K.L.N. COLLEGE OF ENGINEERING

Pottapalayam-630612, Sivagangai District

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

Estd: 1994

Fifth Semester

CURRICULUM AND SYLLABUS

REGULATIONS 2024

For Under Graduate Program

B.E. MECHANICAL ENGINEERING

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

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 ANS 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 Honors Degree								
1.		Capstone Design Project - Level I		12	0	0	12	6
OR								
1.		Honors Elective – I		3	3	0	0	3
2.		Honors 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

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 **15**

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 **11**

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 **11**

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 **11**

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 **11**

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

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

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

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

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

UNIT – V MASS TRANSFER 9

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

TOTAL : 45 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	**Calculate** 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 : 45 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 LABORATORY		**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 0	T 0	P 2	C 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

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

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 - Types of Flexibility - FMS – FMS Components – FMS Application & Benefits - Quantitative analysis in FMS – bottleneck model -Simple Problems. 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 modulues

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

Application of simulation - model of FMS - simulation software - limitation - manufacturing data systems - data flow – AGVS-AS/RS- quantitative analysis of AGV& AS/RS.

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. Shivanand H.K., M.M,Benal, V.Koti,Flexible manufacturing system ,New Age International Pvt.Ltd.,2021
2. Jha.N.K., Handbook of flexible manufacturing systems, Academic Press Inc., 1991.

REFERENCES:

1. Groover M.P., Automation, Production Systems And Computer Integrated Manufacturing, Prentice Hall of India Pvt., New Delhi, 2007
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. Radhakrishnan P. and Subramanyan S., CAD/CAM/CIM, Wiley EasternLtd., New Age International Ltd., 1994.

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.	Apply Flexible Manufacturing System concepts to modern manufacturing applications and factory-of-the-future technologies	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.

PREREQUISITE: NIL

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

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.

PREREQUISITE: NIL

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