III	K2	1,2,3,4,6,7	1,2,3
CO4	Explain the method of power generation from Bio Energy												IV	K2	1,2,3,4,6,7	1,2,3
CO5	Explain the power generation method from the newer renewable energy source												V	K2	1,2,3,4,6,7	1,2,3
CO6	Choose the appropriate power plant by applying the knowledge of characteristics of different power plant and explain its function												II,III ,IV,V	K3	1,2,3,4,6,7, 11,12	1,2,3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	1	1	1	-	1	2	-	-	-	1	-	2	1	1	
CO2	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
CO3	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
CO4	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
CO5	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1	
CO6	3	2	1	1	-	1	2	-	-	-	1	1	2	1	1	

20MEV63	FUNDAMENTALS OF HVAC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn climate variation and its effects on the building heat load.
- To learn building material characteristics and their influence on building heating / cooling load for all weather conditions.
- To study various conversation techniques related to build environment and codes for the same.
- To study various basic concepts related to Duct Installation, Duct Design, Zone Control Systems
- To study various basic concepts related Chilled Water Systems, Cooling Towers, Commercial Refrigeration Systems

PREREQUISITE:

Course Code: 20ME302, 20ME304

Course Name: Fluid Mechanics and Machinery, Engineering Thermodynamics

UNIT - I REFRIGERATION CYCLE 9

Unit of refrigeration, Refrigerating effect, Carnot COP - Refrigerator & heat pumps, Limitations of Carnot cycle

Refrigerants - Definition, Nomenclature, Classification, Essential and Desirable Properties, ODP, GWP & TEWI – and other Environmental issues

Refrigeration cycle - Simple vapour compression – P-h diagram, T-S diagram, COP, Heat rejection ratio, different processes, Effect of sub cooling and super heating, Effect of suction and discharge pressures on the cycle performance, Actual compression cycle – use of P-h charts and Tables.

Vapour absorption and adsorption systems, steam jet, Thermoelectric etc.- concepts only

UNIT – II MAIN COMPONENTS OF HVAC 9

Compressor : Types, classification, Constructional details, working, Selection, capacity control and performance comparison. Condenser: Types, working , Heat transfer estimation, Selection and application , factors affecting condenser performance. Evaporators : Types , heat transfer estimation, selection and application, factors affecting evaporator performance Expansion Devices: Types, Selection and application, Performance

UNIT - III PSYCHROMETRY & HEAT LOAD 9

Psychrometry: Psychrometric terms, Use of Psychrometric Chart, Various Psychrometric processes –Determination of ADP, Enthalpy Calculations , Plotting of air conditioning processes in chart. Factors affecting human comfort, Comfort parameters, Comfort chart. Heat Load Estimation Air Conditioning,

Data collection for Heat load, Study of Drawings, Procedure for heating and cooling load estimation: Interpretation of heat load estimations, Heat load estimation Refrigeration: Product storage temperatures, Design input data, Procedures for estimation of cooling load.

UNIT – IV AIR CONDITIONING SYSTEMS 9

Selection of systems for different Applications: Residential, Commercial – Hotels, Mall, Hospitals, Industrial etc. Window, Ductless split ACs, Package and Ductable units, VRFs/VRV, large DX systems with AHUs, Air cooled and water cooled condensing units. Chilled water systems: Air and water cooled chillers – compressors, types and capacities range and applications, AHUs, Pumps, Fans, Cooling towers and other allied components..

UNIT - V AIR DISTRIBUTION & CONTROL SYSTEMS 9

Duct design methodologies, Different types of duct design, Selection of air terminals, dampers, filters etc. Pressure drop estimation, Constant volume systems, variable air volume systems, VAV boxes, Single duct cooling and heating, VAV with parallel and series fan powered, induction VAVs , accessories, Types of Room air Distribution

Systems.

Fan: Law, Types including ventilation, Selection of fan for various applications, Piping design, Pump and Pumping systems Chilled and cooling water – Types, Selection, Head Requirement, Motor sizing, Electrical Fundamentals, Electrical Control and BMS: Fundaments of Control, Types of controllers, Control systems applicable to Chillers, VRF etc., BMS, Introduction to BAC net.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. James E. BrumbaughAudel, Fundamentals of HVAC Systems Wiley Publications. 4th Edition,2004
2. Roy J. Dossat, Principles of Refrigeration, Pearson, 5th Edition, 2007
3. Richard C. Jordon and Gayle B.Priester, Refrigeration and Air Conditioning Prentice Hall India, 15th Edition, 2000

REFERENCES:

1. Hand book of heating, ventilation and Air-conditioning, Jan. F. Kreider, CRC press. 2000
2. Mike Stubblefield John Harold Haynes - Automotive Heating & Air Conditioning Systems Manual, Haynes Manuals, 2000
3. John W. Mitchell, James E. Braun, Principles of Heating, Ventilation, and Air Conditioning in Buildings, Wiley Publications, 2013.
4. Roger W. Haines, Control Systems for Heating, Ventilating and Air Conditioning, Springer US, 2000
5. Arthur A. Bell Jr., PE, HVAC Equations, Data and Rules of Thumb-McGraw-Hill Professional, 2000

OUTCOMES:

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

Course Name : FUNDAMENTALS OF HVAC SYSTEMS													**Course Code : 20MEV63**		
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**			**PSOs**	
CO1	Estimate heating loads, space heat gains and space cooling loads using accepted engineering methods.								1	K2	1,2,3,4,5,6,7,8			1,2,3	
CO2	Explain the phenomena of various heating systems, like gas and oil furnace also understand the concept of Troubleshooting of heating systems								2	K2	1,2,3,4,6,7,			1,2,3	
CO3	Explain the Fundamentals of Heat Pumps and its Applications								2	K2	1,2,3,4			1,2,3	
CO4	Determine the coil loads for cooling and heating systems								3	K3	1,2,3,4			1,2,3	
CO5	Select equipment and design systems to provide comfort conditions within the building.								4	K3	1,2,3,4			1,2,3	
CO6	Explain the working principle of chillers used in Commercial Refrigeration Systems								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**
CO1	3	3	2	2	1	2	1	1	-	-	-	-	3	2	1
CO2	3	2	2	2	-	2	1	-	-	-	-	-	3	2	1
CO3	3	2	2	1	-	-	-	-	-	-	-	-	3	2	1
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO5	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO6	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1

20MEV73	ENERGY EFFICIENT BUILDINGS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the conventional connections energy efficient buildings and developing proficiency in energy conservation building codes.
- To understand the energy efficient landscape system.
- To understand the different solutions for HVAC in buildings
- To understand the heat transmission in buildings.
- To understand the integration of renewable energy in buildings.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Conventional versus energy efficient BUILDINGS – Historical perspective – Water – Energy – IAQ requirement analysis – Future building design aspects – critically of resources and needs of modern living – Building assessment and green building processes - Energy conservation building codes.

UNIT – II LANDSCAPE AND BUILDING ENVELOPES 9

Energy efficient landscape – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation

UNIT - III HEATING, VENTILATION AND AIR CONDITIONING 9

Natural Ventilation, Passive cooling and heating: Thermal mass effects – Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid methods – energy conservation measures, thermal storage integration in buildings

UNIT – IV HEAT TRANSMISSION IN BUILDINGS 9

Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; heat transfer due to ventilation / infiltration, internal heat transfer; solar temperature; decrement factor; phase lag. Design of day lighting; estimation of building loads: steady state method, network method, numerical method, correlations; computer packages for carrying out thermal design of buildings and predicting performance. Thermal load estimation: Heat balance method. Degree day method for seasonal energy consumption.

UNIT - V BUILDING COOLING AND RENEWABLE ENERGY IN BUILDINGS 9

Passive cooling concepts, Application of wind, water and earth cooling; shading, paints and cavity walls for cooling; roof radiation traps, Earth air tunnel. Solar absorption cooling and solar vapour compression cooling for buildings – Solar water heating systems in buildings – Small wind turbines, standalone PV, Hybrid systems for residential buildings with economics.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Krieder. J., and Rabi. A., Heating and cooling of buildings: design for efficiency, McGraw Hill, 3rd edition 2016.
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Deliver, John Wiley & Sons, 2016.
3. Duffie, A and Beckmann, W. A., Solar Engineering of Thermal Processes, John Wiley, 2019.

REFERENCES:

1. R. Velraj, 'Sensible heat Storage for solar heating and cooling systems' in the book titled "Advances in Solar Heating and Cooling" – Pages 399 - 428 Elsevier Publication, 2016.
2. Energy Efficiency in Buildings Both New and Rehabilitated Edited by José Manuel Andújar and Sergio Gómez Melgar, Printed Edition of the Special Issue Published in Energies'2020.
3. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 2014.
4. UrsalaEicker, "Solar Technologies for buildings", Wiley Publications, 2013.Guide book for national certification examination for energy managers and energy auditors (downloaded from www.energymanagertraining.com).
5. Michael Bauer, Peter Mosle and Michael Schwarz, Green Building - Guidebook for Sustainable Architecture, 2009.

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

Course Name : ENERGY EFFICIENT BUILDINGS													**Course Code : 20MEV73**		
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Compare conventional connections in energy efficient buildings and versatile with energy conservation building codes.												I	K2	1,2,3	1,2
CO2	Explain an energy efficient landscape system.												II	K2	1,2,3	1,2
CO3	Discuss different cooling methods of HVAC in buildings.												III	K2	1,2,3	1,2
CO4	Explain the heat transmission in buildings due to ventilation / infiltration.												IV	K2	1,2,3	1,2
CO5	Describe different methods for estimation of building loads.												IV	K2	1,2,3	1,2
CO6	Explain Passive cooling concepts of renewable energy in buildings												V	K2	1,2,3	1,2
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	
CO4	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	
CO5	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	
CO6	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	

VERTICAL 4: ROBOTICS AND AUTOMATION

		L	T	P	C
20MEV14	APPLIED HYDRAULICS AND PNEUMATICS	3	0	0	3

OBJECTIVES

- To understand the basic concepts of fluid power system.
- To know about the utilization of cylinders, accumulators, valves and various electrical and electronic control components.
- To gain knowledge in design, construction and operation of fluid power circuits.
- To develop the skills in trouble shooting the hydraulic and pneumatic circuits.
- To understand the applications of hydraulic and pneumatic circuits in modern manufacturing industries.

PREREQUISITE:

Course Code: 20ME302

Course Name: Fluid mechanics and Machinery

UNIT - I INTRODUCTION TO FLUID POWER AND HYDRAULIC POWER DRIVES 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids – Properties of fluids and selection – Basics of Hydraulics – Pascal's Law.

Hydraulic power drives: Pumping Theory – Pump Classification – Construction, Working, Design, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps and motors.

UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

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

UNIT - III HYDRAULIC CIRCUITS AND SYSTEMS 9

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

UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Basic principles of Pneumatics, Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators.

Design of Pneumatic circuit – Cascade method for sequencing – Electro Pneumatic System – Elements – Programmable Logic Controllers - Ladder diagram, Timers and Counters.

UNIT - V TROUBLE SHOOTING AND APPLICATIONS 9

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

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Anthony Esposito, "Fluid power with Applications," Pearson Education, 7th Edition, 2009.
2. Majumdar S.R., "Oil Hydrualics Systems- Principles and Maintenance", Tata McGraw- Hill, July 2017.
3. James L. Johnson "Introduction to Fluid Power" Delmar Thomson Learning Publishers 2002.

REFERENCES:

1. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2015.
2. Peter Rohner, Fluid Power Logic Circuit Design, Macmillan Publishers, 1994.
3. Eaton Hydraulics Training Services (Vickers), Industrial Hydraulics Manual 6th Edition. 2015.
4. Frank Yeaple, Fluid Power Design Handbook, 3rd Edition, CRC Press, October 24, 1995.
5. James R. Daines -Fluid Power: Hydraulics and Pneumatics 2nd Edition, Textbook Edition, GW publisher 2009.

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

Course Name : APPLIED HYDRAULICS AND PNEUMATICS												**Course Code : 20MEV14**			
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
CO1	Discuss the function of different types of hydraulic pumps and motors.										I	K2	1,2,3,4		1,2,3
CO2	Describe the features and functions of hydraulic actuators, Direction and Flow control valves.										II	K2	1,2,3,4		1,2,3
CO3	Develop fluid power multi actuation circuits for various purposes in industry.										III	K3	1,2,3,4,5,6		1,2,3
CO4	Discuss the working of different pneumatic and electro pneumatic components, circuits and systems.										IV	K2	1,2,3,4,5,6		1,2,3
CO5	Construct the cascaded electro pneumatic circuits for requiring cylinder sequences.										IV	K3	1,2,3,4,5,6		1,2,3
CO6	Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.										V	K2	1,2,3,4,6		1,2,3
CO-PO Mapping															
CO	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1
CO3	3	2	1	1	3	1	-	-	-	-	-	-	2	2	1
CO4	2	2	1	1	3	1	-	-	-	-	-	-	2	2	1
CO5	3	2	1	1	3	1	-	-	-	-	-	-	2	2	1
CO6	2	2	1	1	-	1	-	-	-	-	-	-	2	2	1

20MEV24	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", McGraw 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: 20MEV24**			
CO	**Course Outcomes**	**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain about the robot parts, specifications, coordinates and robot drive system.	1	K2	1,2	1,2,3
CO2	Discuss the working principle of robot sensors and types of end effectors.	2	K2	1,2	1,2,3
CO3	Explain the Image processing techniques to analyze the real images.	3	K2	1,2,3,4,5	1,2,3
CO4	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
CO5	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
CO6	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**
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	-	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	2	2	1	2	-	-	-	-	-	-	-	2	1	1
CO4	2	2	1	2	1	-	-	-	-	-	-	-	2	1	1
CO5	2	2	1	1	2	-	-	-	-	-	-	-	2	1	1
CO6	2	2	1	1	-	-	-	-	-	-	-	-	2	1	1

20MEV34	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To enable the students to understand the working principle of various sensors and actuators.
- To teach students about the working principle and applications of Inductive and Capacitive sensors.
- To develop the skills of students in selecting the suitable sensors for the required applications.
- To enable the students understand the applications of hydraulic, pneumatic and electrical actuators in modern manufacturing industries.
- To enable the students to understand processing techniques of micro sensors and actuators.

PREREQUISITE:

Course Code: 20GE203

Course Name: Basic Electrical, Electronics and Instrumentation Engineering

UNIT - I INTRODUCTION TO SENSORS AND SIGNAL TRANSMISSION 9

Difference between sensor, transmitter and transducer - Primary measuring elements - Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor, Optical encoders.

UNIT – II INDUCTIVE & CAPACITIVE SENSORS 9

Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn. Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: capacitor microphone, capacitive pressure sensor, proximity sensor.

UNIT - III ACTUATORS 9

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.

UNIT – IV MICRO SENSORS AND MICRO ACTUATORS 9

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.

UNIT - V SENSOR MATERIALS AND PROCESSING TECHNIQUES 9

Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Patranabis.D, “Sensors and Transducers”, Wheeler publisher. 2nd edition 2003.
2. SergejFatikow and Ulrich Rembold, “ Microsystem Technology and Microbotics”, 1st edition, Springer –VerlagNewyork, Inc, 1997.
3. Jacob Fraden, “Hand Book of Modern Sensors: Physics, Designs and Application” 4th edition, Springer, 2014.

REFERENCES:

1. Robert H Bishop, “The Mechatronics Hand Book”, CRC Press, 2007.
2. Thomas. G. Bekwith and Lewis Buck.N, Mechanical Measurements, Oxford and IBH publishing Co. Pvt. Ltd.,1982.
3. MassoodTabib and Azar, “Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures”, 1st edition, Kluwer academic publishers, Springer, 1997.
4. Manfred Kohl, “Shape Memory Actuators”, 1st edition, Springer.
5. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2015.

Course Name: SENSORS AND ACTUATORS													**Course Code: 20MEV34**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
CO1	Discuss the functions of different types of Sensors and Signal transmission.												1	K2	**1,2**	**1**
CO2	Explain the working principle of Inductive, Capacitive type of sensors and applications.												2	K2	**1,2**	**1**
CO3	Describe the working principle and applications of various actuators.												3	K2	**1,2**	**1**
CO4	Explain the working principle of various types of micro sensors.												4	K2	**1,2**	**1**
CO5	Discuss the working principle of various types of micro actuators.												4	K2	**1,2**	**1**
CO6	Explain about the sensor materials and processing techniques for micro sensor and actuator.												5	K2	**1,2**	**1**
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO3	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO4	3	1	-	-	1	-	-	-	-	-	-	-	2	-	-	
CO5	3	1	-	-	1	-	-	-	-	-	-	-	2	-	-	
CO6	3	1	-	-	1	-	-	-	-	-	-	-	2	-	-	

20MEV44	AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To enable the students to understand building blocks of an automation system.
- To enable the students to understand types of automation and Mechanisms.
- To develop the programming skills of students in Microprocessor and PLC.
- To teach the students about Computer Numerical Control technology and programming.
- To develop the skills of students in applying IoT technology in manufacturing.

PREREQUISITE:

Course Code: 20GE203

Course Name: Basic Electrical, Electronics and Instrumentation Engineering

UNIT - I INTRODUCTION 9

Introduction: Importance of automation in the manufacturing industry. Use of Mechatronics based systems. Design of an automated system: Building blocks of an automated system, working principle and examples, Introduction to Computer Aided Design (CAD) processes.

UNIT – II INDUSTRIAL AUTOMATION AND MECHANISMS 9

Types of Industrial Automation – Fixed automation, Programmable automation, Flexible automation, Mechanisms: Types of Ball screws, linear motion bearings, Cams, Systems controlled by camshafts. Electronic Cams, Indexing Mechanisms,Tool Magazines and Automatic Material handling system.

UNIT - III SIGNAL CONDITIONING AND CONTROLLERS 9

Signal Conditioning: Amplification, Filtering, Wheatstone bridge, Pulse Modulation, Signal Conversion, Microprcessor Technology - Architecture, Addressing modes and Programming. PLC- Architecture, I/O processing, Ladder Logic Programming, Analog and Digital data handling, Timers, Counters and Industrial applications.

UNIT – IV CNC TECHNOLOGY 9

Flexible Manufacturing System, CNC technology in manufacturing, vertical milling process. CNC Machine Tools- Tool Magazines, Automatic Palleting, Tool wear monitoring system. Computer Aided manufacturing and Process Planning- Group Technology, Part families, Manual Visual Inpection, Production Flow Analysis, Classification and Coding. CNC machines and Interplotation , Applications, CNC programming.

UNIT - V IoT IN MANUFACTURING 9

Introduction to Human Computer Interaction(HCI) and Internet of Things (IoT) world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing- Simultaneous mapping and localization-Levels of autonomy, Smart factories.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 2015.
2. Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall, 2016.
3. Vijay Madisetti, ArshdeepBahga “Internet of Things: A Hands-On Approach “,1st edition, 2015.

REFERENCES:

1. Bradley, D. A., Dawson D., Burd, N. C. and Loader A. J.,Mechatronics: Electronics in products and processes, CRC Press, Florida, USA, 2010.
2. Gaonkar, R. S., Microprocessor architecture, programming,and applications with the 8085, Penram International Publishing (India), Delhi, 2013.
3. Rao, P. N., CAD/CAM Principles and Applications, Tata McGraw Hill, New Delhi, 2010.
4. Smid, P., CNC Programming Handbook, IndustrualPress,New York, USA, 2008.
5. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013.

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

Course Name: AUTOMATION IN MANUFACTURING													**Course Code: 20MEV44**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain the building blocks of automation system.												1	K2	**1,2**	**1**
CO2	Describe the various types of automation system and Mechanisms.												2	K2	**1,2**	**1**
CO3	Explain about the signal conditioning processes.												3	K2	**1,2,3**	**1,2**
CO4	Develop the Microprocessor and PLC programming codes.												3	K3	**1,2,3,4,5**	**1,2**
CO5	Describe about the CNC technology in manufacturing.												4	K2	**1,2,3,5**	**1,2**
CO6	Apply IoT concept in advanced manufacturing machines .												5	K3	**1,2,3,4,5**	**1,2**
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	
CO4	3	2	2	1	2	-	-	-	-	-	-	-	2	1	-	
CO5	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-	
CO6	3	2	2	1	2	-	-	-	-	-	-	-	2	1	-	

20MEV54	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To enable the students to understand the concept of Virtual Instrumentation (VI) and Programming techniques.
- To teach students about basic building blocks and Data Acquisition in Virtual Instrumentation.
- To develop the programming skills of students in LabVIEW software.
- To enable the students understand the function of VI toolsets and Distributed I/O modules.
- To develop the skills of students in image processing techniques and motion control in VI.

PREREQUISITE:

Course Code: 20GE203, 20ME404

Course Name: Basic Electrical, Electronics and Instrumentation Engineering, Metrology and Measurement Practices

UNIT - I INTRODUCTION 9

Virtual Instrumentation – Definition, flexibility - Block diagram and Architecture for Virtual Instruments versus Traditional Instruments Instrumentation -VI Programming techniques - VI, sub VI, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output.

UNIT – II DATA ACQUISTITION IN VI 9

A/D and D/A converters, Plug-in Analog Input / Output cards – Digital Input and Output Cards, Organization of the DAQ VI system – Opto-isolation – Performing analog input and analog output – Scanning multiple analog channels – Issues involved in selection of Data acquisition cards – Data acquisition modules with serial communication – Design of digital voltmeter with transducer input –Timers and Counters.

UNIT - III APPLICATION OF VIRTUAL INSTRUMENTATION 9

Instrument Control using RS-232C and IEEE488, Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, Active X programming, Publishing measurement data in the web.

UNIT – IV REAL TIME CONTROL IN VI 9

Designs using VI Software - ON/OFF controller – Proportional controller – Modeling and basic control of level and reactor processes – Case studies on development of HMI, SCADA in VI.

UNIT - V OPERATING SYSTEM AND I/O MODULES 9

Operating system requirements, Current trends on PC based instrumentation, analog and digital interfaces, Modular Instruments, VI toolsets Distributed I/O modules, Control Design and Simulation, Digital Signal processing tool kit, Image acquisition and processing, Motion control.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gary W. Johnson, Richard Jennings, “LabVIEW Graphical Programming”, 3rd edition , McGraw-Hill Professional Publishing, 2006.
2. S. Gupta and J. John ,"Virtual Instrumentation using LabVIEW", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.
3. Jovitha Jerome, Virtual Instrumentation using LabVIEW, 1st Edition, PHI, 2010.

REFERENCES:

1. Barry Paton, “Sensor, transducers and Labview”, Prentice Hall of India 2000.
2. R. H. Bishop, "Learning with LabVIEW", 1st edition, Pearson Publishing, 2020.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
4. Rick Bitter, LabVIEW advanced programming technique, 2nd Edition, CRC Press, 2006.
5. Skolkoff, “Basic concepts of LABVIEW 4”, PHI, 1998.

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

Course Name: VIRTUAL INSTRUMENTATION												**Course Code: 20MEV54**		
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSO**
CO1	Define Virtual Instrumentation Concepts.											1	K2	**1,2**	**1**
CO2	Describe the building blocks and VI programming techniques.											1	K2	**1,2,3,5**	**1,2**
CO3	Describe the Data Acquisition (DAQ) methodologies in VI.											2	K2	**1,2,3,5**	**1,2**
CO4	Discuss about the applications of Virtual Instrumentation.											3	K2	**1,2,3,5**	**1,2**
CO5	Describe about the real time control and interfacing methods in VI.											4	K2	**1,2,3,5**	**1,2**
CO6	Discuss operating systems required for Virtual Instrumentation.											5	K2	**1,2,3,5**	**1,2**
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
CO3	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
CO4	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
CO5	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
CO6	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-

20MEV64 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. ZaighamMahmood, 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 : 20MEV64**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain the data collection systems using sensors.												I	K2	1, 2, 3	1, 2, 3
CO2	Describe the data processing and handling methods.												II	K2	1, 2, 3	1, 2, 3
CO3	Explain the data security systems.												III	K2	1, 2, 3	1, 2, 3
CO4	Describe the applications of data analytics in manufacturing sector.												IV	K2	1, 2, 3	1, 2, 3
CO5	Describe the applications of data analytics in inventory and shipment.												IV	K2	1, 2, 3	1, 2, 3
CO6	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**	
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
CO6	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1	

20MEV74	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT – II SENSORS AND ACTUATORS-I 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

UNIT – III SENSORS AND ACTUATORS-II 9

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flowsensors.

UNIT – IV MICROMACHINING 9

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT - V POLYMER AND OPTICAL MEMS 9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2006.
2. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.
3. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002.

REFERENCES:

1. Nadim Maluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2000
3. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002
4. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
5. Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,” Springer 2012.

OUTCOMES:

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

Course Name : MICRO ELECTRO MECHANICAL SYSTEMS												Course Code : 20MEV74			
CO	**Course Outcomes**										**Unit**	**K – CO**	**POs**		**PSO**
CO1	Explain about micro fabrication										I	K2	1, 2, 3		1, 2, 3
CO2	Explain about electrical sensors										II	K2	1, 2, 3		1, 2, 3
CO3	Explain about thermal sensors for a particular application										III	K2	1, 2, 3		1, 2, 3
CO4	Describe about Piezo resistive sensors										IV	K2	1, 2, 3		1, 2, 3
CO5	Describe about various micro machining processes										IV	K2	1, 2, 3		1, 2, 3
CO6	Describe the application of polymers in MEMS										V	K2	1, 2, 3, 12		1, 2, 3
CO-PO Mapping															
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO3**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1

Vertical - 5: Industrial Engineering

20MEV15	STATISTICAL QUALITY CONTROL	L	T	P	C
		3	0	0	3

Use of Statistical quality control table is permitted

OBJECTIVES

- To develop the basic concepts of quality control procedures.
- To impart knowledge about designing and implementation of Statistical Process control in any industry.
- To design and implement acceptance sampling inspection methods in industry.
- To study the process and machine capability.
- To develop the applications of various charts.

PREREQUISITE:

Course Code: 20BS401

Course Name: Statistics and Numerical Methods

UNIT - I QUALITY FUNDAMENTALS 9

Quality – Importance, evolution, definitions, dimensions of quality. Quality control, quality assurance, areas of quality, quality planning, quality objectives and policies, quality costs, economics of quality, Quality loss function, quality Vs productivity, Quality Vs reliability.

UNIT – II CONTROL CHARTS FOR VARIABLES 9

Control Charts for Variables: Control Charts for X bar and R (statistical basis, development and use, estimating process capability; interpretation, the effect of non- normality on the chart, the OC function, average run length); Control Charts for X bar and S; Control Chart for Individual Measurements; Applications of Variables Control Charts

UNIT - III CONTROL CHARTS FOR ATTRIBUTES 9

Control Chart for Fraction-Nonconforming (OC curve of the control chart, variable sample size, nonmanufacturing application, the OC function and ARL calculation); Control Charts for Nonconformities or Defects; Choices Between Attribute and Variable Control Charts, Guideline for Implementing Control charts.

UNIT – IV STATISTICAL PROCESS CONTROL 9

Process stability- process capability study using control charts, capability indices, capability analysis using histogram and normal probability plot, machine capability study, gauge capability study- setting statistical tolerances for components and assemblies. Natural Tolerance Limits of a Process - Based on the Normal Distribution, Nonparametric Tolerance Limits, Predictive model for SQC

UNIT - V ACCEPTANCE SAMPLING 9

Lot-By-Lot Acceptance Sampling For Attributes - The accepting sampling problem, single sampling plan for attributes, Double, Multiple, and sequential sampling, Dodge-Roming sampling plans (AOQL and LTPD plans).

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, Wiley-India, 7th Edition, 2015.
2. Krishnaiah K.,” Applied Statistical Quality Control and Improvement”, PHI, 2017.
3. Dale H. Besterfield, Quality Control, Pearson Education Asia, 8th Edition, 2018.

REFERENCES:

1. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Wiley, 3rd Edition, 2018.
2. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, McGraw-Hill Education, 7th Edition, 2018.
3. Monohar Mahajan, “Statistical Quality Control”, Dhanpat Rai & Sons, 2017.
5. Statistical Quality Control, R C Gupta, Khanna Publishers, New Delhi, 2015

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

Course Name : STATISTICAL QUALITY CONTROL		**Course Code : 20MEV15**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the basic Concepts of Quality and its tools.	I	K3	1,2,3,8,10	1,2,3
CO2	Construct the X bar, R & σ charts from the available data.	II	K3	1,2,3,9,10	1,2,3
CO3	Construct the p, np, c & u charts from the available data	II	K3	1,2,3,8,10	1,2,3
CO4	Control the occurrence of defects in product or service industries.	III	K3	1,2,3	1,2,3
CO5	Select and apply appropriate quality control technique for given application.	IV	K3	1,2,3,8	1,2,3
CO6	Measure the performance of the sampling plans	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**
CO1	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1
CO2	3	2	1	-	-	-	-	-	2	2	-	2	3	2	1
CO3	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1
CO4	3	2	1	-	-	-	-	-	-	-	-	2	3	2	1
CO5	3	2	1	-	-	-	-	2	-	-	-	2	3	2	1
CO6	3	2	1	-	-	-	-	1	2	2	-	2	3	2	1

20MEV25	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 : 20MEV25**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
CO1	Explain about method study procedure & its techniques and work measurement.												I	K2	1,2,8,10	1,2,3
CO2	Select material, process, production equipment, tooling and process parameters for the given product.												I	K3	1,2,3,8,10	1,2,3
CO3	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
CO4	Apply the step by step procedure for estimating the cost of any product.												III	K3	1,2,3,8,10	1,2,3
CO5	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
CO6	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**	
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	1	1	
CO2	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
CO3	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
CO4	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
CO5	3	2	1	-	-	-	-	1	-	1	-	-	2	1	1	
CO6	3	2	1	-	-	-	-	1	2	1	-	-	2	1	1	

20MEV35	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. MartandTelsang, “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” McGraw Hill International edition, 1992.
3. Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corporation,2015

REFERENCES:

1. Elwood S.Buffa, and RakeshK.Sarin, “Modern Production / Operations Management”, John Wiley and Sons, 8th Edition, 2000.
2. KanishkaBedi, “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 : 20MEV35**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain various aspects of product development.	I	K3	1,2,3,11	1, 2,3
CO2	Describe work sampling techniques.	II	K3	1,2,3,8,11	1, 2,3
CO3	Determine the quantity in batch production system.	III	K3	1,2,3,4,5,11,12	1, 2,3
CO4	Explain scheduling rules	IV	K3	1,2,3,4,5,7,11	1, 2,3
CO5	Determine manufacturing lead time for the given production system.	IV	K3	1,2,3,5,11,12	1, 2,3
CO6	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**
CO1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
CO2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
CO3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
CO4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
CO5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
CO6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20MEV45	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", McGraw Hill, 2011.

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

Course Name : SUPPLY CHAIN AND LOGISTIC MANAGEMENT		**Course Code : 20MEV45**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Describe the role and drivers of and supply chain management in achieving competitiveness.	I	K3	1,2,3,11	1, 2, 3
CO2	Explain about Supply Chain Network Design.	II	K3	1,2,3,8,11	1, 2, 3
CO3	Illustrate about the issues related to Logistics in Supply Chain.	III	K3	1,2,3,4,5,11,12	1, 2, 3
CO4	Appraise about Sourcing and Coordination in Supply Chain.	IV	K3	1,2,3,4,5,7,11	1, 2, 3
CO5	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
CO6	Describe about warehouse management.	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**
CO1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
CO2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
CO3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
CO4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
CO5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
CO6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20MEV55 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. PanneerSelvam, 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 : 20MEV55			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Determine the break-even point for a given production system.	I	K3	1,2,3,11	1, 2, 3
CO2	Compute time value equivalent for various cash flow.	II	K3	1,2,3,8,11	1, 2, 3
CO3	Describe various methods of comparison of alternatives.	III	K3	1,2,3,4,5,11,12	1, 2, 3
CO4	Choose a suitable replacement policy for items deteriorating with time.	IV	K3	1,2,3,4,5,7,11	1, 2, 3
CO5	Choose a suitable replacement policy for machines with infinite horizon.	IV	K3	1,2,3,5,11,12	1, 2, 3
CO6	Explain various determinants of cost.	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	PSO 3
CO1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
CO2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
CO3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
CO4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
CO5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
CO6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20MEV65	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. BikasBadhury,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 : 20MEV65**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the principles, functions of maintenance activities.	I	K3	1,2,3,11	1, 2, 3
CO2	Describe the different maintenance categories.	II	K3	1,2,3,8,11	1, 2, 3
CO3	Describe the principles and methods of lubrication.	II	K3	1,2,3,4,5, 11,12	1, 2, 3
CO4	Explain about condition monitoring and instruments used in industry.	III	K3	1,2,3,4,5,7 ,11	1, 2, 3
CO5	Describe the repair methods used for basic machine elements like bed, slide ways.	IV	K3	1,2,3,5,11, 12	1, 2, 3
CO6	Describe the repair methods used for material handling equipment.	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
CO1	3	2	1	-	-	-	-	-	-	-	2	-	3	2	1
CO2	3	2	1	-	-	-	-	1	-	-	2	-	3	2	1
CO3	3	2	1	1	2	-	-	-	-	-	2	1	3	2	1
CO4	3	2	1	2	2	-	1	-	-	-	2	-	3	2	1
CO5	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1
CO6	3	2	1	-	1	-	-	-	-	-	2	1	2	2	1

20MEV75	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge about optimization techniques and approaches.
- To formulate a real time problem as a mathematical programming model.
- To gain mathematical, computational and communication skills for solving problems.
- To gain knowledge to solve networking and inventory problems.
- To gain knowledge on solving different waiting line models

UNIT - I LINEAR PROGRAMMING 9

Introduction to Operations Research, Linear programming (LP) – assumptions, **properties of LP solutions**, Formulations of linear programming problem – Graphical method. Solutions to LPP – simplex, Big M method.

UNIT – II TRANSPORTATION AND ASSIGNMENT MODELS 9

Transportation Problem - Mathematical Model, Types – Balanced and Unbalanced, Solution to Transportation Problem - Finding the initial basic solution, **Optimizing the basic feasible solution applying U–V Method (Modi method)**

Assignment problem –Hungarian method, Travelling salesman problem - Branch and Bound technique.

UNIT - III NETWORK MODELS 9

Network problem: shortest path – Systematic method, Dijkstra's algorithm, Floyd's algorithm Minimal spanning tree – PRIM and Kruskal's algorithm, Maximum flow models – linear programming models, maximal flow problem algorithm

Project network representation, Critical Path Method computations, construction of time schedule, linear programming formulation of CPM, PERT networks.

UNIT – IV INVENTORY MODELS 9

Inventory models, Quantity Discount, Purchase Inventory Model - Q System, P System, Multiple-item Model - Shortage Limitation, Inventory Carrying CostConstraint, EOQ Model - Multi-item Joint Replenishment with and without Shortages, Space Constraint.

UNIT - V QUEUEING MODELS 9

Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. HamdyA.Taha "Operations Research – An Introduction", MacMillan India Ltd., 10th Edition,2017.
2. Panneerselvam R, "Operations Research", Prentice Hall India, 2016.
3. Hira.DGupta.P.K, "Operations Research",S.Chand Publications, 1st Edition, Reprint 2016

REFERENCES:

1. G.Srinivasan, "Operations Research: Principles and Applications", PHI Ltd., 2016.
2. KantiswarupGupta.P.K, Man Muhan" „Operations Research: Sultan Chand & Sons India Ltd., 12th Edition,New Delhi 2016.
3. Philips, Ravindran and Solberg, "Operations Research principle and practise", John Wiley, 2016.
4. Hiller and Liberman, Introduction to Operations Research, McGraw Hill, 2015.
5. Ramamurthy P, "Operations Research", New age International Publishers, 2nd edition, 2007.

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

Course Name : OPERATIONS RESEARCH														Course Code : 20MEV75	
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Solve Linear Programming Problems by appropriate technique.												I	K3	1,2,3,8,10	1,2,3
CO2	Determine the performance characteristics such as time and cost in solving shortest route, transportation problems with an appropriate model.												II	K3	1,2,3,9,10	1,2,3
CO3	Solve the given assignment problem with an appropriate method.												II	K3	1,2,3,8,10	1,2,3
CO4	Determine the optimal solution for a project scheduling problem.												III	K3	1,2,3	1,2,3
CO5	Determine the order quantity of goods under different constraints.												IV	K3	1,2,3,8	1,2,3
CO6	Determine the solutions to single and multi channel queuing problems.												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**	
CO1	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1	
CO2	3	2	1	-	-	-	-	-	2	2	-	2	3	2	1	
CO3	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1	
CO4	3	2	1	-	-	-	-	-	-	-	-	2	3	2	1	
CO5	3	2	1	-	-	-	-	2	-	-	-	2	3	2	1	
CO6	3	2	1	-	-	-	-	1	2	2	-	2	3	2	1	

VERTICAL - 6: MODERN MOBILITY SYSTEMS

20MEV16	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 : 20MEV16**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the various types of engines and components.	I	K2	1, 2, 3	1, 2, 3
CO2	Explain the various types of injection and ignition systems.	I	K2	1, 2, 3	1, 2, 3
CO3	Describe the various types of chassis, frame and steering systems.	II	K2	1, 2, 3	1, 2, 3
CO4	Distinguish between the manual transmissions systems with automatic transmission systems.	III	K2	1, 2, 3	1, 2, 3
CO5	Describe the operation of the brakes and the suspension systems.	IV	K2	1, 2, 3	1, 2, 3
CO6	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**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1

20MEV26 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: 20ME304 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 – NoxAdsorbers - 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", DhanpatRai& 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 : 20MEV26**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain fuel injection systems in SI engine, types of combustion chamber and combustion process.	I	K2	1, 2, 3	1, 2, 3
CO2	Explain different types of fuel injection system and combustion chambers of CI engine.	I	K2	1, 2, 3	1, 2, 3
CO3	Explain different types of air motion, and Turbo charging of IC Engine.	II	K2	1, 2, 3	1, 2, 3
CO4	Explain the mechanism of pollution formation and the evolution of emission norms.	III	K2	1, 2, 3	1, 2, 3
CO5	Describe the properties of various alternative fuels, engine modification required and emission characteristic of alternative fuels.	IV	K2	1, 2, 3	1, 2, 3
CO6	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**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20MEV36 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: 20ME403 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. Kirpalsingh, “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 : 20MEV36			
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain two stroke and four stroke SI and CI engines and valve & port timing diagrams.											I	K2	1, 2, 3	1, 2, 3
CO2	Explain the different circuits in two wheeler fuel systems and ignition system.											II	K2	1, 2, 3	1, 2, 3
CO3	Describe the main frame for two and four wheelers, chassis and drive systems for two wheelers.											III	K2	1, 2, 3	1, 2, 3
CO4	Describe the different types of clutches, gear box and suspension systems.											III	K2	1, 2, 3	1, 2, 3
CO5	Describe the different types of brake system for two wheeler and four wheeler, wheels and tyres.											IV	K2	1, 2, 3	1, 2, 3
CO6	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**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1

20MEV46	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. SandeepDhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.

REFERENCES:

1. MasatakaWakihara 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 : 20MEV46**				
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**	**PSOs**	
CO1	Describe the construction and working of lead acid batteries.										I	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
CO2	Explain the construction and working of lithium ion batteries.										II	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
CO3	Discuss about the testing of batteries.										III	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
CO4	Explain the battery pack system.										IV	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
CO5	Discuss about the battery management system.										IV	K2	1, 2, 3, 4, 6, 7	1, 2, 3	
CO6	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**
CO1	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO2	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO3	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO4	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO5	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO6	2	1	1	1	-	1	2	-	-	-	-	1	2	1	1

20MEV56	ALTERNATE FUELS FOR IC ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To expose potential alternate fuels and their characteristics
- To use appropriate synthetic fuels and fuel additives for better combustion characteristics
- To utilize alcohol fuels effectively for lower emissions
- To elaborate on the utilization of Bio-Diesel and its types as a suitable fuel in CI engines
- To utilize different gaseous fuels and predict their performance and combustion characteristics

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Alcohols, Bio-Diesel, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Biogas, Fuel standards – ASTM & EN.

UNIT – II SPECIAL AND SYNTHETIC FUELS 9

Different synthetic fuels, Merits and demerits, Dual, Bi-fuel and Pilot injected fuel systems, Fuel additives – types and their effect on performance and emission characteristics of engines, Flexi fuel systems, Ethers - as fuel and fuel additives, properties and characteristics.

UNIT - III ALCOHOL FUELS 9

Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Issues & limitation in alcohols

UNIT – IV BIO-DIESEL FUELS 9

Vegetable oils and their important properties. Fuel properties characterization. Methods of using vegetable oils – Blending, preheating, Transesterification and emulsification – Performance, combustion and emission Characteristics in diesel engines. Third generation biofuels, Ternary and Quaternary fuels, Issues & limitation of using vegetable oils in IC engines

UNIT - V GASEOUS FUELS 9

Biogas, Natural gas, LPG, Hydrogen – Properties, problems, storage and safety aspects. Methods of utilization in engines. Performance, combustion and emission Characteristics in engines. Issues & limitation in Gaseous fuels

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ramachandran S., Rapid Thermodynamic Simulation Model of an Internal Combustion Engine on Alternate Fuels,2014

2. Singh A.P. ,Alternative Fuels And Advanced Combustion Techniques As Sustainable Solutions For Internal Combustion Engines, Springer,2021

3. Biernat K, Alternative Fuels Technical and Environmental Conditions, INTECH, 2017

REFERENCES:

1.Keith Owen and Trevor Eoley, Automotive Fuels Reference Book , SAE Publications, 2014

2. PundirB.P , I.C. Engines Combustion and Emission, Narosa Publishing House. 2010

3. Pundir B.P , Engine Combustion and Emission, , Narosa Publishing House 2011

4. Richard L. Bechtold, Automotive Fuels Guide Book, SAE Publications, 2014.

5. S M AshrafurRahman, Alternative Fuels and Their Application to Combustion Engines, MDPI, 2021

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

Course Name : ALTERNATE FUELS FOR IC ENGINES													**Course Code : 20MEV56**			
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain various properties of Alternative Fuels and their merits demerits												I	K2	1,2,3	1,2
CO2	Describe various properties of Different Synthetic fuels and their merits demerits												II	K2	1,2,3	1,2
CO3	Discuss the performance and emission characteristics of engines using additives.												II	K2	1,2,3	1,2
CO4	Explain Properties, Production methods and usage of Alcohol fuels in I.C Engines.												III	K2	1,2,3	1,2
CO5	Describe various properties and production methods of BIO-Diesel fuels.												IV	K2	1,2,3	1,2
CO6	Discuss different types utilization of Gaseous Fuels												V	K2	1,2,3	1,2
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	1	1	1	-	-	-	-	-	-	-	-	2	1	1	
CO2	2	1	1	1	-	-	-	-	-	-	-	-	2	1	1	
CO3	2	1	1	1	-	-	-	-	-	-	-	-	2	1	1	
CO4	2	1	1	1	-	-	-	-	-	-	-	-	2	1	1	
CO5	2	1	1	1	-	-	-	-	-	-	-	-	2	1	1	
CO6	2	1	1	1	-	-	-	-	-	-	-	1	2	1	1	

20MEV66 INTELLIGENT TRANSPORTATION SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES

- To enable the students to study about the functional areas of Intelligent Transportation System. (ITS)
- To teach students about the architecture of Intelligent Transportation System. (ITS)
- To enable the students to know the strategies and algorithms of advanced Transport Management System.
- To teach students about the concepts of Advanced Traveller and Information System (ATIS)
- To develop the skills of the students to implement ITS in developed and developing countries.

PREREQUISITE:

Course Code: 20GE203

Course Name: Basic Electrical, Electronics and Instrumentation Engineering

UNIT - I INTRODUCTION TO INTELLIGENT TRANSPORT SYSTEM 9

Introduction to Intelligent Transportation Systems (ITS) -Definition – Role and Responsibilities – Advanced Traveller Information System – Fleet Oriented ITS Services – Electronic Toll Collection – Critical issues – Security – Safety.

UNIT – II ITS ARCHITECTURE AND HARDWARE 9

Architecture –ITS Architecture Framework – Hardware Sensors –Vehicle Detection – Techniques – Dynamic Message Sign – GPRS – GPS – Toll Collection.

UNIT - III ADVANCED TRANSPORT MANAGEMENT SYSTEM 9

Video Detection – Virtual Loop - Cameras - ANPR – IR Lighting – Integrated Traffic Management – Control Centre – Junction Management Strategies- ATMS – Advanced Traveler Information Systems (ATIS)- Route Guidance – Issues -– Historical – Current – Predictive Guidance – Data Collection – Analysis – Dynamic Traffic Assignment (DTA) – Components – Algorithm.

UNIT – IV ADVANCED TRAVELLER AND INFORMATION SYSTEM 9

Travel Information – Pre Trip and Enroute Methods- Basic ATIS Concepts – Smart Route System – Data Collection – Process – Dissemination to Travelers – Evaluation of Information – Value of Information – Business Opportunities.

UNIT - V CASE STUDIES 9

Automated Highway Systems -Vehicles in Platoons–Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Choudury M A and Sadek A, “Fundamentals of Intelligent Transportation Systems Planning” Artech House, 2003.
2. Pradip Kumar Sarkar, Amit Kumar Jain, “Intelligent Transport Systems”, PHI Learning Publishers, 2018.
3. Turban E.,”Decision Support and Export Systems Management Support Systems", Maxwell Macmillan, 1998.

REFERENCES:

1. Cycle W.Halsapple and Andrew B.Winston, "Decision Support Systems – Theory and Application", Springer Verlog, New York, 1987.
2. Sitausu S. Mittra, "Decision Support Systems – Tools and Techniques", John Wiley, New York, 1986.
3. Henry F.Korth, and Abraham Siberschatz, Data Base System Concepts, 7th edition, McGraw Hill, 2019.
4. Sussman, J. M., "Perspective on ITS", Artech House Publishers, 2005.
5. Turban. E and Aronson. J. E, "Decision Support Systems and Intelligent Systems", Prentice Hall, 2005.

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

Course Name: INTELLIGENT TRANSPORTATION SYSTEM													**Course Code: 20MEV66**		
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSO**
CO1	Describe the role and Responsibilities of Advanced Transportation System (ATS).												1	K2	**1,2**	**1**
CO2	Explain the Architecture and Hardware of ATS.												2	K2	**1,2**	**1**
CO3	Describe the strategies used in Advanced Transport Management System.												3	K2	**1,2,3**	**1,2**
CO4	Discuss about the algorithms used in Dynamic Traffic Assignment System.												3	K2	**1,2,3**	**1,2**
CO5	Describe about the data collection and evaluation process used in Advanced Traveller and Information System.												4	K2	**1,2,3**	**1,2**
CO6	Discuss about the implementation of ITS in developed and developing countries.												5	K2	**1,2,3**	**1,2**
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	
CO6	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	

SEMESTER VIII

		L	T	P	C
20ME8L1	**PROJECT WORK**	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 prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 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

OPEN ELECTIVE – II (VII SEMESTER) offered to other Department

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**
CO1	Summarize the basics of Photovoltaic systems.	I	K2	1, 2, 3	1, 2, 3
CO2	Explain the component of stand- alone photovoltaic systems	II	K2	1, 2, 3	1, 2, 3
CO3	Explain the component of grid connected photovoltaic systems	III	K2	1, 2, 3	1, 2, 3
CO4	Summarize the basics of Hybrid systems.	IV	K2	1, 2, 3	1, 2, 3
CO5	Explain the selection criteria for a given Photovoltaic application.	V	K2	1, 2, 3	1, 2, 3
CO6	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**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO6	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**
CO1	Explain the basic concepts of product design	I	K3	1,2,3,6,9,10	1,2,3
CO2	Describe the basic concepts of concurrent Engineering	I	K3	1,2,3,6,9,10	1,2,3
CO3	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
CO4	Discuss the concepts and importance of product architecture	III	K3	1,2,3,6,9,10	1,2,3
CO5	Apply the quality concepts to develop robust product	IV	K3	1,2,3,6,9,10	1,2,3
CO6	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	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO2	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO3	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1
CO4	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO5	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
CO6	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**
CO1	Discuss the latest technologies in the design of autonomous systems.	I	K2	1, 2, 3, 4, 5, 6, 7	1, 2, 3
CO2	Explain the perception of autonomous system.	II	K2	1, 2, 3, 4, 6, 7	1, 2, 3
CO3	Explain the prediction and routing of autonomous system.	II	K2	1., 2, 3, 4, 6, 7	1, 2, 3
CO4	Explain the planning and control of autonomous driving.	III	K2	1, 2, 3, 4, 6, 7	1, 2, 3
CO5	Explain the importance of electric vehicle and energy storage system.	IV	K2	1, 2, 3, 4, 6, 7	1, 2, 3
CO6	Discuss about the hybrid electric vehicles.	V	K2	1, 2, 3, 4, 6, 7	1, 2, 3

CO-PO Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	1	1	1	2	-	-	-	-	-	2	1	1
CO2	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO3	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO4	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO5	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
CO6	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 : 20OE108			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Illustrate the importance of safety in Boilers and Pressure vessels.	I	K3	1,2,3,4,6,10,12	1,2
CO2	Identify and prevent chemical, environmental mechanical, fire hazard.	II	K3	1,2,3,4,6,10,12	1,2
CO3	Collect, analyze and interpret the accidents data based on various safety techniques.	III	K3	1,2,3,4,5,6,10,12	1,2
CO4	Apply proper safety techniques on safety engineering and management.	IV	K3	1,2,3,4,5,6,10,12	1,2
CO5	Perform hazard analysis.	V	K3	1,2,3,4,5,6,10,12	1,2
CO6	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	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-
CO2	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-
CO3	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-
CO4	3	3	1	1	1	2	-	-	-	1	-	1	2	1	-
CO5	3	3	1	1	1	2	-	-	-	1	-	1	2	1	-
CO6	3	3	1	1	-	2	-	-	-	1	-	1	2	1	-