K.L.N. COLLEGE OF ENGINEERING

Pottapalayam-630612, Sivagangai District

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

Estd: 1994

THIRD YEAR

CURRICULUM AND SYLLABUS

REGULATIONS 2024

For Under Graduate Program

B.E. MECHANICAL ENGINEERING

(For the students admitted from the academic year 2024 – 2025 onwards)

Dr.P.Udhayakumar,
Professor & Head,
Department of Mechanical Engineering,
K.L.N. College of Engineering,
Pottapalayam, Sivaganga – 630612.

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.

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Progra2m Educational Objectives of the Mechanical Engineering Program are as given below

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

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

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

PEO 4 Graduates will adapt to evolving technologies through 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 and techniques and applying research based knowledge.

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

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

DEPARTMENT OF MECHANICAL ENGINEERING

Knowledge and Attitude Profile (WK)

WK1 : A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2 : Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3 : A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4 : Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice are as in the engineering discipline; much is at the forefront of the discipline.

WK5 : Knowledge, including efficient resource use, environmental impacts, whole-life cost, re- use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6 : Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7 : Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8 : Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9 : Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

DEPARTMENT OF MECHANICAL ENGINEERING

Program Outcomes (POs)

PO1 : **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2 : **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3 : **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4 : **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5 : **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6 : **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7 : **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8 : **Individual and Collaborative Teamwork:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9 : **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10 : **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one"s own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11 : **Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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B.E.MECHANICALENGINEERING
REGULATIONS 2024
CHOICE BASED CREDITSYSTEM
CURRICULUM AND SYLLABUS

SEMESTER V

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	24ME501	Design of Machine Elements	PC	3	3	1	0	4
2.	24ME502	Heat and Mass Transfer	PC	3	3	1	0	4
3.	24ME503	CAD / CAM	PC	3	3	0	0	3
4.		Professional Elective - I	PE	3	3	0	0	3
5.		Professional Elective - II	PE	3	3	0	0	3
PRACTICAL								
6.	24ME5L1	Dynamics Laboratory	PC	3	0	0	3	1.5
7.	24ME5L2	CAD / CAM Laboratory	PC	4	0	0	4	2
8.	24ME5L3	Heat and Mass Transfer Laboratory	PC	3	0	0	3	1.5
9.	24HS5L2	Skill Development Course – I	EEC	2	0	0	2	1*
			TOTAL	**27**	**15**	**2**	**12**	**22**
For Honours Degree								
1.		Capstone Design Project – Level I	EEC	12	0	0	12	6
OR								
1.		Honours Elective – I		3	3	0	0	3
2.		Honours Elective – II		3	3	0	0	3
For Minor Degree								
1.		Minor Elective – I		3	3	0	0	3
2.		Minor Elective – II		3	3	0	0	3

*** The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER VI

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	24ME601	Design of Transmission Systems	PC	3	3	1	0	4
2.	24ME602	Finite Element Analysis	PC	3	3	1	0	4
3.	24ME603	Geometric Dimensioning and Tolerancing	PC	3	3	0	0	3
4.	24ME604	Standards in Mechanical Engineering	PC	1	1	0	0	1
5.		Open Elective	OE	3	3	0	0	3
6.		Professional Elective - III	PE	3	3	0	0	3
7.		Professional Elective – IV	PE	3	3	0	0	3
8.	24MC601	Disaster Management	MC	2	2	0	0	-
PRACTICAL								
9.	24ME6L1	Computer Aided Simulation Laboratory	PC	4	0	0	4	2
10.	24ME6L2	Micro Project	EEC	2	0	0	2	1
11.	24HS6L2	Skill Development Course – II	EEC	2	0	0	2	1*
TOTAL				**29**	**21**	**2**	**8**	**24**
For Honours Degree								
1.		Capstone Design Project – Level I	EEC	12	0	0	12	6
OR								
1.		Honours Elective – I		3	3	0	0	3
2.		Honours Elective – II		3	3	0	0	3
For Minor Degree								
1.		Minor Elective – I		3	3	0	0	3
2.		Minor Elective – II		3	3	0	0	3

*** The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA**
 # mandatory Summer internship (2 weeks – 1 credit)

Professional Elective Courses – Verticals

Vertical 1	Vertical 2	Vertical 3	Vertical 4	Vertical 5	Vertical 6
Design	**Thermal Engineering**	**Automation**	**Manufacturing & Materials Engineering**	**Industrial & Systems Engineering**	**AI driven Mechanical System**
Product Life Cycle Management	Compressible Flow and Turbo machinery	Industrial IoT	Flexible Manufacturing Systems	Industrial Engineering and Management	Data Structures
Jigs, Fixture & Gauge Design	Power Generation Technology	PLC in Industrial Automation	Smart and Sustainable Manufacturing	Operations Research	Industry 4.0
Product Design And Development	Refrigeration and Air Conditioning Systems	Applied Hydraulics and Pneumatics	Digital Manufacturing	Lean Manufacturing	Machine Learning Theory and Applications
Innovation in Design	Computational Fluid Dynamics	Data Analytics for Mechanical Engineering	Additive Manufacturing	Statistical Quality Control	Artificial Intelligence Applications in Mechanical Engineering
Tribology in Design	Battery Technology	Industrial Robotics	Materials In Industrial Applications	Production Planning and Control	Soft Computing Techniques and Applications
Piping Design Engineering	Fundamentals of Electric Vehicles	Machine Vision and Image Processing	Semiconductor Materials And Manufacturing	Production and Operations Management	Introduction to MATLAB

Vertical 1: Design

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEV11	Product Life Cycle Management	PE	3	3	0	0	3
2.	24MEV21	Jigs, Fixture & Gauge Design	PE	3	3	0	0	3
3.	24MEV31	duct Design And Development	PE	3	3	0	0	3
4.	24MEV41	Innovation In Design	PE	3	3	0	0	3
5.	24MEV51	Tribology in Design	PE	3	3	0	0	3
6.	24MEV61	Piping Design Engineering	PE	3	3	0	0	3

Vertical 2: Thermal Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEV12	Compressible Flow and Turbo machinery	PE	3	3	0	0	3
2.	24MEV22	Power Generation Technology	PE	3	3	0	0	3
3.	24MEV32	Refrigeration and Air Conditioning Systems	PE	3	3	0	0	3
4.	24MEV42	Computational Fluid Dynamics	PE	3	3	0	0	3
5.	24MEV52	Battery Technology	PE	3	3	0	0	3
6.	24MEV62	Fundamentals of Electric Vehicles	PE	3	3	0	0	3

Vertical 3: Automation

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEV13	Industrial Internet of Things	PE	3	3	0	0	3
2.	24MEV23	PLC in Industrial Automation	PE	3	3	0	0	3
3.	24MEV33	Applied Hydraulics and Pneumatics	PE	3	3	0	0	3
4.	24MEV43	Data Analytics for Mechanical Engineering	PE	3	3	0	0	3
5.	24MEV53	Industrial Robotics	PE	3	3	0	0	3
6.	24MEV63	Machine Vision and Image Processing	PE	3	3	0	0	3

Vertical 4: Manufacturing & Materials Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEV14	Flexible Manufacturing Systems	PE	3	3	0	0	3
2.	24MEV24	Smart and Sustainable Manufacturing	PE	3	3	0	0	3
3.	24MEV34	Digital Manufacturing	PE	3	3	0	0	3
4.	24MEV44	Additive Manufacturing	PE	3	3	0	0	3
5.	24MEV54	Materials In Industrial Applications	PE	3	3	0	0	3
6.	24MEV64	Semiconductor Materials and Manufacturing	PE	3	3	0	0	3

Vertical 5: Industrial & Systems Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEV15	Industrial Engineering and Management	PE	3	3	0	0	3
2.	24MEV25	Operations Research	PE	3	3	0	0	3
3.	24MEV35	Lean Manufacturing	PE	3	3	0	0	3
4.	24MEV45	Statistical Quality Control	PE	3	3	0	0	3
5.	24MEV55	Production Planning and Control	PE	3	3	0	0	3
6.	24MEV65	Production and Operations Management	PE	3	3	0	0	3

Vertical 6: AI driven Mechanical System

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEV16	Data Structures	PE	3	3	0	0	3
2.	24MEV26	Industry 4.0	PE	3	3	0	0	3
3.	24MEV36	Machine Learning Theory and Applications	PE	3	3	0	0	3
4.	24MEV46	Artificial Intelligence Applications in Mechanical Engineering	PE	3	3	0	0	3
5.	24MEV56	Soft Computing Techniques and Applications	PE	3	3	0	0	3
6.	24MEV66	Introduction to MATLAB	PE	3	3	0	0	3

OPEN ELECTIVE (VI SEMESTER) – offered to other Department

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24OE101	Power Plant Engineering	OE	3	3	0	0	3
2.	24OE102	Industrial Safety Practices	OE	3	3	0	0	3
3.	24OE103	Supply Chain Management	OE	3	3	0	0	3
4.	24OE104	3D Printing	OE	3	3	0	0	3

ELECTIVE for Minor Degree in Mechanical Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	24MEM01	Fundamentals of Mechanical Engineering	ES	3	3	0	0	3
2.	24MEM02	Manufacturing Systems	ES	3	3	0	0	3
3.	24MEM03	Materials Engineering	ES	3	3	0	0	3
4.	24MEM04	Fundamentals of Product Design	ES	3	3	0	0	3
5.	24MEM05	Robotics and Automation	ES	3	3	0	0	3
6.	24MEM06	Management Concepts	ES	3	3	0	0	3

24ME501	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To apply the procedure for choosing standard data
- To design the shaft based on the strength and rigidity.
- To apply the theories of failure.
- To design the procedure for shafts, couplings, joints, and springs.
- To apply the theory of lubrication and the design procedure for bearings

UNIT – I INTRODUCTION **9+3**

Basic requirements of machine elements, Use of standards in design, Aesthetic and ergonomic considerations in Design, Selection of Materials, Determination of Loads, Deflection in simple machine parts, Theories of Failure, Factor of safety, Design against Static Load, Design against Fluctuating loads, Fatigue failure theories.

UNIT – II DESIGN OF SHAFTS AND COUPLINGS **9+3**

Shaft materials, Design of solid and hollow shafts on strength and torsional rigidity basis, Types of keys, Design of square, flat, and Kennedy keys, Design of splines, Design of Couplings - Rigid and flexible couplings.

UNIT – III DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS **9+3**

Springs: Types of springs, Terminology of helical spring, Styles at end, series, and parallel connection, -exponential relationship Spring material, Design of helical, concentric, multi-leaf Springs against variable loading, Surge in springs.
Power screws: Forms of threads, Terminology, Torque requirement, self-locking, Design of power screw.
Flywheels considering stresses in rims and arms for engines and punching machines-Connecting Rods, Crankshafts, and Piston

UNIT – IV DESIGN OF TEMPORARY AND PERMANENT JOINTS **9+3**

Threaded joints, Screw threads –Terminology, ISO metric, Bolted joint – Simple analysis and eccentrically loaded.
Welded joints - Butt, parallel fillet, and transverse fillet welds - Welded joints subjected to axial and eccentric load, bending, and torsional moment.
Types of rivet heads, rivet materials, Types of failure, Longitudinal butt joint, circumferential lap joint, and eccentrically loaded riveted joint for boiler shells. Joint failure and evaluation, Fail-safe design

UNIT – V DESIGN OF BEARINGS **9+3**

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

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Bhandari V B, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 5th Edition, 2020.
2. Joseph Shigley, Charles Mischke, Richard Budynas, and Keith Nisbett “Mechanical Engineering Design”, 11th Edition, Tata McGraw-Hill, 2020.

REFERENCES:

1. Sundararajamoorthy T. V. Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2018.
2. Alfred Hall, Halowenko, A., and Laughlin, H., “Machine Design”, Tata McGraw Hill Book Co (Schaum"s Outline), 2010
3. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”, Tata McGraw-Hill Book Co., 3rd Edition, 2013.
4. AnselUgural, “Mechanical Design – An Integral Approach", Tata McGraw-Hill Book Co, 1stEdition, 2003.
5. Ganesh Babu, Sridhar, “Machine Design”, Tata McGraw-Hill Education, 2nd Edition, 2010.

OUTCOMES:

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

Course Name : DESIGN OF MACHINE ELEMENTS		**Course Code : 24ME501**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C301.1	Design the given machine component for static and fluctuating loads.	I	K3
C301.2	Design a shaft and coupling for a given application.	II	K3
C301.3	Design suitable springs for various loading conditions and power screws.	III	K3
C301.4	Design suitable joints for given applications, including both permanent and temporary joints.	IV	K3
C301.5	Design suitable sliding contact and rolling contact bearings for the given application	V	K3

24ME502	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To enable students to calculate conductive heat rate under steady and transient conditions.
- To equip students with the ability to determine heat transfer during convection.
- To develop students' competence to determine heat transfer during phase change and design heat exchangers
- To provide students with knowledge of thermal radiation principles to calculate radiative heat exchange between surfaces
- To familiarize students with mass transfer fundamentals to solve mass transfer problems

UNIT – I CONDUCTION **9+3**

Conduction – general 3D equation – One Dimensional Steady State Heat Conduction – – plane walls and cylinders, Composite walls — Critical thickness of insulation - Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler‟s charts.

UNIT – II CONVECTION **9+3**

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes and Free Convection over vertical surface. Introduction to CFD.

UNIT – III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS **9+3**

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

UNIT – IV RADIATION **9+3**

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

UNIT – V MASS TRANSFER **9+3**

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

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Yunus A. Cengel, Afshin J. Ghajar, "Heat Transfer: Fundamentals and Applications”, Tata McGraw Hill, 6th Edition, 2020
2. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 3rd edition, 2011

REFERENCES:

1. Bergman T.L., Lavine A.S., Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 8th ed., John Wiley , 2018.
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 10th Edition, 2022.
3. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 5th Edition, 2017
4. Rajput R.K., A Text Book of Heat and Mass Transfer, S. Chand Publishers, 7th Edition, 2018
5. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 10th Edition 2010.

OUTCOMES:

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

Course Name : HEAT AND MASS TRANSFER		**Course Code : 24ME502**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C302.1	**Determine** heat transfer rates in simple geometries under steady and transient conditions.	I	K3
C302.2	**culate** heat transfer in internal and external flows by applying free and forced convection correlations.	II	K3
C302.3	**Calculate** heat transfer rate during boiling and condensation and design heat exchangers by applying LMTD and NTU methods	III	K3
C302.4	**Determine** radiative heat transfer between various types of surfaces.	IV	K3
C302.5	**Determine** mass transfer rate by applying diffusive and convective mass transfer equations and correlations.	V	K3

24ME503	CAD / CAM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the applications of computers in design and manufacturing of mechanical components and apply the concept of 2D and 3D transformations.
- To understand the fundamentals of parametric curves, surfaces and solid modeling techniques.
- To know about the CAD standards.
- To understand principles of tooling and drive systems in CNC and prepare manual part programming for manufacturing components in lathe and milling machines.
- To learn about IoT enabled manufacturing system.

UNIT – I INTRODUCTION 8

Product life cycle, Design process- Shigley model, Computer aided design, methodology, Reasons for implementing CAD, Benefits, Applications, CAD System architecture, co-ordinate systems- 2D and 3D transformations, Projective transformation, homogeneous coordinates. Computer Aided Manufacturing — Hierarchy, Elements — CAM data base, Production management, manufacturing control.

UNIT – II GEOMETRIC MODELING 11

Wireframe modeling and its limitations; Parametric representation of analytic curves, parametric representation of synthetic curves - Cubic spline, Bezier, B-spline, NURBS, curve manipulation;
Surface models: Types of surfaces, parametric representation of surfaces, design examples. Fundamentals of solid modeling: Boundary representation, Constructive Solid Geometry, solid manipulations, solid modeling based applications.

UNIT – III CAD STANDARDS AND MASS PROPERTY CALCULATIONS 8

Standards - Graphical Kernel System, standards for exchange images - Open Graphics Library, Data exchange standards. CG and interference, Geometric Tolerance, automation Mass Property Calculations: Introduction, geometrical property formulation, mass property
formulation; Design and engineering applications.

UNIT – IV CNC MACHINING AND PART PROGRAMING 9

Classification of CNC machines, Tooling for CNC machines, Automatic tool changer, work handling devices, Drive systems — stepper and servo motors, Recirculating ball screw and nut assembly.
Detailed Manual part programming on Lathe & Milling machines using G codes and M codes - Cutting Cycles, Loops, Sub program and Macros - Introduction of CAM package.

UNIT – V IOT IN CAM 9

Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007
2. Dr. Sadhu Singh, “Computer Aided Design & Manufacturing, Khanna Publishers 5th Edition 2018.

REFERENCES:

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ 2nd Edition, Pearson Education, 2001
2. M.S.Sehrawat and J.S.Narang “CNC Machines Computer Numerical Control” Dhanpatrai& Co Publishers, 2nd Revised Edition 2002.
3. S.Kant Vajpayee “Principles of Computer Integrated Manufacturing” Prentice hall of India, New Delhi 2003
4. Dr. K.C. Jain and VikasGohil “ CAD/CAM/CIM” Khanna Publishers 2014
5. K.Lalit Narayanan, K.MallikarjunaRao, M.M.M.Sarcar, “Computer Aided Design and Manufacturing” Prentice hall of India, New Delhi 2008

OUTCOMES:

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

Course Name : CAD / CAM		**Course Code : 24ME503**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C303.1	Explain the application of computers in design & elements of CAM	I	K3
C303..2	Explain the fundamentals of parametric curves, surfaces and Solid modeling techniques.	II	K2
C303.3	Explain the different types of Standard systems used in CAD	III	K2
C303.4	Explain the principles of tooling and drive systems in CNC and prepare manual part programming for Lathe and Milling Machines.	IV	K3
C303.5	Explain the fundamentals of IOT in CAM.	V	K2

24ME5L1 **DYNAMICS LABORATORY** **L T P C**
0 0 3 1.5

- To understand the fundamental principles of mechanical vibrations, dynamics, and kinematics of machines.
- To experimentally determine the static and dynamic responses of mechanical systems under various loading and boundary conditions.
- To develop the ability to analyze and interpret motion mechanisms such as cams, governors, and gear trains.
- To evaluate and calculate key system parameters such as velocity ratio, moment of inertia, angular setting, and natural frequency using experimental setups.
- To enhance hands-on skills in using mechanical apparatus for dynamic testing and
- improve understanding of real-world machine behavior through laboratory practice

LIST OF EXPERIMENTS

1. Determine the deflection in Cantilever beam under different loading conditions.
2. Determine the critical speeds of shafts with concentrated loads.
3. Draw the Cam profile and study about jump phenomenon.
4. Determine the unbalanced mass and relative angular setting for balancing the rotating body.
5. Determine the velocity ratio of simple and compound gear train.
6. Determine the natural frequency, damping coefficient for single and multi-degree spring mass system.
7. Determine the natural frequency of single rotor system.
8. Determine the natural frequency of double rotor system.
9. Draw the controlling force diagram for Governors.
   Draw the controlling force diagram for Proell, Governors.
   Draw the controlling force diagram for Proell,
   Governors. Draw the controlling force diagram for Hartnell Governors.
10. Determine the mass moment of Inertia of axisymmetric bodies using Turn Table apparatus
11. Determine the mass moment of Inertia using bifilar suspension and compound pendulum.
12. Determine the mass moment of inertia of fly wheel and axle system

TOTAL : 45 PERIODS

S.No.	Name of the equipment	Quantity
1.	Transverse vibration setup of a cantilever	1
2.	Whirling of shaft apparatus	1
3.	Cam follower setup.	1
4.	Dynamic balancing machine	1
5.	Gear Models	1
6.	Spring mass vibration system	1
7.	Torsional Vibration of single rotor system setup	1
8.	Governor apparatus -Watt, Porter, Proell and Hartnell governors	1
9.	Turn table apparatus	1
10.	Compound pendulum and bifilar suspension	1
11.	Flywheel setup.	1

OUTCOMES:

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

Course Name : DYNAMICS LABORATORY		**Course Code : 24ME5L1**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C306.1	Calculate the deflection of the cantilever beam and Determine the critical speed of the shaft. Draw the Cam profile	1,2,3	K3
C306.2	Determine the unbalanced mass and relative angular setting for balancing the rotating body and cam analysis. calculate the speed ratio and train value of simple and compound gear train	4,5	K3
C306.3	Calculate the natural frequency of the longitudinal and torsional vibratory systems.	6,7,8	K3
C306.4	Calculate the Effect of Actual Spindle Speed on Sleeve Displacement, Effect of Radius of Rotation on Centrifugal Force and draw the characteristics curve for different types of	9	K3
C306.5	Determine the Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus, compound pendulum and bifilar suspension, flywheel.	10,11, 12	K3

24ME5L2	CAD / CAM LABORATORY	L T P C 0 0 4 2

OBJECTIVES:

- To gain practical experience in handling 3D part modeling using software systems.
- To create assembly drawing using part drawing and also to create detailed drawing.
- To gain practical experience in preparing the manual part programming for CNC lathe.
- To gain practical experience in preparing the manual part programming for pocketing in CNC milling
- To gain practical experience in preparing the manual part programming for linear and circulation interpolation and canned cyles for drilling in CNC milling.

LIST OF EXPERIMENTS

3D GEOMETRIC MODELLING

1. Introduction of 3D Modelling software
2. Creation of 3D assembly model of following machine elements using 3D Modelling software
   - Flange Coupling
   - Plummer Block
   - Screw Jack
   - Universal Joint
   - Geneva mechanism
   - CAM and follower mechanism
   - Quick return mechanism of shaping machine

Manual Part Programming.

(i). Part Programming - CNC Turning Centre
   - Straight, Taper and Radius Turning.
   - Thread Cutting.
   - Rough and Finish Turning Cycle.
   - Drilling and Tapping Cycle.

(ii). Part Programming - CNC Machining Centre
   - Linear Cutting.
   - Circular cutting.
   - Cutter Radius Compensation.
   - Canned Cycle Operations.
   - Pocketing

4. Design and fabrication of a component using extrusion based additive Manufacturing.
5. Perform machining operation in the given work piece using Wire cut EDM

TOTAL : 60 PERIODS

S.No.	Name of the equipment	Quantity
1.	Computer Server	1
2.	Computer systems networked to the server	30
3.	Laser Printer	1
4.	CNC Lathe	1
5.	CNC milling machine	1
6.	3D Printer	1
7.	Wire cut EDM	1
Software		
8.	High end integrated modeling and manufacturing CAD / CAM software	15 Licenses

OUTCOMES:

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

Course Name : CAD / CAM LABORATORY		**Course Code : 24ME5L2**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C307.1	Draw 3D part drawings using 3D modeling software.	1,3	K3
C307.2	Assemble the parts and create detailed drawing.	2,4	K3
C307.3	Prepare manual part programming and perform machining process in CNC Lathe for the given component.	5,6, 7,8	K3
C307.4	Prepare manual part programming for rectangular and circular pocketing in CNC milling for the given component.	9,10	K3
C307.5	Prepare manual part programming for linear and circular interpolation & drilling canned cycles in CNC milling for the given component.	11,12	K3

24ME5L3 HEAT AND MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To learn to measure thermal conductivity of materials.
- To study forced convective heat transfer
- To study the free convective heat transfer
- To study the performance of Heat exchangers.
- To study radiative heat transfer

LIST OF EXPERIMENTS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of Thermal conductivity of insulating powder
3. Determination of Thermal conductivity of composite slab
4. Heat transfer from pin-fin apparatus
5. Determination of heat transfer coefficient under forced convection through a tube
6. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
7. Effectiveness of double pipe heat exchangers.
8. Effectiveness of cross flow heat exchanger.
9. Determination of Stefan – Boltzmann constant.
10. Determination of emissivity of a grey surface

TOTAL : 45 PERIODS

S.No.	Name of the equipment	Quantity
1.	Lagged pipe apparatus	1
2.	Thermal conductivity of insulating powder apparatus	1
3.	Composite wall apparatus	1
4.	Pin-fin apparatus	1
5.	Forced convection inside tube apparatus	1
6.	Natural convection-vertical cylinder apparatus	1
7.	Parallel flow/Counter flow heat exchanger apparatus	1
8.	Cross flow heat exchanger apparatus	1
9.	Stefan-Boltzmann apparatus	1
10.	Emissivity measurement apparatus	1

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

Course Name : HEAT AND MASS TRANSFER LAB		**Course Code : 24ME5L3**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C308.1	**Determine** the thermal conductivity of solid materials	1,2,3	K3
C308.2	**Measure** the fin efficiency of a pin fin under natural/forced convection conditions	4	K3
C308.3	**Determine** the convective heat transfer coefficient in natural and forced convection modes	5,6	K3
C308.4	**Measure** the performance of parallel/counter/cross flow heat exchangers	7,8	K3
C308.5	**Determine** the Stefan-Boltzmann constant and Emissivity of a gray surface.	9,10	K3

24HS5L1	**SKILL DEVELOPMENT COURSE – I** **PIPING DESIGN**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1***

MODULE 1 **15**

Material Selection, Types, Size, Schedule, Method of Joining, Drawing Types - Pipes, Bolts, Gaskets, Body, Bonnet, Trim, Disk & Seat, Stem, Actuator, Packing. Valves - types, selection criteria, construction. Valve actuator - types, selection criteria, construction.
Pipe Rack Spacing - Pipe Flexibility - Heat Expansion - Pipe Anchors - Pipe Insulation Shoes - Pipe Guides, Pipe Span, Pipe Support, Field Support, Dummy Support, Hanger Rods

MODULE 2 **15**

Design & Build Exercise: Students design a small piping system (with valves, supports, insulation) and prepare full documentation (P&ID, isometric, BOM).

TOTAL 30 Periods

24ME601 DESIGN OF TRANSMISSION SYSTEMS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To apply knowledge on the working principle of power transmission components.
- To develop the step by step procedure for the design of mechanical drives
- To apply the thermal considerations for design of components.
- To construct to draw ray diagram of gear box
- To design the clutches and brakes.

UNIT – I DESIGN OF BELT AND CHAIN DRIVES 9+3

Belt drive — Belt construction, belt length- geometric relationships, Analysis of belt tensions, conditions for maximum power, Characteristics of belt drives, Basic procedure for selection of V belt.
Chain drive — Construction of roller chain, chain length — geometrical relationship, polygonal effect, Sprocket wheels, design of chain drive. Wire ropes

UNIT – II SPUR GEARS AND HELICAL GEARS 9+3

Gear drives – classification, selection, Spur gear – terminology, gear trains, interference and undercutting, backlash, force analysis - beam strength, wear strength, gear tooth failure, selection of material, Design of spur gear, Spiral gears, Helical Gears – terminology, virtual number of teeth, tooth proportions, force analysis – beam strength, effective load, wear strength, design of helical gear. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT – III BEVEL, WORM AND CROSS HELICAL GEARS 9+3

Bevel gears – terminology, force analysis – beam and wear strength, effective load, design of bevel gears. Worm gears – terminology, proportion, force analysis, friction, selection of material, strength and wear rating, thermal considerations. Design of worm gears.

UNIT – IV GEAR BOXES 9+3

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

UNIT – V CAMS, CLUTCHES AND BRAKES 9+3

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses Clutches – torque transmitting capacity, friction materials, design of multidisc, cone, centrifugal clutches.
Brakes — energy equations, block brake with short and long shoe, pivoted block brake with long shoe, internal expanding brake, band and disk brakes.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Bhandari V B, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 5th Edition, 2020.
2. Joseph Shigley, Charles Mischke, Richard Budynas, and Keith Nisbett “Mechanical Engineering Design”, 11th Edition, Tata McGraw-Hill, 2020.

REFERENCES:

1. Sundararajamoorthy T. V. Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2018.
2. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2015.
3. Text Book f o Machine Design by `MOHAMAD JALALUDEEN S. Anuradha Publications; 2009
4. Machine Design by P Kannaiah by Scitech Publications India Private Limited.

Ganesh Babu, Sridhar, “Machine Design”, Tata McGraw-Hill Education, 2nd Edition, 2010.

OUTCOMES:

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

Course Name : DESIGN OF TRANSMISSION SYSTEMS		**Course Code : 24ME601**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C309.1	Design a belt and chain sprockets for the given power transmission conditions.	1	K3
C309.2	Design a spur and helical gears based on strength and wear consideration.	2	K3
C309.3	Design bevel gear and worm gear pair based on strength and wear consideration.	3	K3
C309.4	Design various gear boxes (sliding mesh, constant mesh, multispeed) through geometric progression, standard step ratio, ray diagram and kinematics layout.	4	K3
C309.5	Design various clutches, internal and external shoe brakes.	5	K3

24ME602	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To apply basic elasticity principles and variational methods to simple structural problems.
- To formulate and solve one-dimensional structural problems and to analyze the vibration characteristics of bars.
- To apply finite element formulation to trusses and beams with different loading conditions
- To develop finite element formulations for 2D problems using triangular elements, understand plane stress/strain and axisymmetric conditions
- To analyze 1D and 2D steady-state heat transfer problems

UNIT – I INTRODUCTION **9+3**

Introduction to FEM, engineering applications, Methods to solve engineering problems, past present and future of FEA, General procedure of FEA, Types of FEA analysis. Principles of Elasticity: Strain displacement relations, Stress strain relations for 1D and 2D, Potential energy method, RayleighRitz method and Galerkin method, applied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads.

UNIT – II ONE-DIMENSIONAL PROBLEMS **9+3**

One Dimensional Second Order Equations, Discretization, Derivation of Shape functions, Stiffness matrices, force vectors and assembly of matrices, Solution of structural problems - Bar. Longitudinal vibration frequencies of bars and mode shapes.

UNIT – III TRUSSES AND BEAMS **9+3**

Formulation plane trusses element, Stiffness matrix (No derivation), Numerical Problems on point load, Formulation beam element, derivation of shape functions, stiffness matrix and load vector (No derivations), Numerical Problems on beams carrying concentrated, UDL and couples. (Problems with 2
elements only)

UNIT – IV TWO-DIMENSIONAL PROBLEMS **9+3**

Second Order 2D Equations - Scalar and Vector Variable Functions, Variational formulation, FiniteElement formulation, 3 noded triangular elements-Shape functions and element matrices and vectors. Equations of elasticity — Plane stress, plane strain and axisymmetric problems — Body forces and temperature effects – Stress and strain calculations.

UNIT – V HEAT FLOW PROBLEMS AND ISOPARAMETRIC FORMULATION **9+3**

Steady state heat transfer analysis: 1D analysis of composite walls and fins — 2D analysis of thin plate Natural co-ordinate systems, Isoparametric elements —Shape functions- stress-strain and strain displacement relations — Numerical integration

TOTAL : 60 PERIODS

TEXT BOOKS:

1. P.Seshu, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd. New Delhi, 2012.
2. J.N.Reddy, “An Introduction to the Finite Element Method”, McGraw-Hill International 4th Editions), 2019.

REFERENCES:

1. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 4th Edition, Prentice-Hall of India, Eastern Economy Editions. 2015
2. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons,2005 (Indian Reprint 2013)
3. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2013
4. Gokhale Nitin S “Practical Finite Element Analysis” Finite To Infinite edition, 2020.
5. Cook, Robert.D., Plesha, Michael.E & Witt, Robert.J. “Concepts and Applications of Finite Element Analysis”, Wiley Student Edition, 2004.

OUTCOMES:

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

Course Name : FINITE ELEMENT ANALYSIS		**Course Code : 24ME602**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C310.1	Design a belt and chain sprockets for the given power transmission conditions.	1	K3
C310..2	Design a spur and helical gears based on strength and wear consideration.	2	K3
C310.3	Design bevel gear and worm gear pair based on strength and wear consideration.	3	K3
C310.4	Design various gear boxes (sliding mesh, constant mesh, multispeed) through geometric progression, standard step ratio, ray diagram and kinematics layout.	4	K3
C310.5	Design various clutches, internal and external shoe brakes.	5	K3

24ME603	GEOMETRIC DIMENSIONING AND TOLERANCING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to understand Indian standards for machine drawing.
- To gain knowledge in limits, fits and tolerances.
- To gain knowledge about graphical representation of surface finish.
- To read the blue print and understand the given information.
- To gain knowledge about assembly drawing from the part drawings of the industrial components.

UNIT – I INTRODUCTION **9**

Drawing reading, Angle of projection, Tolerance and its uses, Tolerance types, GD&T, Main factors in GD&T, Classification in GD&T, Tolerance charts.

UNIT – II DATUM **9**

Straightness, Flatness and Circularity, Datum, Uses of Datum, Cylindricity, Profile of line, Profile of surface, Implementation of tolerance in CAD Software

UNIT – III CONTROL FRAMES **9**

Perpendicularity, Parallelism, Position, Angularity, Concentricity, symmetry, Circular runout, Total runout, Feature control frame, Modifiers, Maximum material condition and Least material condition, Implementation of GD&T symbols in CAD Software

UNIT – IV LIMITS AND FITS **9**

Limits and Fits, Types of Fits, System of fits, Surface finish, Surface finish symbols, Lay, Implementation of Datum & Surface finish symbols in CAD Software

UNIT – V INDUSTRIAL DRAWINGS **9**

Understanding of Part drawing and Assembly drawing, Concept of Machining stocks Understanding of the GD&T in industrial drawings

TOTAL : 45 PERIODS

TEXT BOOKS:

1. K.R.Gopalakrishna, “Machine Drawing”, 23rd Edition, Subhas Stores, Bangalore, 2017.
2. K.L.Narayana, P.Kannaiah and K.Venkata Reddy, “Production Drawing”, 3rd Edition, New Age International Publishers, New Delhi, 2014.

REFERENCES:

1. ThamosP.Olivo and Dr.C.ThamosOlivo, “Basic Blueprint Reading and Sketching”, 9th Edition Revised, Industrial Press Inc, New York, 2010.
2. Walter W Sturtevant, “Practical Problems in Mechanical Drawing and Blue- Print Reading”, Wentworth Press, 2016.
3. BIS recommendation for school practices: SP46:2003.

OUTCOMES:

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

Course Name : GEOMETRIC DIMENSIONING AND TOLERANCING		**Course Code : 24ME603**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C311.1	Explain the various factors in GD&T	I	K3
C311.2	Discuss the uses of datum.	II	K3
C311.3	Determine the requirement of material in Maximum condition and	III	K3
C311.4	Describe the various types of limits, fits and tolerance.	IV	K3
C311.5	Explain the assembled view of the mechanical products with GD & T.	V	K3

24ME604 STANDARDS IN MECHANICAL ENGINEERING

L	T	P	C
1	0	0	1

UNIT – I OVERVIEW OF STANDARDS 7

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

UNIT – II IMPORTANT STANDARDS RELEVANT TO MECHANICAL ENGINEERS 8

Overview of Quality Management Systems (as per IS/ISO 9001), Environmental Management Systems (as per IS/ISO 14001), Occupational Health & Safety Management Systems (as per IS/ISO 45001), Laboratory Quality Management Systems (as per IS/ISO/IEC 17025), Energy Management System (as per IS/ISO 50001). Overview of Indian standards for 1. Engineering Drawing 2. Mechanical Testing of metals (Tensile test, Hardness, Impact test) 3. Non-destructive testing of metals 4. Safety of machinery (IS 16819) 5. Refrigeration and Air Conditioning, ASTM Standards, Life Cycle Assessment, ASME Standards, BRC Standards, NABL Standards

TOTAL : 15 PERIODS

REFERENCES:

1. **Rüdiger Wolfrum**, “International Standards and the WTO”
2. **Virendra Kumar Gupta**, “Understanding ISO 9001:2015 Quality Management System”
3. **“ISO 14001: Environmental Management Systems”** – Key sustainability-focused standard.
4. **ASTM Standards** – Mechanical testing (tensile, hardness, impact).
5. **ASME Boiler & Pressure Vessel Code** – Mechanical engineering safety standards.
6. **ISO 14040/14044** – Life Cycle Assessment standards.
7. **BRC Global Standards** – Food safety and supply chain assurance.
8. **NABL Accreditation Documents** – Laboratory quality aligned with ISO/IEC 17025.

OUTCOMES:

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

Course Name : STANDARDS IN MECHANICAL ENGINEERING		**Course Code : 24ME604**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C312.1	Describe Indian and International Standards	I	K2
C312.2	Describe the roles and functions of BIS related to Indian industries	I	K2
C312.3	Explain the Engineering Drawing Standards	II	K2
C312.4	Differentiate different ISO Standards	II	K2
C312.5	Describe ASTM Standards, ASME Standards, BRC Standards, NABL Standards	II	K2

24MC601	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

24ME6L1	COMPUTER AIDED SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To analyze the structural behavior
- To perform thermal analysis on engineering components such as composite walls, plates, and shells,
- To carry out stress analysis of axisymmetric components
- To determine natural frequencies and mode shapes of different beam configurations
- To develop skills in 3D modeling and perform torsional and thermo-mechanical analysis

LIST OF EXPERIMENTS

1. Determine the heat distribution along the composite wall.
2. Determine the S.F.D, B.M.D and deflection of cantilever beam various types of loading problem.
3. Determine the S.F.D, B.M.D and deflection of simply supported beam various types of loading problem.
4. Determine the S.F.D, B.M.D and deflection of fixed beam various types of loading problem.
5. Calculate the thermal stress and heat transfer in plates
6. Calculate the thermal stress and heat transfer in shells.
7. Determine the Stress analysis of axi – symmetric components.
8. Calculate the natural frequency and mode shape analysis in cantilever beams.
9. Calculate the natural frequency and mode shape analysis in SSB beams.
10. Calculate the natural frequency and mode shape analysis in Fixed beams.
11. 3D Modeling of pulley.
12. Torsion analysis
13. Thermo mechanical analysis

TOTAL : 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Name of the equipment	Quantity
1	Computer Work Station	30
2	Printer	1
3	ANSYS Software	30 License

OUTCOMES:

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

Course Name : COMPUTER AIDED SIMULATION LABORATORY		**Course Code : 24ME6L1**	
CO	**Course Outcomes**	**Unit**	**K–CO**
C316.1	Determine the heat distribution along the composite wall.	1	K3
C316.2	Determine the S.F.D, B.M.D and deflection of beam with various types of loading problem(Cantilever, SSB, Fixed Beam) case study problems	2,3,4	K3
C316.3	Calculate the thermal stress and heat transfer in plates and shells, Determine the Stress analysis of axi — symmetric	5,6,7	K3
C316.4	Calculate the natural frequency and mode shape analysis of beams (Cantilever, SSB, Fixed Beam).	8,9,10	K3
C316.5	3D Modeling of pulley , torsion analysis and Thermo mechanical analysis	11,12, 13	K3

24ME6L2	MICRO PROJECT	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To allow the students to explore the breadth of research that is being performed within the college.
- To implement knowledge of mechanical engineering to design a component.
- To apply the programming knowledge to solve a real-world situation/problem.
- To work as an individual or in a team in development of technical projects.
- To communicate and report effectively project related activities and findings.

GUIDELINE FOR REVIEW AND EVALUATION

Micro Project shall carry 100 marks and shall be evaluated through continuous assessment only. Every student is expected to present a minimum of 2 technical seminars / demonstrations per semester before the evaluation committee and for each technical seminar, marks can be equally apportioned. The three member committee appointed by Head of the Department will evaluate the seminar and at the end of the semester the marks can be consolidated and taken as the final mark. The evaluation shall be based on the seminar paper/ report (40%), presentation (40%) and response to the questions asked during presentation (20%).

TOTAL : 30 PERIODS

OUTCOMES:

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

Course Name : MICRO PROJECT		**Course Code : 24ME6L2**
CO	**Course Outcomes**	**K–CO**
C317.1	Identify and define a problem statement from the requirements raised from literature survey need analysis.	K4
C317.2	Build and Test mechanical components for developing real life applications.	K4
C317.3	Work in teams, write comprehensive report.	K4
C317.4	Demonstrate prototyping which will lead them towards entrepreneurship.	K4
C317.5	Deliver an effective presentation of the academic project.	K4

24HS6L1	SKILL DEVELOPMENT COURSE – II LEAN METHODOLOGY PRACTICE	L 0	T 0	P 2	C 1*

MODULE 1 **20**

- Five phases of the DMAIC framework for structured process improvement.
- Lean waste elimination and Six Sigma variation reduction
- Cycle time, task time, and throughput as measures of process flow
- Voice of the customer to Critical-to-Quality (CTQ) project requirements
- Potential causes of variation using a cause-and-effect diagram
- Hypothesis testing to validate or reject assumed root causes
- Proactive risk responses using Failure Modes and Effects Analysis (FMEA)
- Control plans assign monitoring responsibilities and contingency actions
- Components of a Standard Operating Procedure (SOP) for a new process
- Role of governance reviews in sustaining process improvements
- Review control chart data to determine if a process remains stable

MODULE 2 **10**

Case Studies:

Reducing Defects in a Pump Assembly Line

Reducing Paint Defects in Automotive Manufacturing

TOTAL 30 Periods

24MEV11	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the fundamental concepts and components of PLM.
- To explore various product development approaches such as bottom-up, top-down, and modular design.
- To define product modelling and understand its fundamental concepts and issues.
- To understand PDM architectures, product data interchange, and portal integration.
- To learn various methods of integrating PLM systems with other enterprise applications like ERP.

UNIT – I INTRODUCTION TO PLM **9**

History, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. Product Data and Product Workflow, Company"s PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

UNIT – II PRODUCT DEVELOPMENT **9**

Product Development Approaches: Bottom-up design, Top-down design, Front-loading design workflow, Design in context, Modular design. Concurrent engineering, partnership with supplier, collaborative and Internet based design, work structuring and team deployment, Product and process systemization, problem, identification and solving methodologies, improving product development solutions.

UNIT – III PRODUCT MODELING **9**

Product Modelling - Definition of concepts - Fundamental issues — Role of Process chains and product models -Types of product models — model standardization efforts-types of process chains - Industrial demands. Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration).

UNIT – IV PRODUCT DATA MANAGEMENT **9**

Product Data Management (PDM), Benefits and Terminology, PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. Information authoring tools (e.g., MCAD, ECAD, and technical publishing), core functions (e.g., data vaults, document and content management, workflow and program management), Functional applications (e.g., configuration Management).

UNIT – V INTEGRATION OF PLM WITH OTHER APPLICATIONS, PLM SOFTWARES **9**

Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD PLM Softwares-Basic features and modules of ENOVIA and Windchill

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006.
2. Antti Saaksvuori, Ansel miImmonen, Product Life Cycle Management Springer, 1st Edition 2002

REFERENCES:

1. John.Stark Product Lifecycle Management,(Volume 5) ,2023.
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.
3. Razwan Udroiu and Paul Bere, Product Lifecycle Management terminology and applications, BoD — Books on Demand, 2018.
4. Gerd Hartmann, Ulrich Schmidt Product Lifecycle Management with SAP: The Complete Guide to MySAP PLM - Strategy, Technology and Implementation Galileo Press, 2005
5. Sameer Kumar, William A. Krob Managing Product Life Cycle in a Supply Chain: Context: A Prescription Based on Empirical Research, Springer Science & Business Media, 2006

OUTCOMES:

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

Course Name : PRODUCT LIFE CYCLE MANAGEMENT		**Course Code : 24MEV11**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain basic concepts of product life cycle management	I	K2
2.	Demonstrate product development approaches.	II	K2
3.	Explain elements of product modeling.	III	K2
4.	Prepare the concept of product data management with example	IV	K2
5.	Discuss about integration of PLM with other applications.	V	K2

24MEV21	JIGS, FIXTURE & GAUGE DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the design principles of jigs, fixtures, and gauges, along with their functional differences, economic importance, and common design defects.
- To learn various locating and clamping principles, devices, standard parts, and methods used in jig and fixture design, including force analysis, tolerance analysis, and safety considerations.
- To acquire knowledge on the design of different types of drill jigs, clearances, and application of jigs in modern manufacturing processes.
- To develop the ability to design suitable fixtures for specific manufacturing operations.
- To apply the Taylor‟s principle and to design functional gauges such as flush pin, positional, and receiver gauges for real-world applications.

UNIT – I BASICS OF JIGS, FIXTURESAND GAUGES 9

Introduction — Jigs and Fixtures — Difference between Jigs and Fixtures , Economy and cost - Elements of Jigs and Fixtures , Fool Proofing – Materials used in Jigs and Fixtures , Essential features of Jigs and Fixtures ,Common defects in Jigs design. Introduction to Gauge , IS specifications for gauges , General Design Principles and Design steps.

UNIT – II LOCATING AND CLAMPING PRINCIPLES 9

Introduction to locating and clamping devices, difference between jigs and fixture, advantages of jigs and fixture, materials used in jigs and fixture, locating principle, locating methods and devices, standard parts, clamping — analysis of clamping forces, tolerance and error analysis. Consideration of Safety factor while designing of Jig Fixture and Gauge.

UNIT – III Jigs 9

General considerations in design drill jigs , types of drill jigs , Drill bushings, Method of constructions , clearance — handling clearance, swarf and cutting fluid clearances, burr grooves Methods of inserting bushes, Design Drill jigs for given components, Drill jigs and modern manufacturing.

UNIT – IV Fixture 9

Introduction to fixtures, Types of fixtures & Application — overview, Vise fixtures, milling fixtures , Boring fixtures, broaching fixtures , Lathe fixtures, grinding fixtures, welding fixture , indexing fixture, Design of fixtures for the given components.

UNIT – V Gauge 9

Gauge design : introduction, Types of gauges, gauges tolerance , selection of materials for gauges. Taylors principle, ideal gauge. Design of Positional gauges, Indicator, Flush pin and Receiver gauges. Case studies of gauges for selected components.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. P H Joshi, “Jigs and Fixture”, Tata McGraw Hill, 2010.
2. P.C. Sharma, “A Text Book of Production Technology”, S. Chand, 2007
3.

REFERENCES:

1. Kempster, “Introduction to Jigs & Tool Design”, Viva Books Pvt. Ltd,1998.
2. Cyryll Donaldson, George H.Lecain, V.C. Goold, “Tool Design”, Tata Mcgraw Hill, 2002.
3. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi,
4. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, 2017.
5. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.

OUTCOMES:

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

Course Name : JIGS, FIXTURE & GAUGE DESIGN		**Course Code : 24MEV21**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the fundamental concepts, functions, and importance of jigs, fixtures, and gauges in manufacturing processes.	I	K2
2.	Apply the principles of locating and clamping to and design effective jig and fixture setups, considering standard parts, tolerances and safety factors.	II	K3
3.	Design of various types of drill jig for specific components by incorporating standard elements such as drill bushings, clearance requirements, and modern manufacturing practices.	III	K3
4.	Design and select appropriate fixtures (e.g., milling, lathe, welding) for specific machining operations by understanding their functions.	IV	K3
5.	Design a gauge based on Taylor‟s principle, material selection, tolerances, and apply gauge design to practical case studies.	V	K3

24MEV31	PRODUCT DESIGN AND DEVELOPEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the modern product development process and the formulation of engineering specifications for new products.
- To translate conceptual idea into detailed design.
- To establish the product architecture by understanding component interactions, standardization, and implications on product performance, variety, and manufacturability.
- To implement Design for Manufacturing (DFM), Design for Assembly (DFA), and prototyping principles in order to reduce cost and complexity
- To integrate industrial design principles into product development by considering aesthetics,
- ergonomics, user needs, and managing the industrial design process

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 Design for Assembly (DFA) and Serviceability – Rapid Prototyping and Digital Twin Concepts.

UNIT – V INDUSTRIAL DESIGN 9

Integrated process design – Managing costs – Robust design –Integrating CAE, CAD, CAM tools 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. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 2019.
2. George E Dieter, Linda C Schmidt, “Engineering Design”, Mc-Graw Hill International Edition, 5th Edition, 2012

REFERENCES:

1. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education.
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, 7thEdition 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 : 24MEV31**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the basic concepts of product design and development	I	K2
2.	Explain various concepts for a product design and to select the best concept	II	K2
3.	Discuss the concepts and importance of product architecture	III	K2
4.	Illustrate the importance of industrial design in view of aesthetics factors and ergonomic factors	IV	K2
5.	Explain the manufacture guidelines for reducing manufacturing cost without compromising quality	V	K2

24MEV41	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.

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 **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

REFERENCES:

1. Stephen Wunker, Jessica Wattman and David Farber, Jobs to Be Done: A Roadmap for Customer-Centered Innovation, AMACOM, 2016.
2. Michael G. Luchs, Scott Swan, Abbie Griffin, Design Thinking: New Product Development Essentials from the PDMA, Wiley, 2015
3. Alexander Osterwalder, Yves Pigneur, Patricia Papadakos, Gregory Bernarda, Value Proposition Design: How to Create Products and Services Customers Want, Wiley, 2014
4. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Bloomsbury Publishing India Private Limited, 2011
5. Jeanne Liedtka and TimOgilvie, Designing for Growth: A DesignThinking Tool Kit for Managers, Columbia University Press, 2011

OUTCOMES:

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

Course Name : INNOVATION IN DESIGN		**Course Code : 24MEV41**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain seven concerns in design thinking.	I	K2
2.	Describe new needs to context with example.	II	K2
3.	Describe the constraints and technologies for comprehension.	III	K2
4.	Identify the manufacturing challenges in crafting.	IV	K2
5.	Explain the innovation domains.	V	K2

24MEV51	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the importance and history of tribology and the classification of lubricants
- To study the different types of friction and wear mechanisms techniques.
- To identify the friction forces and power loss in a hydrodynamic journal bearing
- To know the pressure distribution and load-carrying capacity of the slider and hydrostatic bearings
- To study the different types of surface features associated with the bearing materials

UNIT – I INTRODUCTION TO TRIBOLOGY 9

Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

UNIT – II FRICTION AND WEAR 9

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals. Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

UNIT – III HYDRODYNAMIC JOURNAL BEARINGS 9

Friction forces and power loss in a lightly loaded journal bearing, Petroff"s equation, mechanism of pressure development in an oil film, and Reynold"s equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld"s number and it"s significance; partial bearings, end leakages in journal bearing, numerical examples.

UNIT – IV PLANE SLIDER BEARINGS WITH FIXED/PIVOTED SHOE 9

Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, center of pressure, numerical examples. Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. Introduction to Hydrostatic journal bearings.

UNIT – V BEARING MATERIALS 9

Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials. Introduction to Surface engineering: Concept and scope of surface engineering. Surface modification — transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for
wear and corrosion resistance.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Introduction to Tribology B. Bhushan John Wiley & Sons, Inc., New York 2002
2. Engineering Tribology PrasantaSahoo PHI Learning Private Ltd, New Delhi 2011

REFERENCES:

1. Introduction to Tribology in bearings B. C. Majumdar Wheeler Publishing.
2. Engineering Tribology G. W. Stachowiak and A. W. Batchelor Butterworth-Heinemann 1992.
3. Friction and Wear of Materials Ernest Rabinowicz John Wiley &Sons 1995
4. Engineering Tribology J. A. Williams Oxford Univ. Press 2005
5. Handbook of tribology: materials, coatings and surface treatments B.Bhushan, B.K. Gupta McGraw-Hill 1997

OUTCOMES:

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

Course Name : TRIBOLOGY IN DESIGN		**Course Code : 24MEV51**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Understand the fundamentals of tribology and associated parameters	I	K2
2.	Apply concepts of tribology for the performance analysis and design of components experiencing relative. motion.	II	K3
3.	Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application.	III	K3
4.	Select proper bearing materials and lubricants for a given tribological application.	IV	K3
5.	Apply the principles of surface engineering for different applications of tribology.	V	K3

24MEV61 **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.

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 Hand book", McGraw Hill Handbook,7th Edition,2000.
2. George A Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair", CRC Press, 2003.

REFERENCES:

1. Sam kannapan, Introduction to Pipe stress analysis "Abi Enterprises Inc.,2008
2. Peter Smith, Fundamentals of piping design",GulfpublishingCompany,2007
3. "Power and Process Piping Standards "ASME B 31.1&B31.3,2012.
4. Kellogg M W, "Design of Piping Systems", John Wiley & Sons, 2019.
5. Liang-Chuan Peng and Tsen-Loong Peng, "Pipe Stress Engineering", ASME Press, New York, 2009.

OUTCOMES:

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

Course Name : PIPING DESIGN ENGINEERING		**Course Code : 24MEV61**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Apply various codes and standards for piping systems	I	K3
2.	Calculate the piping wall thickness and branch reinforcement	II	K3
3.	Draw the lay out for piping systems and equipment	III	K3
4.	Determine the stresses induced in the pipes under various loadings	IV	K3
5.	Explain the concept of piping lay out and stresses acting on it.	V	K2

24MEV12 COMPRESSIBLE FLOW AND TURBOMACHINERY

L	T	P	C
3	0	0	3

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.

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 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, 6th Edition (2018).
2. Kothandaraman.C.P. Domkundwar. S, Domkundwar. A.V., “A course in thermal Engineering",5th Edition,”DhanpatRai& sons, 2016.

REFERENCES:

1. Anderson, J.D., "Modern Compressible flow", McGraw Hill,4th Edition, , 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 Turbo machinery", 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 : 24MEV12**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Determine fluid properties in isentropic flow through variable area ducts.	I	K3
2.	Calculate fluid properties in flow through constant area ducts.	II	K3
3.	Determine the changes in fluid properties in normal & oblique shock.	III	K3
4.	Analyze the performance enhancement of gas turbine by applying	IV	K4
5.	Explain the working of rotary compressor.	V	K2

24MEV22 POWER GENERATION TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the operation and maintenance of coal based thermal power plants.
- To study the diesel, combined cycle power plants.
- To understand different types of nuclear engineering and power plants.
- To understand different types of power from renewable energy.
- To study energy, economic and environmental issues of power plants.

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, Fuel and ash handling, Draught system, Feed water treatment.

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

Recap of 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). Safety measures for Nuclear Power plants.

UNIT – IV POWER FROM RENEWABLE ENERGY 9

Hydro Electric Power Plants. 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‟s Power Plant Engineering", Nag.P.K. Tata McGraw — Hill Publishing Company Ltd., 5th Edition 2021.
2. A Textbook of Power Plant Engineering by R.K. Rajput,1 January 2016.

REFERENCES:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Power Plant Engineering by B. VijayaRamnath C. Elanchezhian, L. Saravanakumar | 1 November 2019.
4. Power Plant Engineering, As per AICTE: Theory and Practice by Dipak Kumar Mandal, SomnathChakrabarti, et al. | 1 January 2019.
5. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

OUTCOMES:

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

Course Name : POWER GENERATION TECHNOLOGY		**Course Code : 24MEV22**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the layout, construction and working of the thermal power plant.	I	K2
2.	Determine the performance of the otto, diesel, dual and Gas power cycles.	II	K3
3.	Explain the layout, construction and working of the nuclear power plants.	III	K2
4.	Explain the layout, construction and working of the Renewable energy	IV	K2
5.	Explain the power plant economics and environmental effects.	V	K2

24MEV32 REFRIGERATION AND AIR CONDITIONING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the properties .Classification and Nomenclature of different Refrigerant.
- To understand the underlying principles of operations in different Refrigeration & Air Conditioning systems and components.
- To understand the knowledge on design aspects of Refrigeration.
- To understand the psychrometric properties and processes.
- To provide knowledge on Air Conditioning Systems with Controls

UNIT – I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle sub cooling and super heating- effects of condenser and evaporator pressure on COP multi pressure system — low temperature refrigeration - Cascade systems — problems. Equipment"s: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT – III VAPOUR ABSORPTION AND OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems — Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems

UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air conditioning processes, mixing of air streams.

UNIT – V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", McGraw Hill, 4th edition, 2021.
2. R. S. Khurmi, J. K. Gupta, “A Text Book of Refrigeration and Air-conditioning”, Eurasia Publishing House, 2019.

REFERENCES:

1. Roy J. Dossat, "Principles of Refrigeration", Pearson Education Asia, 4th edition, 2019.
2. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 2021.
3. ASHRAE Hand book, Fundamentals, 2010
4. Jones W.P., "Air conditioning engineering", Elsevier Butterworth-Heinemann, 5th edition, 2018
5. A. R. Trott, T C Welch , Refrigeration and air-conditioning, Butterworth Heinemann, 2018

OUTCOMES:

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

Course Name : REFRIGERATION AND AIR CONDITIONING SYSTEMS		**Course Code : 24MEV32**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the principle of refrigeration, cycles, properties and their environment effects.	I	K2
2.	Calculate COP of vapor compression Cycle and Explain the working principle of components of vapour compression refrigeration system.	II	K3
3.	Describe the working principle of vapour absorption and other	III	K2
4.	Determine psychometric properties of moist air	IV	K3
5.	Analyze the cooling load factor for winter and summer air conditioning	V	K4

24MEV42 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To apply the fundamentals of CFD, and develop 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
- To understand the concept of turbulence modeling.

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, Tran sportiveness, 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. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., Munipalli, R., Shankar, V., Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 4th edition, 2020
2. Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2007.

REFERENCES:

1. Atul Sharma, “Introduction to Computational Fluid Dynamics”, Springer, 2022.
2. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, 2014.
3. YogeshJaluria& Kenneth E. Torrance, “Computational Heat Transfer”, CRC press, 2002
4. Suhas V, Patankar, “Numerical Heat transfer and Fluid flow”, Taylor & Francis, 2009.
5. John. F. Wendt, “Computational Fluid Dynamics – An Introduction”, Springer, 2009.

OUTCOMES:

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

Course Name : COMPUTATIONAL FLUID DYNAMICS		**Course Code : 24MEV42**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Derive**the governing equations of fluid flow and heat transfer.	I	K3
2.	**cretize** 1 D steady and transient diffusion equations using finite difference method.	II	K3
3.	**Discretize** 1 D steady and transient diffusion equations using finite volume method	III	K3
4.	**Derive** finite volume equations for 1 D convention diffusion problem.	IV	K3
5.	**Describe** various turbulence models.	V	K2

24MEV52	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.

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, 3rd E. 2002.
2. T.Minami, M.Tatsumisago,M.Wakihara,C. Iwakura,S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009.

REFERENCES:

1. Masataka Wakihara and OsamuYamamoto, Lithiumion 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 : 24MEV52**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Describe the construction and working of batteries used in	I	K2
2.	Explain the construction and working of advanced energy storage systems including Li-ion battery	II	K2
3.	Explain the performance characteristic of battery.	III	K2
4.	Discuss about the battery management system.	IV	K2
5.	Discuss the environmental aspects, energy consumption, reuse and recycling of batteries.	V	K2

24MEV62	FUNDAMENTALS OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the development of EVs from technological, environmental, and societal perspectives.
- To acquire the knowledge on modern electric vehicles (EVs)
- To introduce the fundamental concepts and principles of electric drive train topologies.
- To Model, analyze and design electric vehicles and to understand energy management strategies.

UNIT – I INTRODUCTION 9

Basics of vehicles mechanisms, history of electric vehicles (EV), Types of Electric Vehicle, Electric vehicle Architecture: Major components of electric vehicle need and importance of EV, Power/Energy supplies requirements for EV applications, EV advantages and Impacts.

UNIT – II ENERGY SOURCES FOR EV 9

Energy storage requirements, Battery parameters, Types of Batteries, Modeling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation and ultra-capacitors as energy sources for EV.

UNIT – III ELECTRIC PROPULSION 9

Electric Propulsion EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

UNIT – IV BATTERIES AND AUXILIARIES 9

Battery parameters. Types and characteristics of EV batteries- Lead Acid, Nickel metal hydride, Lithium-ion Batteries. Battery testing and maintenance; charging schemes. On-board and off-board battery chargers. Battery state-of-charge indicators.

UNIT – V ENERGY MANAGEMENT STRATEGIES AND EMERGING EV TECHNOLOGIES 9

EV energy management strategies, classification and comparison of various energy management strategies, energy efficiency comparison for various EV variants, Hybrid electric vehicles (HEVs): types, operating modes, control, generator/motor requirements.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. MehrdadEhsani, YiminGao, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles — Fundamentals, Theory and Design, CRC Press, New York, Third Edition,2019.
2. Prof. Sunil R.Pawar (Electrical Vehicle Technology: The Future Towards Eco-Friendly Technology, 2ND Edition, 2021.

REFERENCES:

1. IqbalHussain, Electric & Hybrid Vehicles – Design Fundamentals, CRC Press, New York, Second Edition,2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons Ltd., England, Second Edition,2012.
3. SandeepDhameja, Electric Vehicle Battery Systems, Newness, Massachusetts, 2002.
4. Dr Mike Westbrook, M H Westbrook, The Electric Car: Development & Future of Battery, Hybrid & Fuel-Cell Cars, British library Cataloguing in Publication Data, First Edition, 2001
5. S. S. Thipse, “Alternative Fuels”, Jaico Publications, First Edition 2010

OUTCOMES:

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

Course Name : FUNDAMENTALS OF ELECTRIC VEHICLES		**Course Code : 24MEV62**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the working of components of EVs	I	K2
2.	Discuss various energy sources for EVs including batteries and fuel cells.	II	K2
3.	Explain the working of electric motor drives for EVs.	III	K2
4.	Discuss the functioning of various batteries for EVs.	IV	K2
5.	Explain the emerging technologies and working of hybrid electric vehicles (HEVs).	V	K2

24MEV13 INDUSTRIAL INTERNET OF THINGS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To outline the fundamentals of Internet of Things.
- To describe the architecture and support systems of IIoT
- To summarize the implementation and data monitoring system associated with IIoT.
- To describe about IIoT analytics and Cyber Physical Systems.
- To illustrate the applications of IIoT concepts in various industries.

UNIT – I INTRODUCTION AND ARCHITECTURE OF IoT 9

Introduction–Definition and characteristics of IoT–Physical and Logical Design of IoT–Communication models and APIs–Challenges in IoT–Evolution of IoT–Components of IoT–A Simplified IoT Architecture–Core IoT Functional Stack.

UNIT – II INDUSTRIAL IoT (IIoT) 9

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking. Industrial Support systems for IIoT, Smart Factories.

UNIT – III IMPLEMENTATION SYSTEMS AND DATA MONITORING WITH IIoT 9

Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and IoT Hub systems. IoT Gate way, IoT Edge Systems and It‟s Programming, Cloud computing, Real Time Dashboard for Data Monitoring and Predictive Maintenance with IIoT technology.

UNIT – IV IIoT ANALYTICS AND CYBER PHYSICAL SYSTEMS(CPS) 9

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.CPS architecture, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Introduction to digital twin, Augmented Reality and Virtual Reality, CPS in CNC Machines and Automotive systems overview of .cyber physical production system

UNIT – V INDUSTRIAL IoT- APPLICATIONS AND CASE STUDIES 9

Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries, Healthcare, Power Plants, Inventory Management & Quality Control, Transportation and Logistics, Facility Management.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Alasdair Gilchrist “Industry 4.0: The Industrial Internet of Things” Apress Publications, 1st Edition, 2016.
2. Dr. OvidiuVermesan, Dr. Peter Friess, “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers, 1st Edition, 2013.

REFERENCES:

1. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat,."Industrial Internet of Things: Cyber manufacturing Systems", Springer publications ,2017.
2. GiacomoVeneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT" Packt publisher,2018.
3. S. Misra, C. Roy, and A. Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0" CRC Press, 2021.
4. Rajkamal, "Embedded System: Architecture, Programming and Design" McGraw Hill Education publisher, 3rd Edition, 2017.
5. Bartodziej, Christoph Jan, "The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gabler Wiesbaden publisher, 1st Edition, 2016.

OUTCOMES:

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

Course Name : INDUSTRIAL INTERNET OF THINGS		**Course Code : 24MEV13**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain in detail about architecture, physical and logical design of	I	K2
2.	Explain in detail about architecture and support systems for the Industrial Internet of Things(IIoT).	II	K2
3.	Describe the basic implementation systems of IIoT and data	III	K2
4.	Explain in detail about IIoT analytics and architecture of Cyber	IV	K2
5.	Apply the IIoT concepts in different industries and also to real-time case studies.	V	K3

24MEV23	PLC IN INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the fundamentals of PLCs and their roles in industrial automation.
- To describe PLC hardware circuits, I/O devices, modules and communication interfaces.
- To illustrate the ladder logic programming languages and also symbols used in programming.
- To apply PLC programming in industrial process control.
- To summarize the implementation process of PLC with real-world industrial automation systems.

UNIT – I INTRODUCTION TO PLC 9

Basics of Industrial Automation — Overview of Control Systems: Open loop and closed loop systems–Introduction to PLCs: Definition, history and evolution–PLC vs. Relay-based control systems — Applications of PLC in industry.

UNIT – II PLC HARDWARE 9

PLC architecture: CPU, power supply, input /output modules–Input devices: switches, sensors, encoders—Output devices: actuators, motors, solenoids — Memory types and programming devices — Communication interfaces and networks.

UNIT – III PLC PROGRAMMING 9

Programming languages: Ladder Logic Diagram (LD), Function Block Diagram (FBD), Structured Text (ST), Sequential Function Chart (SFC)–Basic programming instructions: Relay instructions, timers, counters – Data handling: MOV, ADD, SUB, MUL, DIV — Comparison and logical instructions.

UNIT – IV ADVANCED PLC FUNCTIONS 9

Analog I/O Processing—PID Control using PLC—Communication protocols (Modbus, Profibus, Ethernet/IP)–PLC interfacing with HMI (Human-Machine Interface) and SCADA–Fault detection and trouble shooting.

UNIT – V INDUSTRIAL APPLICATIONS 9

Conveyor systems control – Packaging and bottling automation – Temperature, level, and flow control–Motor control and sequencing–Case studies in automotive, chemical, and manufacturing industries.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. W. Bolton, Programmable Logic Controllers, 6th Edition, Elsevier, 2015
2. Frank D. Petruzella, Programmable Logic Controllers, 6th Edition, McGraw-Hill, 2025.

REFERENCES:

1. JohnW. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, 5th Edition, Prentice Hall, 2002
2. Jon Stenerson, PLC Programming for Industrial Automation, 2nd Edition, 2003
3. Glen A. Mazur & William J. Weindorf, Programmable Logic Controllers: Principles and Applications, 3rd Edition, 2021
4. Max Rabiee, Programmable Logic Controllers: Hardware and Programming, 5th Edition, 2023
5. Vijay R. Jadhav, Programmable Logic Controller, Khanna Publisher, 3rd Edition, 2008

OUTCOMES:

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

Course Name : PLC IN INDUSTRIAL AUTOMATION		**Course Code : 24MEV23**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain in detail about the basic concepts of PLCs and their role in industrial automation.	I	K2
2.	Discuss about PLC hardware, I/O devices, and communication interfaces.	II	K2
3.	Describe the ladder logic programming techniques used in PLC control logic.	III	K2
4.	Apply the PLC programming logic codes in industrial processes.	IV	K2
5.	Explain in detail about the PLC based real-world industrial	V	K3

24MEV33	APPLIED HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the basic concepts of fluid power system.
- To discuss about the utilization of cylinders, accumulators, valves and various electrical and electronic control components
- To illustrate the design, construction and operation of fluid power circuits.
- To build the skills for trouble shooting the hydraulic and pneumatic circuits.
- To illustrate the applications of hydraulic and pneumatic circuits in modern manufacturing industries.

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. KV mapping method

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.

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, CRC Press, 3rd Edition, October 24, 1995.
5. James R. Daines “Fluid Power: Hydraulics and Pneumatics” ,GW publisher, 2nd Edition,2009.

OUTCOMES:

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

Course Name : APPLIED HYDRAULICS AND PNEUMATICS		**Course Code : 24MEV33**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Discuss the function of different types of hydraulic pumps and motors.	I	K2
2.	Describe the features and functions of hydraulic actuators, Direction and Flow control valves.	II	K2
3.	Develop fluid power multi actuation circuits for various purposes in industry.	III	K3
4.	Construct the cascaded electro pneumatic circuits for requiring cylinder sequences	IV	K3
5.	Illustrate the various trouble shooting methods and applications of hydraulic and pneumatic systems.	V	K3

24MEV43 DATA ANALYTICS FOR MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To outline the various methods of data collection.
- To illustrate the data processing and data handling methods used in mechanical engineering.
- To demonstrate the streaming of data analytics and data security.
- To summarize the concepts of data analytics in manufacturing sector.
- To apply the concepts of data analytics in manufacturing, energy management and safety systems.

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.

REFERENCES:

1. Sabina Jeschke, Christian Brecher, Houbing Song, Dana B. Rawat, "Industrial Internet of Things: Cyber- manufacturing Systems", Springer, 2016.
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.
3. Adrian McEwen, Hakim Cassimally , "Designing the Internet of Things", John

Wiley and Sons Ltd, 2014.
4. Thomas Er, Dr. Zaigham Mahmood, Professor Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", PHI, 2013.
5. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, Wiley Publications, 2013.

OUTCOMES:

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

Course Name : **DATA ANALYTICS FOR MECHANICAL ENGINEERING**		**Course Code : 24MEV43**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the data collection systems using sensors.	I	K2
2.	Describe the data processing and handling methods.	II	K2
3.	Explain the data security systems.	III	K2
4.	Describe the applications of data analytics in manufacturing Sector.	IV	K2
5.	Apply data analytics techniques to energy and safety management by identifying and demonstrating their practical applications in	V	K3

24MEV53	INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the functions of the basic components and coordinate system of a robot.
- To describe the working principle of various robot drive system and end effectors
- To summarize the use of various types of robot Sensors.
- To apply the Robot Kinematic equations to design any type of robot manipulators.
- To summarize the implementation procedures and safety issues of robot.

UNIT – I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Laws of Robot- 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 - Material Handling, Processing and Assembly- Material Handling, Processing and Assembly.

UNIT – II ROBOT DRIVE SYSTEMS &END EFFECTORS 9

End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers — Two fingered and three fingered grippers — Internal grippers and external grippers — Selection and design considerations. Robot Drive Systems: Pneumatic drives — Hydraulic drives – Mechanical drives – Electrical drives – D.C. servo motors, stepper motor and A.C. servo motors – Salient features, applications and comparison of all these drives.

UNIT – III SENSORS 9

Requirements of a sensor, principles and applications of the following types of sensors — Position sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors) — Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters) – Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors) – Touch sensors (Binary sensors, Analog sensors) – Wrist Sensors – Compliance Sensors – Slip Sensors.

UNIT – IV ROBOT KINEMATICS 9

Forward kinematics — Inverse kinematics — Differences: Forward kinematics and Reverse kinematics of manipulators with two and three degrees of freedom (In 2 dimensional), four degrees of freedom (In 3 dimensional) – Derivations and problems.

UNIT – V ROBOT INTELLIGENCE AND IMPLEMENTATION 9

Teach pendant programming - Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands and simple Programs. Implementation: RGV — AGV — Implementation of robots in industries – Various steps - Safety considerations for robot operations.- Economic Analysis of Robots, Collaborative robots

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and AshishDutta, Industrial Robotics: Technology, Programming and Applications, Tata McGraw Hill, 2nd Edition 2017.

2. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2010.

REFERENCES:

1. Deb S.R., “Robotics Technology and Flexible Automation”, Tata McGraw Hill Book Co., 2nd Edition, 2017.
2. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 3rd Edition 2017
3. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2nd Edition, 2017.
4. S.P. SukhatMT, “Solar Energy: principles of Thermal Collection and Storage”, Tata McGraw-Hill 2014.
5. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd., 1997.

OUTCOMES:

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

Course Name : INDUSTRIAL ROBOTICS		**Course Code : 24MEV53**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain about the robot parts, specifications, coordinates and robot drive system.	I	K2
2.	Discuss the working principle of end effectors and drives systems	II	K2
3.	Discuss the working principle of robot sensors	III	K2
4.	Derive the equations of forward and Reverse kinematics for the robot manipulator.	IV	K3
5.	Describe the steps for implementation of robots in industries and safety considerations for robot operations	V	K2

24MEV63	MACHINE VISION AND IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the basic concepts of optics in imaging.
- To describe the various hardware components of an imaging system for machine vision applications.
- To discuss about the image processing techniques.
- To illustrate the image processing algorithms and application issues.
- To summarize the various applications of machine vision and its challenges.

UNIT – I INTRODUCTION 9

Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system, implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation.

UNIT – II IMAGE ACQUISITION 9

Scene constraints – Lighting parameters – Lighting sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection – Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications and Selection – Geometrical Image formation models – Camera Calibration.

UNIT – III IMAGE PROCESSING 9

Machine Vision Software – Fundamentals of Digital Image – Image Acquisition Modes – Image Processing in Spatial and Frequency Domain–Point Operation, Thres holding, Gray scale Stretching — Neighborhood Operations, Image Smoothing and Sharpening – Edge Detection – Binary Morphology – Color image processing.

UNIT – IV IMAGE ANALYSIS 9

Feature extraction – Region Features, Shape and Size features – Texture Analysis – Template Matching and Classification – 3D Machine Vision Techniques – Decision Making.

UNIT – V MACHINEVISION APPLICATIONS 9

Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile, applications in non-visible spectrum, metrology and gauging, OCR and OCV, vision guided robotics — Field and Service Applications – Agricultural, and Bio medical field, augmented reality, surveillance, bio-metrics.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Pearson Education, Fourth Edition, 2018
2. E. R. Davies, “Machine Vision: Theory, Algorithms, Practicalities”, Elsevier. Fourth edition, 2012.

REFERENCES:

1. Eugene Hecht, A. R. Ganesan “Optics”, Fourth Edition, 2008.
2. Alexander Hornberg, “Handbook of Machine Vision”, First Edition, 2006
3. EmanueleTrucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition, 1998.
4. Rafael C. Gonzales, Richard. E. Woods, “Digital Image Processing Publishers”, Fourth Edition, 1992.
5. MilanSonka,VaclavHlavac,andRogerBoyle,“ImageProcessing,Analysis,andMachine Vision”, Cengage India Publishers, Fourth Edition, 2024.

OUTCOMES:

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

Course Name : MACHINE VISION AND IMAGE PROCESSING		**Course Code : 24MEV63**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain and apply the basic concepts of optics in imaging.	I	K2
2.	Discuss about the various hardware components of an imaging system for machine vision applications.	II	K2
3.	Explain in detail about the various image processing techniques.	III	K2
4.	Describe the image Processing algorithms and the issues involved in applying them to various machine vision applications.	IV	K2
5.	Explain in detail about the various applications of Machine vision system and it‟s challenges.	V	K2

24MEV14	FLEXIBLE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the Importance of Flexible Manufacturing Systems.
- To understand the modern manufacturing systems
- To understand Flexible Manufacturing System Simulations
- To familiarize with Group Technology concepts.
- To identify the role of AI in FMS.

UNIT – I PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS **9**

Introduction to FMS - development of manufacturing systems - benefits - major elements of FMS -types of flexibility - FMS application and flexibility —single product, single batch, n — batch scheduling problem - knowledge based scheduling system.

UNIT – II COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMSLS AND TECHNIQUES **9**

Introduction - composition of FMS - hierarchy of computer control — computer control of work center and assembly lines - FMS supervisory computer control - types of software specification and selection - trends.

UNIT – III FMS SIMULATION AND DATA BASE **9**

Application of simulation - model of FMS - simulation software - limitation - manufacturing data systems - data flow - FMS database systems - planning for FMS database.

UNIT – IV GROUP TECHNOLOGY AND JUSTIFICATION OF FMS **9**

Introduction - matrix formulation - mathematical programming formulation - graph formulation -knowledge based system for group technology — economic justification of FMS - application of possibility distributions in FMS systems Justification.

UNIT – V APPLICATIONS OF FMS AND FACTORY OF THE FUTURE **9**

FMS application in machining, sheet metal fabrication, prismatic component production –aerospace application - FMS development towards factories of the future - artificial intelligence and expert systems in FMS - design philosophy and characteristics for future.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Kalpakjian S., Manufacturing Engineering and Technology, Addison-Wesley PublishsingCo., 2013.
2. Groover M.P., Automation, Production Systems And Computer Integrated Manufacturing, Prentice Hall of India Pvt., New Delhi, 2007.

REFERENCES:

1. Radhakrishnan P. and Subramanyan S., CAD/CAM/CIM, Wiley EasternLtd., New Age International Ltd., 1994.
2. Raouf A. and Daya B.M., Flexible manufacturing systems: recent development, ElsevierScience, 1995.
3. Ohno T., Toyota production system: beyond large-scale production, Productivity Press (India) Pvt. Ltd., 1992.
4. Shivanand H.K.V, Flexible manufacturing system ,New Age International Pvt.Ltd.,2016

5. Jha.N.K., Handbook of flexible manufacturing systems, Academic Press Inc., 1991.

OUTCOMES:

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

Course Name : FLEXIBLE MANUFACTURING SYSTEMS		**Course Code : 24MEV14**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Prepare planning, scheduling and control of flexible Manufacturing systems.	I	K3
2.	Choose various computer controls and software's for flexible manufacturing systems.	II	K3
3.	Prepare data base system and build FMS Simulation	III	K3
4.	Demonstrate simulation on software's with the aid of group technology and product classification.	IV	K3
5.	Analyze various applications of FMS and factory of the future	V	K4

24MEV24	SMART AND SUSTAINABLE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the Importance of smart and Sustainable Manufacturing .
- To understand the importance of product and process integration
- To Practice the methods of solving problems using Artificial Intelligence
- To study various tools/techniques and assess environmental impacts of sustainable manufacturing.
- To perform energy efficiency analysis and Life cycle analysis of sustainable manufacturing.

UNIT – I INTRODUCTION TO SMART AND SUSTAINABLE MANUFACTURING 9

Need - Internet technology and Manufacturing Industry - Digital enterprises -Manufacturing portals – Benefits, Fuzzy Logic, Genetic Algorithms, Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing, Planning, Scheduling and Control Introduction to Sustainable Manufacturing; Drivers of Sustainable Manufacturing; Concept of Triple bottom line; Environmental, Economic and Social Dimensions of Sustainability; Relation between Lean and Sustainable manufacturing; Green manufacturing

UNIT – II INTERNET BASED COLLABORATIVE CAD/CAM 9

Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacturing, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design. Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping

UNIT – III ARTIFICIAL INTELLIGENCE IN MANUFACTURING 9

Components of manufacturing – Soft and Hard Automation – Flexible Manufacturing Cell – Flexible handling methods -Basic concepts of Artificial intelligence and expert systems – Intelligent System Components –System architecture and Data flow – System Operations. Scope of AI-in manufacturing components of intelligent manufacturing .

UNIT – IV SUSTAINABILITY TOOLS , TECHNIQUES AND ASSESSMENT 9

Environmental Conscious, Quality Function Deployment, Design for Environment; Design for Disassembly, Design for recycling, Eco friendly Product design methods. Environmental Impact Assessment Methods Sustainability Assessment -Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment; Corporate Social Responsibility.

UNIT – V SUSTAINABILTY CHARACTERIZATION AND LIFE CYCLE 9

Sustainable characteristics of manufacturing processes - Energy efficiency analysis of manufacturing processes - Sustainability analysis and Scope of sustainable manufacturing centers Life cycle analysis-Remanufacture and disposal, tools for LCA, optimization for achieving sustainability in manufacturing, value analysis, analysis for carbon footprint-Case studies in sustainability analysis.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Kusiak, A., Intelligent Design and Manufacturing, Wiley-Interscience,1992.
2. Mrityunjay Singh, T.Ohji and Rajiv Asthana, Green and Sustainable Manufacturing of Advanced Materials , Elsevier Publishers, 2015.

REFERENCES:

1. Dagli, C.H., Intelligent systems in design and manufacturing, ASME,1994.
2. Huang, G.Q. and Mak, K.L., Internet Applications in Product design and Manufacturing ,Springer, 2003.
3. Parsaei, H.R. and Jamshidi, M., Design and implementation of intelligent manufacturing systems, Prentics Hall, 1995
4. S.Vinodh, Sustainable Manufacturing: Concepts tools methods and Case studies, CRC Press Publishers,2020
5. G. Atkinson, S. Dietz, E. Neumayer, Handbook of Sustainable Manufacturing, Edward Elgar Publishing Limited, 2007.

OUTCOMES:

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

Course Name : SMART AND SUSTAINABLE MANUFACTURING		**Course Code : 24MEV24**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Apply knowledge-based techniques in smart manufacturing and justify the importance of sustainable manufacturing	I	K3
2.	Practice building of intelligent systems for smart manufacturing	II	K3
3.	Select suitable intelligent system for smart Manufacturing	III	K3
4.	Illustrate state-of-the-art tools and techniques of sustainable manufacturing and apply them to solve case studies on sustainability assessment of projects.	III	K3
5.	Analyze energy efficiency systems in manufacturing centers and determine life cycle assessments for various manufacturing applications.	IV	K3

24MEV34	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 analyze and apply concepts of big data and cloud computing
- To understand about machine learning and artificial intelligence.

UNIT – I INTRODUCTION 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-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 DATA ANALYSIS IN MANUFACTURING PROCESS 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

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 : 24MEV34**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Describe the basic components of Digital manufacturing.	I	K2
2.	Apply the digital thread in smart Manufacturing enterprise	II	K3
3.	Illustrate virtual commissioning of Digital Twin in Smart Factory	III	K2
4.	Select suitable data analysis method for digital manufacturing process.	IV	K2
5.	Select suitable sensors and sensing techniques for intelligent manufacturing operations.	V	K2

24MEV44	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide a detailed understanding of additive manufacturing processes.
- To analyze and evaluate advanced software tools, processes, and techniques that facilitate additive manufacturing and personal fabrication
- To be familiar with the characteristics of different materials used in additive manufacturing.
- To know the principle methods, areas of usage, possibilities, limitations, and environmental effects of additive manufacturing technologies.
- To evaluate and optimize additive manufacturing process selection and integration strategies for achieving enhanced efficiency and performance

UNIT – I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain-Classification —Rapid Prototyping- Rapid Tooling — Rapid Manufacturing — Applications- Benefits — Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare. Case studies.

UNIT – II CAD & REVERSE ENGINEERING 9

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 – Software"s for Additive Manufacturing Technology: MIMICS, MAGICS.

UNIT – III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

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 9

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

Introduction-basic process of Three-dimensional Printing (3DP), shape deposition manufacturing (SDM), Selective laser melting, (SLM) Electron beam melting (EBM), and its applications, Binder jetting. Overview of 4D AM

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Andreas Gebhardt and Jan-Steffen Hötter, Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser Publications, United States, 2016
2. Ian Gibson, David W. Rosen and Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd edition, Springer., United States, 2015

REFERENCES:

1. AmitBandyopadhyay and Susmita Bose, *Additive Manufacturing*, CRC Press, 3rd Edition, 2025.
2. Andreas Gebhardt, Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing, Hanser Gardner Publications, 2011.
3. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and Practice, Springer, 2006 (Reprint 2015).
4. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC Press, 2nd Edition, 2019.
5. Majumdar J.D. and Manna I., Laser Assisted Fabrication of Materials, Springer Series in Materials cience, 2013

OUTCOMES:

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

Course Name : ADDITIVE MANUFACTURING		**Course Code : 24MEV44**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the process of Rapid prototyping, Rapid tooling and Rapid manufacturing	I	K2
2.	Apply data processing for Additive Manufacturing Technology	II	K3
3.	Explain the principle, Processes, applications of SLA, SGC, FDM	III	K2
4.	Explain the principle, Processes, applications of SLS and LENS	IV	K2
5.	Explain the principle, Processes, applications of 3D printing and SDM, SLM and EBM processes	V	K2

24MEV54	MATERIALS IN INDUSTRIAL APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on the classification of different types of engineering materials and their applications.
- To emphasize the importance of material selection criteria for **aerospace and naval applications**.
- To study the materials used in automotive engines and transmissions and how to choose them.
- To introduce state-of-the-art techniques in material characterization.
- To highlight the significance and applications of shape memory alloys in Bio-medical engineering.

UNIT – I CLASSES OF ENGINEERING MATERIALS AND ITS MECHANICAL PROPERTIES 9

Evolution of engineering materials, Properties of Conventional Materials -Yielding, Strain Hardening and Fracture — Design for Strength —basis of material selection - Selection strategy, Attribute limits and Material indices, structural index Selection procedure- Materials processing and design processes and their influence on design, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection.

UNIT – II MATERIALS FOR AEROSPACE AND NAVAL APPLICATIONS 9

Alloys for aerospace applications: Materials required for engine parts, Super alloys for high temperature applications, Single crystal blades made of Ni based super alloys, Aerospace grade low density high strength Ti and Al alloys, Ultra-high strength steel with the toughness for missile applications, composite materials. Special alloys for naval applications: Corrosion resistive materials, Advanced magnetic materials – Ultra high energy product permanent magnets, emerging materials such as nano-materials, smart materials and composite materials

UNIT – III MATERIALS FOR AUTOMOTIVE APPLICATIONS 9

Materials selection for engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Clutches. Materials selection for bearings, Bumper, shock absorbers, Materials for electronic devices meant for engine control, ABS, Steering, Suspension, Sensors, temperature sensors for climate control, anti-collision, Anti-fog, Head lamps.

UNIT – IV MATERIALS FOR HIGH TEMPERATURE APPLICATIONS 9

Application of High Temperature Materials, Shape Memory Alloys, Fundamentals of Shape Memory Alloy (SMA) Behavior — Phase Transformation, Lattice Structure and Deformation Mechanism, Origin of the One-Way Shape Memory Effect, Two-Way Shape Memory Effect. Carbon/Carbon composites, Properties & Advantages, Super Alloys, Ceramic Material Systems and Their Properties.

UNIT – V SMART MATERIALS AND MATERIALS FOR BIO-MEDICAL APPLICATIONS 9

Nickel, Titanium alloy (Nitinol), Materials characteristics of Nitinol, martensitic transformations, austenitic transformations, thermoelastic martensitic transformations Shape memory polymers, mechanism of shape memory, Primary moulding, secondary moulding, types and applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gladius Lewis, “Selection of Engineering Materials”, Prentice Hall Inc. New Jersey USA, 1995
2. Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.

REFERENCES:

1. Sujata V., Bhat., “Biomaterials”, Narosa Publication House, New Delhi, 2002
2. ASM Handbook. “Materials Selection and Design”, Vol. 20- ASM Metals Park Ohio. USA, 1997.
3. ASM Handbook, “Selection of Materials Vol. 1 and 2”, ASM Metals Park, Ohio. USA, 1991.
4. Cantor,“ Automotive Engineering: Lightweight, Functional, and Novel Materials”, Taylor & Francis Group, London, 2006
5. Prasad, N. Eswara, Wanhill, R. J. H Aerospace Materials and Material Technologies – Indian Institute of Metals Series, 2017

OUTCOMES:

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

Course Name : MATERIALS IN INDUSTRIAL APPLICATIONS		**Course Code : 24MEV54**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Classify different types of materials and understand its properties	I	K3
2.	Identify suitable alloys for aerospace and naval applications	II	K3
3.	Discuss on the different materials used for automotive engines and	III	K3
4.	Describe the state-of-the-art techniques in material characterization for high temperature materials.	IV	K3
5.	Select suitable Shape memory alloys for Bio medical Engineering applications	V	K3

24MEV64	SEMICONDUCTOR MATERIALS AND MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study about the basic theories involved in the semiconductor physics.
- To understand the optical properties of semiconductors
- To understand the physical principles of various semiconductor devices
- To practice the Synthesis and processing of semi-conducting materials
- To impart knowledge on the composition and structure on the manufacturing of semiconductor materials

UNIT - I INTRODUCTION TO SEMICONDUCTORS 9

Classical free electron theory (Qualitative) – Quantum free electron theory : Fermi-Dirac distribution - density of states - Introduction to origin of band gap - E-k diagram - effective mass of an electron - energy bands In solids - Fermi energy level - Equilibrium carrier concentration for Intrinsic and extrinsic semiconductors- conductivity of Intrinsic and extrinsic semiconductors - law of mass action - variation of Fermi level with doping and temperature.

UNIT - II OPTICAL PROPERTIES OF SEMICONDUCTORS 9

Direct and indirect band gap semiconductors - electron-hole pair generation and recombination - non-radiative and radiative recombination in semiconductors – Electron – hole injection – Internal Quantum Efficiency – Junctions: P-N junction – Bias – P-I-N junction – Heterojunctions- Quantum wells – work function and Schottky junction –Ohmic contacts – Band to band absorption and Emission - Optical absorption and emission due to defect centers.

UNIT - III SEMICONDUCTOR DEVICES 9

Ideal PN junction – Avalanche and Zener diodes – BJT - JFET –– MOSFET – LEDs – OLEDs - Diode lasers - LCDs – Photodetectors – Phototransistors - Solar cells – CCD sensors – Junction photodiodes - Hall effect and Its Applications

UNIT - IV SEMICONDUCTING MATERIALS 9

Semiconductors – concept of doping-N-type & P-type - simple and compound semiconductors –Direct and indirect bandgap semiconductors- amorphous silicon, oxide semiconductors; amorphous semiconductors - FER, MOSFET and CMOS –ohmic contacts, schottky diode – hall probe & hall sensor

UNIT - V MANUFACTURING OF SEMICONDUTOR MATERIALS 9

Electronic materials - methods of crystal growth for bulk single crystals - zone melting-refining, leveling - synthesis of epitaxial films by Vapour Phase Epitaxy (VPE), Physical Vapor Deposition (PVD), Metal organic Chemical Vapour Deposition (MOCVD), and Molecular Beam Epitaxy (MBE) - lithography; production of silicon - starting applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. S.O. Kasap Principles of Electronic Materials and Devices, , McGraw Hill, 2006
2. Pradeep fuley, Electrical, magnetic, and Optical Materials, 1st edition, CRC press, 2010

REFERENCES:

1. Optoelectronics and Photonics : Principles and Practices, S.O.Kasap, Pearson, 2013
2. Principles of Electronic Materials and Devices, S.O. Kasap, McGraw Hill, 2006.
3. Pierret, R.F., 1996. Semiconductor device fundamentals. Pearson Education India.
4. Raghavan V, Materials Science and Engineering, 4th Edition, Prentice Hall of India, 1998.
5. S. O. Pillai,“ Solid state physics”, New age International Pvt Ltd, 6th edition, 2005.

OUTCOMES:

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

Course Name : SEMICONDUCTOR MATERIALS AND MANUFACTURING		**Course Code : 24MEV64**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Discuss about the basic theories involved in the semiconductor physics.	I	K3
2.	Explain the optical properties of semiconductors.	II	K3
3.	Classify the physical principles of various semiconductor devices.	III	K3
4.	Demonstrate the Synthesis and processing of semi-conducting materials for engineering applications	IV	K3
5.	Illustrate the impact of composition and structure on the manufacturing of semiconductor materials	V	K3

24MEV15 INDUSTRIAL ENGINEERING AND MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To acquire knowledge required in the Industrial Management and Engineering profession.
- To outline various plant layouts.
- To gain understanding in work study, method study and ergonomics.
- To provide knowledge on quality control charts.
- To enable to have clear knowledge on human resource, personnel management.

UNIT – I INTRODUCTION 9

Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. Concepts of management, importance, functions of management, scientific management, Taylor‟s principles, theory X and theory Y, Fayol‟s principles of management.

UNIT – II PLANT LAYOUT 9

Plant Layout , Locational Analysis, Selection Criteria, Governing Factors, Types Of Layouts, Plant Maintenance, Methods Of Plant And Factory Layouts

UNIT – III OPERATIONS MANAGEMENT 9

Importance, types of production, applications, Work study, method study and time study, work sampling, PMTS, micro–motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

UNIT – IV QUALITY CONTROL CHARTS 9

Quality control, its importance, SQC, attribute sampling inspection with single and double sampling, Control charts — X and R — charts X and S charts and their applications, numerical examples.

UNIT – V RESOURCE MANAGEMENT 9

Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Khan.M.I, Industrial Engineering New Age International, 2nd Edition , 2022.
2. Khanna. O.P., Industrial Engineering and Management Dhanpat Rai & Sons, 2020.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", Cengage Learning, 8th Edition, 2012.
2. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, Wiley-India, 7th Edition, 2015.
3. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Wiley, 3rd Edition, 2018.

4. Chase R.B, Nicholas J. Aquilano, F.and Jacobs R, "Production and Operations Management: Manufacturing and Services, Irwin/McGraw-Hill, 2010
5. Panneer selvam R, "Production and Operations Management 3rd Edition, 2012.

OUTCOMES:

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

Course Name : INDUSTRIAL ENGINEERING AND MANAGEMENT		**Course Code : 24MEV15**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Describe the theory in industrial engineering and their applications.	I	K3
2.	Select a plant layout for the given criteria	II	K3
3.	Evaluate the work methods through work measurement.	III	K4
4.	Select and apply appropriate quality control technique for given production process.	IV	K3
5.	Choose a job evaluation method and develop a rating system.	V	K3

24MEV25 **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 TRANSPORTATIONANDASSIGNMENTMODELS 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 Cost Constraint, EOQ Model - Multi-item Joint Replenishment with and without Shortages, Space Constraint. Replacement theory

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. Hamdy A.Taha "Operations Research – An Introduction", MacMillan India Ltd., 10th Edition,2017.
2. PanneerselvamR,"OperationsResearch",PrenticeHallIndia,2016.

REFERENCES:

1. G.Srinivasan, “Operations Research: Principles and Applications”, PHI Ltd.,2016.
2. Kanti swarup Gupta.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 OperationsResearch,McGrawHill,2015.
5. Hira.DGupta.P.K,”OperationsResearch”,S.ChandPublications,1st Edition,Reprint2016

OUTCOMES:

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

Course Name : OPERATIONS RESEARCH		**Course Code : 24MEV25**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Solve Linear Programming Problems by appropriate	I	K3
2.	Determine the performance characteristics such as time and cost in solving shortest route, transportation and assignment problems with an appropriate model.	II	K3
3.	Determine the optimal solution for a project scheduling problem.	III	K3
4.	Determine the order quantity of goods under different constraints.	IV	K3
5.	Determine the solutions to single and multichannel queuing problems.	V	K3

24MEV35 **LEAN MANUFACTURING** **L T P C**
3 0 0 3

OBJECTIVES:

- To outline the principles and elements of lean manufacturing.
- To gain knowledge about the value chain and to map the current state of material and information flow through the value chain.
- To develop road map of lean implementation by understanding the activities.
- To apply the lean tools to implement lean manufacturing system in an organization.
- To outline about six sigma concept methodologies.

UNIT – I INTRODUCTION TO LEAN MANUFACTURING 9

Lean Manufacturing – Scope – Waste and Activity analysis – Examples – Elements of Lean Manufacturing, Mass vs Lean Manufacturing

UNIT – II PRIMARY TOOLS 9

5S, Total Productive Maintenance, OEE Calculation, Process mapping and Value Stream Mapping – Development and analysis of Current and Future state maps, Workcell, Application cases on lean tools

UNIT – III SECONDARY TOOLS 9

–Poka-Yoke, Spider Chart, DFMA, Kanban, Autonomation, JIT, Pull system

UNIT – IV IMPLEMENTATION 9

Lean Manufacturing rules – Training & Implementation for lean manufacturing, Lean measurement, Project selection for lean systems.

UNIT – V LEAN INTEGATION 9

Lean integration with other strategies: Lean Six Sigma, Lean and ERP, ISO 9001 with Lean, Optimized Production Technology, Lean in service domain.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Pascal Dennis, Lean production simplified, CRC press, New York, 3rd edition , 2016
2. Steve Blank, Bob Dorf, K&S Ranch (2012) the startup Owner‟s Manual: The Step-By-Step Guide for Building a great company, Wiley, Kindle Edition, 2020.

REFERENCES:

1. Design and Analysis of Lean Production Systems, Ronald G. Askin and Jeffrey B. Goldberg, Wiley, 2001.
2. Mikell P. Groover, Automation, Production Systems and CIM, Pearson Education, 4th Edition, 2016
3. Rother M. and Shook J, Learning to See: Value Stream Mapping to Add Value and Eliminate Muda , Lean Enterprise Institute, Version 1.3 , 2003
4. Jeffrey K. Liker, the Toyota Way,: 14 Management Principles from the World's Greatest Manufacturer, Tata Mc Grew Hill, 2nd Edition,2021
5. Prof. Kate & Prof. Phadke: Toyota Production System - Elementary Concepts, Everest publishing house, 1st edition, 2016

OUTCOMES:

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

Course Name : LEAN MANUFACTURING		**Course Code : 24MEV35**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the fundamental concepts of lean manufacturing	I	K3
2.	Select a suitable tool to transform conventional manufacturing into Lean manufacturing plants	II	K3
3.	Choose an secondary lean tool to solve the given industrial problems.	III	K3
4.	Analyze the methods to implement Lean Manufacturing in industries.	IV	K4
5.	Solve productivity related problems using the concepts of FMEA and six sigma	V	K3

24MEV45	STATISTICAL QUALITY CONTROL	L	T	P	C
		3	0	0	3

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.

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. Dale H. Besterfield, Quality Control, Pearson Education Asia, 8th Edition, 2018.

REFERENCES:

1. AmitavaMitra, “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. MonoharMahajan, “Statistical Quality Control”, DhanpatRai& Sons, 2017.
4. Krishnaiah K.,” Applied Statistical Quality Control and Improvement”, PHI, 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 : 24MEV45**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the basic Concepts of Quality and its tools.	I	K2
2.	Construct the control charts for variables from the available data.	II	K3
3.	Choose an appropriate method to control the occurrence of defects in product or service industries.	III	K3
4.	Select and apply appropriate quality control technique for given production process.	IV	K3
5.	Choose a sampling plan for the given quality inspection.	V	K3

24MEV55 PRODUCTION PLANNING AND CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to understand the various components and functions of production planning and control
- To gain knowledge about method study, motion study and work study,
- To know about 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).

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

OUTCOMES:

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

Course Name : PRODUCTION PLANNING AND CONTROL		**Course Code : 24MEV55**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain various aspects of product development.	I	K3
2.	Choose a work measurement system for the given production process.	II	K3
3.	Determine the quantity in batch production and analyze the process capability for the given conditions.	III	K3
4.	Determine a production schedule for the given production system.	IV	K3
5.	Determine manufacturing lead time for the given production system.	V	K3

24MEV65	PRODUCTION AND OPERATIONS MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the concept of Production and Operations Management in creating and enhancing a firm‟s competitive advantages.
- To gain knowledge about forecasting techniques in both manufacturing and service industry.
- To know about the inputs, strategies and models for aggregate planning.
- To outline the concepts of MRP and ERP.
- To know about the tools for capacity planning.

UNIT – I INTRODUCTION 9

Objectives of Operations Management, Scope of Operations Management, Relationship of Operations with other Functional areas, Manufacturing Vs Service sector, Operations Decision making, Phases in Product Design and Development, Product Life Cycle, Process Selection.

UNIT – II FORECASTING 9

Need, Determinants of Demand, Demand Patterns, Qualitative Forecasting Methods-Delphi techniques. Market Research, Nominal Group Technique. Quantitative Forecasting methods —Moving Average Methods, Exponential Smoothing Methods, Regression methods, Monitoring and Control of Forecasts, Requirements and Selection of Good forecasting methods.

UNIT – III AGGREGATEPLANNING 9

Role of aggregate Product planning, Managerial inputs to Aggregate planning, Pure and Mixed strategies, Mathematical Models for Aggregate planning —Transportation Method, Linear programming Formulation, Linear Decision Rues, Master Production Schedule(MPS), Procedure for developing MPS.

UNIT – IV MRPANDERP 9

MRP- Lot sizing methods–Implementation issues, MRP–II. ERP–evolution, comparison of ERP with traditional systems, benefits, need for ERP, overview of modules in ERP. ERP implementation: Requirement analysis, alternatives, life cycle, implementation methodology.

UNIT – V CAPACITYMANAGEMENT 9

Measures of capacity, Factors affecting capacity, Capacity Planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning, Capacity Requirement Planning- Business Process Outsourcing.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Chase R.B, NicholasJ. Aquilano,F. and Jacobs R, "Production and Operations Management: Manufacturing and Services, Irwin/McGraw-Hill, 2010.
2. Panneerselvam.R,"ProductionandoperationsManagement",PHI,3rdEdition,2012

REFERENCES:

1. Lee J. Krajewski, Manoj K. Malhotra, Larry P. Ritzman, "Operations Management: Processes and Supply Chains", Pearson Education,11th Edition,2015
2. William J Stevenson, "Operations Management", McGraw Hill, 13th Edition, 2018.
3. Hiller and Liberman, "Introduction to Operations Research", McGraw Hill, 2015.
4. Jay Heizer, Barry Render, Chuck Munson, "Operations Management: Sustainability and Supply Chain Management", Pearson, 2017.
5. Mary Sumner, "Enterprise Resource Planning", 2nd Edition, Pearson Education, 2007.

OUTCOMES:

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

Course Name : PRODUCTION AND OPERATIONS MANAGEMENT		**Course Code : 24MEV65**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the different phases in product design and development.	I	K3
2.	Forecast demand for Production and Service Systems.	II	K3
3.	Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.	III	K3
4.	Determine the lot size of a product for the given conditions in an industry.	IV	K3
5.	Calculate capacity requirements and developing capacity alternatives.	V	K3

24MEV16	DATA STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge about the concepts of ADTs
- To Learn linear data structures – lists, stacks, and queues
- To Learn non-linear data structures – Trees
- To gain knowledge about sorting, searching and hashing algorithms
- To apply Tree and Graph structures

UNIT – I Linear Data Structure – List 9

Abstract Data Types (ADTs) — List ADT — array-based implementation — linked list implementation —singly linked lists- circularly linked lists- doubly-linked lists – applications of lists.

UNIT – II Linear Data Structures – Stacks, Queues 9

Stack ADT — Operations - Applications - Evaluating arithmetic expressions- Conversion of Infix to postfix expression - Queue ADT — Operations - Circular Queue.

UNIT – III Non Linear Data Structure– Trees 9

Tree ADT – tree traversals - Binary Tree ADT – expression trees – applications of trees – binary search tree ADT –Threaded Binary Trees- AVL Trees – B-Tree - Heap – Applications of heap.

UNIT – IV Non Linear Data Structure - Graphs 9

Definition – Representation of Graph – Types of graph - Breadth-first traversal - Depth-first traversal – Topological Sort – Bi-connectivity – Applications of graphs.

UNIT – V Searching, Sorting and Hashing Techniques 9

Searching- Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort - Shell sort — Radix sort. Hashing- Hash Functions — Separate Chaining.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education,1997.
2. ReemaThareja, “Data Structures Using C”, Second Edition , Oxford University Press, 2011

REFERENCES:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, “Introduction to Algorithms", Second Edition, Mcgraw Hill, 2002.
2. Aho, Hopcroft and Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
3. Stephen G. Kochan, “Programming in C”, 3rd edition, Pearson Education.

OUTCOMES:

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

Course Name : DATA STRUCTURES		**Course Code : 24MEV16**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Apply** array-based and linked list techniques to construct and manipulate linear data structures.	I	K3
2.	**Demonstrate** stack and queue operations to solve expression evaluation.	II	K3
3.	**Develop** the tree structures such as AVL and Heap to do efficient data organization.	III	K3
4.	**Utilize** graph traversal algorithms to identify connectivity features for topological sorting problems.	IV	K3
5.	**Use** sorting and hashing methods to organize data and prepare solutions for optimized searching and collision	V	K3

24MEV26	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explore the need of industry 4.0, IOT architecture and its protocols
- To interpret the big data usage and the cyber threads on Industry 4.0
- To reason out the use of cloud computing and data analytics in Industry 4.0
- To familiarize the concepts of digital manufacturing
- To learn the real time usage of IOT, cloud computing, data analytics in Industry 4.0

UNIT – I IoT IN INDUSTRIAL REVOLUTION 9

Introduction to Industry 4.0 - Basics of Internet of Things (IOT) and Network protocol - IOT Architecture and its standards - Industry Internet of Things (IIOT) - Need of sustainability assessment of Industries - Lean Production and Smart factory - Introduction to sensors and actuators.

UNIT – II BIG DATA AND CYBER SECURITY IN INDUSTRY 4.0 9

Cyber Physical Systems (CPS) - Features - Role of Al in Industry 4.0 - Need of Big Data in IIOT - Big Data analytics - Data management using Hadoop - Cybersecurity in Industry 4.0 - Components - Threats and Awareness - Security issues within Industry 4.0 network.

UNIT – III CLOUD COMPUTING FOR IoT 9

Introduction to Cloud computing - Cloud computing service options - Cloud deployment models - Cloud virtualization - Types of Hypervisors - IOT Gateway, IOT Edge, and its programming

UNIT – IV DIGITAL MANUFACTURING 9

Introduction to Digital manufacturing - Architecture of Digital manufacturing - Digital Twin technology for smart manufacturing system - Road map to success in Digital Manufacturing - Identification of current situation in Industry.

UNIT – V APPLICATIONS AND CASE STUDIES 9

Application: Assembly sectors in Factories, Inventory and Quality control in Industries, Industrial security and Safety Management and Health care sectors. Case Study: Processing and packing industries and Automobile manufacturing sectors.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC press, ISBN 9781032146751.
2. Cheng FT, editor. Industry 4.1: Intelligent Manufacturing with Zero Defects. John Wiley & Sons; 2021.

REFERENCES:

1. Bernabe JB, Skarmeta A. Introducing the challenges in cybersecurity and privacy: The european research landscape. In Challenges in Cyber security and Privacy-the European Research Landscape 2022. River Publishers.
2. Kurfess TR, Saldana C, Salee by K, Dezfouli MP. A review of modern communication technologies for digital manufacturing processes in industry 4.0. Journal of Manufacturing Science and Engineering. 2021.

OUTCOMES:

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

Course Name : INDUSTRY 4.0		**Course Code : 24MEV26**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Apply** the concepts of Industry 4.0 to **interpret and analyze** the architecture of IoT systems and their communication	I	K3
2.	**Implement** Big Data technologies to **analyze** industrial processes and to **address** the cyber threats in Industry 4.0 environments.	II	K3
3.	**Utilize** cloud computing and data analytics tools to **enhance** industrial automation and decision-making.	III	K3
4.	**Demonstrate** the application of digital manufacturing techniques for **efficient and smart production systems**.	IV	K3
5.	**Integrate** IoT, cloud computing, and Industry 4.0 technologies to **develop** innovative industrial solutions.	V	K3

24MEV36 MACHINE LEARNING THEORY AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To Familiarize with the concepts of Machine learning and its variants
- To identify the type of machine learning
- To gain knowledge in regression analysis
- To Introduce the concepts of Reinforcement learning
- To acquire knowledge about use of machine learning in various industries

UNIT – I INTRODUCTION TO MACHINE LEARNING 9

Introduction and basic concepts - Need for machine learning - Types of machine learning - Relation between Machine Learning and Statistics - Performance metrics of machine learning — Python libraries suitable for Machine Learning.

UNIT – II SUPERVISED LEARNING 9

Supervised Learning – Classification - Decision trees - Support vector machines - K-nearest neighbor clustering - Regression analysis - Linear regression - Logistic regression Model representation.

UNIT – III UNSUPERVISED LEARNING 9

Unsupervised Learning - Clustering, types of clustering - K - means clustering - Dimensionality reduction - Semi-supervised learning.

UNIT – IV REINFORCEMENT LEARNING 9

Elements of Reinforcement learning - Multi-armed Bandits - The agent — Environment Interface - Goals and Rewards, Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value functions - Optimal Policies and Optimal Value
Functions - optimality and Approximation.

UNIT – V APPLICATIONS OF MACHINE LEARNING IN INDUSTRIAL SECTORS 9

Applications of machine learning in Industrial sectors - Energy sector: oil and gas - Basic materials sector: Chemicals and Basic resources - Industrials sector - Industrial manufacturing.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (India) Private Limited, 2013.
2. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

REFERENCES:

1. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.
2. Larrañaga, P., Atienza, D., Diaz-Rozo, J., Ogbechie, A., Puerto-Santana, C. E., & Bielza C., Industrial Applications of Machine Learning. CRC Press, 2018.

OUTCOMES:

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

Course Name : MACHINE LEARNING THEORY AND APPLICATIONS		**Course Code : 24MEV36**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Understand** the fundamental concepts of Machine Learning to **analyze** real-world data problems.	I	K2
2.	**Implement** Supervised Learning Techniques to organize **and interpret** datasets effectively.	II	K3
3.	**Implement** clustering and dimensionality reduction techniques to **organize and interpret** datasets effectively.	III	K3
4.	**Employ** Reinforcement Learning techniques to **design** adaptive decision-making systems.	IV	K3
5.	**Integrate and apply** Machine Learning concepts to **solve** industrial and practical problems.	V	K3

24MEV46	ARTIFICIAL INTELLIGENCE APPLICATIONS IN MECHANICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge about the various characteristics of Intelligent agents
- To learn the different control strategies in AI
- To learn the different search strategies in AI
- To know about the application of AI in robots
- To familiarize with application of Al in Mechanical and Manufacturing Industry

UNIT – I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

Introduction to Al, Problem formulation, Problem Definition, Production systems, Control strategies, Search strategies, Problem characteristics.

UNIT – II PROBLEM SOLVING METHODS 9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems.

UNIT – III CONSTRAINT HANDLING AND GAME DECISIONS 9

Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search - Game Playing – Optimal Decisions in Games – Alpha - Beta Pruning - Stochastic Games.

UNIT – IV ARTIFICIAL INTELLIGENCE IN ROBOTICS 9

Reinforcement Learning- planning and search, localization, tracking, mapping and control- - path smoothing algorithms - SLAM algorithm- Precision agriculture-Robot Performance optimization.

UNIT – V APPLICATION OF ARTIFICIAL INTELLIGENCE IN MECHANICAL MANUFACTURING INDUSTRIES 9

Fault diagnosis- Quality inspection- Improving the safety of working places- Material modeling and smart materials-Automobile engineering- building self-driving cars and autonomous vehicles, Auto parking.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Russell Stuart, Norvig Peter, “Artificial Intelligence Modern Approach”, Pearson Education series in AI, 3rd Edition, 2010.
2. Gebrail Bekda,Sinan Melih Nigdeli, MeldaYücel, “Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering (Advances in
3. Computational Intelligence and Robotics)”, 2019.

REFERENCES:

1. Rajasekaran,S., VijayalakshmiPai,GA., Neural Network, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall India.2010.
2. Dan.W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, PHI Learning, 2009.

OUTCOMES:

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

Course Name : ARTIFICIAL INTELLIGENCE APPLICATIONS IN MECHANICAL ENGINEERING		**Course Code : 24MEV46**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Demonstrate** an understanding of the fundamental concepts and purpose of Artificial Intelligence in solving real-world	I	K2
2.	**Implement** the appropriate search algorithms for any AI problem	II	K3
3.	**Illustrate the** Constraint Handling Problems and Decision making in Games.	III	K3
4.	**Apply** Artificial Intelligence concepts to **develop** and **control** robotic systems	IV	K3
5.	**Utilize** Artificial Intelligence approaches to **enhance** processes in Mechanical and Manufacturing industries.	V	K3

24MEV56 SOFT COMPUTING TECHNIQUES AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To familiarize with basic concept of soft computing techniques
- To understand the fuzzy logic concepts.
- To learn about genetic Algorithm and its hybrid modeling
- To gain knowledge in Neural networks..
- Techniques on various soft computing used in different applications practice

UNIT – I INTRODUCTION TO SOFT COMPUTING 9

Evolution of Computing: Soft Computing Constituents, Conventional AI to Computational Intelligence- Various Soft Computing Techniques and Their Description- Constrained and unconstrained optimization problems -Decision Variables.

UNIT – II FUZZY LOGIC ANALYSIS 9

Introduction to Fuzzy logic, Fuzzy sets, Membership functions, Fuzzy rules, Fuzzy logic architecture-Adaptive Neuro-Fuzzy Inference Systems (ANFIS).

UNIT – III GENETIC ALGORITHM 9

Evolutionary computation-Introduction, Population, Fitness function, Crossover, Mutation, Reproduction-Solving single-objective optimization problems using GAs- Particle swarm optimization (PSO) Algorithm

UNIT – IV NEURAL NETWORKS 9

Motivation and properties of Biological Neural Networks, Feed Forward Neural Networks, Recurrent Neural Networks-Perceptron"s classification-Activation Functions-Back Propagation Networks.

UNIT – V SOFT COMPUTING APPLICATIONS 9

Applications of GA in Mechanical Industries-Applications of Fuzzy logic in Machining, Robotics and Composites-Application of soft computing techniques to solve design, thermal and manufacturing related case studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA, DOI: 10.4018/978-1-5225-30350, 2022.ISBN13: 9781522530350
2. Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.

REFERENCES:

1. Kaushik Kumar, Supriyo Roy, J. Paulo Davim, Soft Computing Techniques for Engineering Optimization, ISBN 9780367780210, CRC Press,2021
2. Melanic Mitchell, an Introduction to Genetic Algorithm, MIT Press, 2000. Science and Engineering. 2021.

OUTCOMES:

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

Course Name : SOFT COMPUTING TECHNIQUES AND APPLICATIONS		**Course Code : 24MEV56**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Understand** the fundamental concepts of soft computing techniques to **solve** engineering problems.	I	K2
2.	**Implement** fuzzy logic concepts and **develop** hybrid models for intelligent decision-making.	II	K3
3.	**Utilize** Genetic Algorithm techniques to **optimize** computational and industrial processes.	III	K3
4.	**Apply** the neural network to **address** real-world challenges.	IV	K3
5.	**Demonstrate** the use of soft computing techniques to **enhance** industrial applications.	V	K3

24MEV66 **INTRODUCTION TO MATLAB**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the fundamentals of MATLAB programming and its environment for scientific computing.
- To apply MATLAB commands and functions to solve mathematical and engineering problems involving matrices, plotting, and numerical computation.
- To develop user-defined functions and scripts to automate engineering calculations and data processing.
- To employ numerical techniques in MATLAB to solve real-world mechanical engineering problems such as root finding, differential equations, and optimization.
- To analyze, simulate, and visualize mechanical systems using MATLAB and Simulink tools for design and performance evaluation.

UNIT – I BASICS Of MATLAB 6+6

Overview of MATLAB and its applications in mechanical engineering-Basic syntax: variables, data types, operators, expressions-Input/output functions-Control statements-Error handling and debugging.

Practical Component:

1. Write simple scripts for arithmetic and polynomial calculations
2. Write a simple program for Temperature conversion, beam deflection calculation.

UNIT – II ARRAYS, MATRICES AND PLOTTING 6+6

Creating and manipulating vectors and matrices-Matrix operations and linear algebra applications-Element-wise operations and built-in matrix functions-Data visualization: 2D plots (plot, subplot, loglog, semilogx, semilogy)-3D plotting (mesh, surf, contour).

Practical Component:

1. Demonstrate a Program to visualize temperature distribution on a plate.
2. Solve systems of linear equations related to mechanical systems

UNIT – III FUNCTIONS AND FILE HANDLING 6+6

Creating user-defined functions and function handles-Local and global variables-MATLAB file I/O: reading and writing data from .txt, .csv, and .mat files-Modular programming and function decomposition.

Practical Component:

1. Write a function to compute moment of inertia for different cross-sections
2. Demonstrate a Program to analyze thermodynamic data from an external file

UNIT – IV NUMERICAL METHODS USING MATLAB 6+6

Introduction to numerical methods in engineering-Roots of equations (bisection, Newton–Raphson methods)-Numerical differentiation and integration-Ordinary differential equations (ODE).

Practical Component:

1. Produce a program for a spring-mass-damper system
2. Demonstrate a program for Finding natural frequency using root-finding methods

UNIT – V APPLICATIONS IN MECHANICAL ENGINEERING 6+6

MATLAB in mechanical design and analysis-Finite Element Analysis (basic introduction

using MATLAB)-Simulation of kinematic mechanisms (linkages, pendulum, gears).

Practical Component:

1. Simulate the vibration of a cantilever beam

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Amos Gilat, MATLAB: An Introduction with Applications, 6th Edition, Wiley, 2024.
2. Holly Moore, MATLAB for Engineers, 6th Edition, Pearson Education, 2023.

REFERENCES:

1. Stormy Attaway, MATLAB*: A Practical Introduction to Programming and Problem Solving*, 6th Edition, Butterworth–Heinemann (Elsevier), 2022.
2. Brian Hahn and Daniel T. Valentine, *Essential* MATLAB *for Engineers and Scientists*, 7th Edition, Academic Press (Elsevier), 2023.

OUTCOMES:

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

Course Name : INTRODUCTION TO MATLAB		**Course Code : 24MEV66**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	**Demonstrate** the understanding of MATLAB interface, syntax, and basic programming constructs.	I	K3
2.	**Apply** MATLAB functions for data visualization, and matrix computations.	II	K3
3.	**Develop** MATLAB scripts and functions to automate computational tasks.	III	K3
4.	**Solve** mechanical engineering problems using numerical methods implemented in MATLAB.	IV	K3
5.	**Build** and simulate simple mechanical systems using MATLAB.	V	K3

24OE101	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

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.

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 : 24OE101**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Describe the layout and functioning of subsystems of thermal power plant and explain the improvisation of Rankine cycle.	I	K3
2.	Describe the layout and functioning of gas turbine power plant and combined cycle power plant.	II	K3
3.	Explain the working of various types of nuclear power plant	III	K2
4.	Describe the working principle of various renewable energy powerplants.	IV	K2
5.	Explain the different tariff procedures for energy consumption	V	K2

24OE102	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.

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.

TOTAL : 45 PERIODS

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 : 24OE102**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Identify and prevent chemical, environmental mechanical, fire hazard.	I	K3
2.	Collect, analyze and interpret the accidents data based on various safety techniques.	II	K3
3.	Apply proper safety techniques on safety engineering and management.	III	K3
4.	Perform hazard analysis.	IV	K3
5.	Design the system with environmental consciousness	V	K3

24OE103	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study about the role and drivers of and supply chain management.
- To explain about Supply Chain Network Design.
- To illustrate about the issues related to Logistics in Supply Chain.
- To appraise about Sourcing and Coordination in Supply Chain.
- To study about the application of Information Technology and Emerging Concepts in Supply.

UNIT – I INTRODUCTION 9

Supply Chain Management concepts and Definitions — Objectives and Components of Supply chain- Scope and Importance- Evolution of Supply Chain - 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.

UNIT – IV SOURCING AND COORDINATION IN SUPPLY CHAIN 9

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect — Effect of lack of co-ordination in supply chain and obstacles — Building strategic partnerships and trust within a supply chain.

UNIT – V SUPPLY CHAIN AND INFORMATION TECHNOLOGY 9

The role of IT in supply chain- The supply chain IT frame work Customer Relationship Management — Internal supply chain management — supplier relationship management — future of IT in supply chain — E-Business in supply chain. Context of Industry 4.0, smart supply chain, resilience supply chain

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning,and Operation”, Pearson Education, Sixth edition ,2016.
2. Janat Shah, Supply Chain Management — Text and Cases, Pearson Education, Firstedition, 2009.

REFERENCES:

1. James B. Ayers, “Handbook of Supply Chain Management”, St.Lucle press, Secondedition,2006.
2. Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury, Second edition,2006
3. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management, PHI,2010
4. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2010.

OUTCOMES:

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

Course Name : SUPPLY CHAIN MANAGEMENT		**Course Code : 24OE103**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain the principles of supply chain management	I	K3
2.	Design, organize and manage a supply network considering various logistics issues	II	K3
3.	Apply forecasting and purchasing/Inventory concepts to improve supply chain operations	III	K3
4.	Explain logistics technology tools and resources	IV	K3
5.	Apply internet technology systems to support logistics management decisions.	V	K3

24OE104	3D PRINTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the evolution of Solid Freeform Manufacturing proliferation into various fields.
- To gain knowledge on Design for Additive Manufacturing and its importance in quality improvement of fabricated parts.
- To impart knowledge in polymerization and sheet lamination processes and their applications.
- To know about material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT – I INTRODUCTION 9

Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect-Operative aspect.

UNIT – II VAT POLYMERIZATION 9

Stereo lithography Apparatus (SLA): Principles — Photo Polymerization of SL Resins - Pre Build Process — Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications

UNIT – III SHEET LAMINATION PROCESSES 9

Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT – IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure — Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications Case Studies.

UNIT – V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

Binder Jetting: Three dimensional Printing (3DP): Principles — Process - Physics of 3DP - Types of printing: Continuous mode — Drop on Demand mode - Process — Materials - Advantages - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations. Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

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.

REFERENCES:

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

OUTCOMES:

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

Course Name : 3D PRINTING		**Course Code : 24OE104**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Recognize the importance in the evolution of SFM, proliferation into the various fields and its effects on supply chain.	I	K3
2.	Describe the principles and applications of polymerization with case studies.	II	K3
3.	Describe the principles and applications of sheet lamination processes with case studies.	III	K3
4.	Explain principles of material extrusion and powder bed fusion processes and design guidelines.	IV	K3
5.	Recognize the importance in the evolution of SFM, proliferation into the various fields and its effects on supply chain.	V	K3

24MEM01 FUNDAMENTALS OF MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To analyze and predict the effect of force and motion in rigid bodies.
- To understand the concepts of stress, strain and elastic constants.
- To investigate fluid properties and examine the performance characteristics of pumps and turbines for efficient fluid power systems.
- To apply and evaluate the laws of thermodynamics in the analysis of simple open and closed systems.
- To analyse and evaluate heat transfer mechanisms under steady and transient conditions for effective thermal system design

UNIT – I ENGINEERING MECHANICS 9

Introduction – Units and Dimensions – Laws of Mechanics – Lame‟s theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle- Centre of Gravity-Centroid of Sections- I-T-H

UNIT – II STRENGTH OF MATERIALS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – Stresses on Beams- Stresses on Springs, Shaft- Stresses on Thick and Thin Cylinders

UNIT – III FLUID MECHANICS 9

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume- Flow – Energy equation- Momentum Equation-Classification and Working principle of Pump and Turbine.

UNIT – IV THERMODYNAMICS 9

Classical approach: Thermodynamic systems — Control volume - System and surroundings — Universe — Properties - State-process — Cycle — Equilibrium - Work and heat transfer — Point and path functions - First law of thermodynamics for open and closed systems - First law applied to a control volume - SFEE equations [steady flow energy equation] - Second law of thermodynamics - Heat engines - Refrigerators and heat pumps - Carnot cycle - Carnot theorem.

UNIT – V HEAT TRANSFER 9

One-dimensional Heat Conduction: Plane wall – Cylinder – Sphere - Composite walls – Critical thickness of insulation –Heat transfer through extended surfaces (simple fins). Convection: Free convection and forced convection - Internal and external flow -Radiation: Black–Gray bodies - Radiation Shape Factor (RSF)

TOTAL : 45 PERIODS

TEXT BOOKS:

1. R.S.Khurmi &J.K.Gupta, Thermal Engineering, S.Chand& Co. Ltd., 2019
2. S.Domkundwar, C.P.Kothandaraman&A.V.Domkundwar, Thermal Engineering, DhanpatRai& Co. 2018

REFERENCES:

1. Vela Murali, “Engineering Mechanics”, Oxford University Press 2020
2. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
3. Bansal, R.K, “Fluid Mechanics and Machinery,” Laxmi Publications (P) Ltd., 2018.
4. Nag.P.K., “Engineering Thermodynamics”, 5th Edition, Tata McGraw-Hill, New Delhi, 2013.
5. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

OUTCOMES:

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

Course Name : FUNDAMENTALS OF MECHANICAL ENGINEERING		**Course Code : 24MEM01**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Analyze the rigid body in equilibrium condition	I	K3
2.	Describe the concepts of stress and strain in various structures	II	K2
3.	Determine and predict the properties and characteristics of a fluid	III	K3
4.	Apply the law of thermodynamics for simple open and closed systems.	IV	K3
5.	Apply heat transfer fundamentals to different surface configuration for various condition	V	K3

24MEM02	MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study how NC systems are being used in mechanical component design.
- To familiarize with the concepts of micromachining process
- To understand the concepts of cellular manufacturing and FMS.
- To study about various smart manufacturing processes.
- To gather knowledge on 3D printing and its application in industry

UNIT – I CNC MACHINING PROCESS **9**

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros-
Introduction of CAM package.

UNIT – II MICROMACHINING PROCESS **9**

Introduction to Micromachining - Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon — Plasma Etching — Deep Reaction Ion Etching (DRIE) — Isotropic Wet Etching — Gas Phase Etchants -Basic surface micro machining processes – Structural and Sacrificial Materials - Striction and
Antistriction methods – LIGA Process - Assembly of 3D MEMS.

UNIT – III CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS) **9**

Group Technology(GT),Part Families–Parts Classification and coding–Simple Problems in Opitz Part Coding system–Production flow Analysis–Cellular Manufacturing–Composite part concept–Types of Flexibility - FMS — FMS Components — FMS Application & Benefits — FMS Planning and Control–Quantitative analysis in FMS

UNIT – IV SMART MANUFACTURING PROCESS **9**

Smart Manufacturing Process – Need – classification – merits, demerits and applications-Brief Overview

UNIT – V INTRODUCTION TO 3D PRINTING PROCESS **9**

Overview — Need - Development of 3D Printing Technology, 3D Printing process chain - Impact of 3D Printing on Product Development – Virtual Prototyping- Rapid Tooling – Rapid Prototyping to 3D Printing-Industrial applications of 3D Printing.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2013
2. Groover M.P., “Automation, Production Systems And Computer Integrated Manufacturing”, Prentice Hall of India Pvt., New Delhi, 2017.

REFERENCES:

1. Kalpakjian S., “Manufacturing Engineering and Technology”, Addison-Wesley PublishsingCo., 2013.
2. Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,” Springer 2012.
3. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi, 2007.
4. McGeough, “Advanced Methods of Machining”, Chapman and Hall, London, 1998.
5. Paul De Garmo, J.T.Black, and Ronald. A.Kohser, “Material and Processes in Manufacturing” Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

OUTCOMES:

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

Course Name : MANUFACTURING SYSTEMS		**Course Code : 24MEM02**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Apply NC and CNC programming concepts to develop part program for Lathe and milling machines.	I	K3
2.	Analyse the surface machining process for various applications	II	K3
3.	Summarize the different types of techniques used in cellular manufacturing and FMS.	III	K3
4.	Explain the need for unconventional machining process and its classifications.	IV	K2
5.	Describe the working principle of 3D printing process and its applications.	V	K2

24MEM03 **MATERIALS ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn iron-iron carbide phase diagram for microstructure formation.
- To learn various heat treatment processes and its microstructure formation.
- To know the different types of ferrous and non-ferrous alloys and their uses in engineering field.
- To know the different polymer, ceramics and composites and their uses in engineering field.
- To learn the various testing procedures and material characterization in engineering field.

UNIT – I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

Iron – Iron carbide equilibrium diagram, Isothermal transformation diagrams, cooling curves superimposed on I.T. diagram, continuous cooling Transformation (CCT) diagram

UNIT – II HEAT TREATMENT 9

Full annealing, normalizing, hardening and tempering of steel. carburizing, Nitriding, cyaniding, Flame and Induction hardening

UNIT – III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel , stainless and tool steels, HSLA, Maraging steels, alloy cast irons, Copper and its alloys, Aluminium and its alloys; Al-Cu — precipitation strengthening treatment — Titanium alloys, Mg-alloys, Ni-based super alloys

UNIT – IV NON-METALLIC MATERIALS 9

Polymers, Ceramics, Composites- Matrix and reinforcement Materials-applications of Composites - Nano composites, Bio materials, Semiconductors.

UNIT – V MECHANICAL PROPERTIES 9

Testing of materials under tension, compression and shear loads — Hardness tests, Impact test fatigue and creep failure mechanisms.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 9th edition ,2018.
2. Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994.

REFERENCES:

1. A. Alavudeen, N. Venkateshwaran, and J. T.WinowlinJappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
2. Am andeep Singh Wadhwa, andHarvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.
3. G.S .Upadhyay and AnishUpadhyay, “Materials Science and Engineering”, Viva Books Pvt.Ltd, New Delhi, 2020.
4. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd. 6th edition, 2019.

5. George Dieter, Mechanical Metallurgy, Tata McGraw-Hill, 3rd Edition, New Delhi, 2013.

OUTCOMES:

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

Course Name : MATERIALS ENGINEERING		**Course Code : 24MEM03**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain alloys and phase diagram, Iron-Iron carbon diagram and	I	K2
2.	Explain different heat treatment processes.	II	K2
3.	Clarify the effect of alloying elements on ferrous and non-ferrous metals.	III	K2
4.	Summarize the properties and applications of non-metallic materials.	IV	K2
5.	Explain the testing of mechanical properties and material characterization.	V	K2

24MEM04 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

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. YousefHaik, 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 : 24MEM04**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Chitale A K and Gupta R C, “Product Design and Manufacturing”, PHI 2007.	I	K3
2.	YousefHaik, T. M. M. Shahin, “Engineering Design Process”, Cengage Learning, 2nd Edition Reprint, 2010.	II	K3
3.	Chitale A K and Gupta R C, “Product Design and Manufacturing”, PHI 2007.	III	K3
4.	YousefHaik, T. M. M. Shahin, “Engineering Design Process”, Cengage Learning, 2nd Edition Reprint, 2010.	IV	K3
5.	Chitale A K and Gupta R C, “Product Design and Manufacturing”, PHI 2007.	V	K3

24MEM05 ROBOTICS AND AUTOMATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To outline the anatomy and coordinate system of a robot.
- To illustrate the robot kinematic derivations and equations.
- To describe the architecture and key components of automation system.
- To demonstrate PLC based automation system with industrial applications.
- To summarize the various applications of automation system and case studies.

UNIT – I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Laws of Robot- 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, End effectors and types, Robot Drive systems.

UNIT – II ROBOT KINEMATICS 9

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation-D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms– Derivations and problems.

UNIT – III AUTOMATION AND KEY COMPONENTS 9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, supervisory control and data acquisition (SCADA), Role of computers in measurement and control. Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT.

UNIT – IV AUTOMATION WITH PLC 9

PLC based electro-hydraulic systems, PLC programming using ladder logic for automation and robotics applications, Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relays, timers and counters, ladder logic circuit for simple applications.

UNIT – V APPLICATIONS OF AUTOMATION SYSTEMS AND CASE STUDIES 9

Automation systems in Manufacturing, Assembly Lines, Quality control, Process control, Office automation, Internet of things for plant automation and overview of Industry 4.0, Case Studies: Pick and place robot, Automatic Engine Management System, Autonomous Guided Vehicles (AGVs), Automatic Camera, Domestic Washing Machine system, Unmanned Aerial Vehicles(UAVs).

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and AshishDutta, Industrial Robotics: Technology, Programming and Applications, Tata McGraw Hill, 2nd Edition 2017.
2. Bolton W, Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering, Pearson, Education (Singapore) Pvt Ltd., 4th edition, 2010.

REFERENCES:

1. Deb S.R., “Robotics Technology and Flexible Automation”, Tata McGraw Hill Book Co., 2nd Edition, 2017 .
2. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 3rd Edition 2017
3. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2nd Edition, 2017.
4. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated
5. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd.,1997.

OUTCOMES:

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

Course Name : ROBOTICS AND AUTOMATION		**Course Code : 24MEM05**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Explain about the robot parts, specifications, coordinates and robot drive system.	I	K2
2.	Derive the equations of forward and Reverse kinematics for the robot manipulator.	II	K2
3.	Explain about the architecture and key components of automation system.	III	K2
4.	Explain in detail about PLC based Automation system.	IV	K2
5.	Describe about the various applications and case studies of automation system.	V	K2

24MEM06 MANAGEMENT CONCEPTS & ENTREPRENEURSHIP

L	T	P	C
3	0	0	3

OBJECTIVES:

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

UNIT – I INTRODUCTION 9

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

UNIT – II ORGANIZING AND STAFFING 9

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

UNIT – III DIRECTING AND CONTROLLING 9

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

UNIT – IV ENTREPRENEURSHIP 9

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

UNIT – V BUSINESS ENTERPRISE 9

Social Sector Perspectives and Social Entrepreneurship - Social Entrepreneurship Opportunities and Successful Models - Social Innovations and Sustainability - Marketing Management for Social Ventures - Risk Management in Social Enterprises - Legal

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Tripathi P.C, Reddy P.N. “Principles of Management”, McGraw Hill, 7th Edition, 2021.
2. Harold Koontz, Heinz Weihrich, “Essentials of Management” McGraw Hill, 11th Edition, 2020.

REFERENCES:

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

OUTCOMES:

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

Course Name : MANAGEMENT CONCEPTS & ENTREPRENEURSHIP		**Course Code : 24MEM06**	
CO	**Course Outcomes**	**Unit**	**K–CO**
1.	Compare various management approaches, planning strategies	I	K3
2.	Explain the staffing and structure for an organization	II	K3
3.	Make use of communication methods, leadership styles for building effective control in an organization	III	K3
4.	Develop entrepreneurial ideas	IV	K3
5.	Plan various steps involved in setting up a business enterprise	V	K3