Cummins College of Engineering for Women

(An autonomous institute affiliated to Savitribai Phule pune university)
Karve Nagar, Pune - 411 052.

Syllabus Structure and Syllabus

of

T. Y. B. Tech.
(Mechanical Engineering)

2023 Pattern [R0]

List of Abbreviations

Abbreviation	Title
PCC	Programme Core Course
BSC	Basic Science Course
ESC	Engineering Science Course
PE	Programme Elective Course
OE	Open Elective
VSEC	Vocational and Skill Enhancement Course
CC	Co-curricular Courses / Liberal Learning Course
IKS	Indian Knowledge System
VEC	Value Education Course
RM	Research Methodology
INTR	Internship
PROJ	Project
CEP	Community Engagement Project
RM	Research Methodology
Mm	Multidisciplinary Minor
AEC	Ability Enhancement course

Autonomous Program Structure
Third Year B .Tech.
Fifth Semester (Mechanical Engineering)
Academic Year: 2025-26 Onwards

Course Code	Course Title	Teaching Scheme Hours / Week			Cr	Examination Scheme			Total Marks
		L	T	P		ISE	ESE	Pr/Or	
23PCME501	Heat transfer	3	0	0	3	50	50	-	100
23PCME502	Measurement and Quality Control	2	0	0	2	25	25	.	50
23PCME503	Machine Design	3	1	0	4	50	50	-	100
23PCME504	Computer Aided Engineering	3	0	0	3	50	50	-	100
23PECME501	Programme Elective-I*	3	0	0	3	50	50	-	100
23MDm501	Introduction to Artificial Intelligence and Machine Learning	3	0	0	3	50	50	-	100
23PCME501L	Heat Transfer Lab	0	0	2	1	25	-	25	50
23PCME502L	Measurement and Quality Control lab	0	0	2	1	25	-	25	50
23PCME504L	Computer Aided Engineering Lab	0	0	2	1	25	-	25	50
23MDm501L	Multidisciplinary Minor Course 2 Lab**	0	0	2	1	25	-	25	50
	Total	17	01	08	22	375	275	100	750

L-Lecture, T=Tutorial, P= Practical, Cr= Credits, ISE =In Semester Evaluation, ESE =End Semester Examination, Pr/Or= Practical/Oral.

*Programme Elective-I	
23PECME501A	Introduction to Hydraulic Systems
23PECME501B	EV Architecture and Energy Storage
23PECME501C	Electronic Packaging and Manufacturing
23PECME501D	Internet of Things (IoT)

**Multidisciplinary Minor Course 2 Lab	
23MDm501L	AI and ML Laboratory

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Course Name	Heat Transfer	L	T	P
Course Code	**23PCME501**	3	-	-
Pre-requisite	Physics, Engineering Mathematics, Fluid Mechanics			

Course Objectives: The course prepares students to

1. To apply the laws of heat transfer and identify the requirement of an extended surface for heat transfer enhancement.
2. To determine the heat transfer rate in forced and natural convection.
3. To predict the radiation heat transfer with the use of a radiation shield for the given application.
4. To calculate the performance of the heat exchanger.
5. To calculate the rate of heat transfer and condensation.

Course Outcomes: Students will be able to

1. Apply laws of heat transfer to determine the heat transfer rate in steady and transient state heat conduction in solids.
2. Analyse the convective heat transfer rate using appropriate correlations.
3. Predict the heat transfer rate in radiation mode and with the use of a radiation shield.
4. Calculate the efficiency of the heat exchanger for the given set of operating conditions.
5. Calculate the rate of heat transfer and condensation for the given set of operating conditions.

Unit:- 1	Steady State Conduction Heat Transfer	

Modes of Heat Transfer, Fourier's law of heat conduction. Steady heat conduction in a 1-D system. Heat conduction in a composite slab, cylinder. Heat conduction with internal heat generation. Heat transfer through extended surfaces. Critical radius of insulation and insulating materials. Transient heat conduction in solids using lumped heat capacity analysis.

Unit:- 2	Convection Heat Transfer	

Mechanism of convection heat transfer, Energy Equation, Forced convection over a flat plate, cylinder. Concept of thermal and velocity boundary layer, Empirical correlations, Forced convection in a pipe, Reynolds and Colburn's analogy. Natural convection over a flat plate and a cylinder. Non-dimensional parameters and it's significance. Comparison study analysis in Natural convection and forced convection.

Unit:- 3	**Radiation Heat Transfer**	
Fundamental concepts and laws of radiation, Black and gray body radiation analysis, Radiation between two gray surfaces, Radiation shields. Comparison and analysis of radiation shielding with and without it.		

Unit:- 4	**Heat Exchangers**	
Introduction and Classification, Overall heat transfer coefficient. Heat exchanger analysis using LMTD and NTU method, Effectiveness of heat exchanger, Application – Case study of heat exchanger.		

Unit:- 5	**Boiling and Condensation**	
Boiling heat transfer, Bubble shape and size consideration, bubble growth and collapse, critical diameter of bubble, and boiling correlations. Condensation heat transfer, Laminar and Turbulent flow condensation, Film condensation on horizontal tubes, Film condensation inside horizontal tubes, Influence of the presence of the non-condensable gases. Engineering applications of boiling and condensation (PCM, CPU cooling, and power plants)		

Text Books:	
1.	F.P.Incropera, D.P.Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley
2.	Y.A.Cengal and A.J.Ghajar Heat and Mass Transfer – Fundamentals and Applications,Tata McGraw Hill Education Private Limited
3.	Heat Transfer : J.P.Holman McGraw-Hill Publication – 10th Edition

Course Name	Measurement & Quality Control (MQC)	L	T	P
Course Code	**23PCME502**	**2**	**-**	**-**
Pre-requisite	Manufacturing Process, Machine Drawing			

Course Objectives: The course prepares students to

1. Understand the GD & T symbols and its use.
2. Aware about the concept of IS-919, their design procedure and design gauges.
3. Understand the advances in measurement viz. CMM, Laser, Machine Vision System etc.
4. To study principles, working, mathematical relation characteristics, advantages and limitations of various sensors and transducers for the typical application
5. Understand the process of use of Quality Control Technique in engineering industries.
6. Understand Statistical Quality Control Acceptance Sampling & ISO-QMS

Course Outcomes: Students will be able to

1. Interpret/apply GD&T for a part drawing for inspection
2. Specify type and design the limit gauges
3. Comprehend the working of different sensors and transducers for the typical application
4. Apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problems.
5. Apply Statistical Quality Control tool(s) to analyse and interpret the data.

Unit: 1	GD & T	

- Introduction to Metrology
- GD&T Basics: Need and Rules, Features and Material Conditions [MMC & LMC], Regardless of Feature's Size & Rule, Functional Gauging,
- Datum: Types, Selection & datum Control, MMB and LMB, Adding GD&T to a Design;
- Feature Control Frame: SLOF for Drawings (Size, Location, Orientation & Form)
- Form Tolerances: (Surface, Median Line/MMC): Straightness, Flatness, Circularity, Cylindricity Orientation Tolerances: (Surface, Axis): Parallelism, Perpendicularity Angularity Profile Tolerances: Profile of a Surface and Line – Basics, Profile (Modifiers)
- Location Tolerances: True Position Concentricity, Symmetry: Runout Tolerances, Circular and Total Runout and Real Life Example

Unit: 2	Inspection Gauge & Industrial Inspection	

- Design of Limit Gauges: Tolerances, Limits and Fits [IS 919-1993], Types gauges, Limit gauge design (numerical).
- Introduction to Coordinate Measuring Machine (CMM): Types of CMM and Applications,
- Machine Vision Systems: Measurement – Multisensory systems. Inspection 4.0

Unit: 3	Mechanical Measurements	

- Temperature Measurement: Types - thermometer, thermostat, RTD, thermocouple, thermistors, pyrometers
- Flow Measurement: Types - rate meter, turbine flow sensors, Electromagnetic type, and ultrasonic type
- Motion Measurement: Types - displacement sensor, vibration, speed and acceleration sensor,
- Application based case studies

Unit: 4	**Quality: Tools, Techniques and System**	

- Quality: Characteristics & elements, Cost vs Value
- Quality Tools: 7 QC Tools, QFD, FMECA, 5S, Kaizen, Poka yoke, Kanban, Six Sigma: DMAIC - Introduction and application
- Quality Management System: Introduction to ISO 9001, TS-16949, ISO-14000.

Unit: 5	**Statistical Quality Control and Acceptance Sampling**	

- Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart),
- Process Capability Indices: (cp, cpk, ppk), Statistical Process Control (Numerical).
- Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical)

Text Books:
1. A.K. Sawhney, Electrical & Electronic Instruments & Measurement, Dhanpat Rai and Sons, 11th ed., 2000.
2. B. C. Nakra and K. K. Choudhari, Instrumentation Measurements and Analysis, Tata McGraw Hill Education, Second ed., 2004.
3. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication
4. I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication, 2019.
5. Jain R.K., Engineering Metrology, Khanna Publication.
6. Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
7. IS: 919 - Recommendation for limits and fits for Engineering, B.I.S. Publications.
8. Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.
9. Basterfield D. H., Quality control, Pearson Education India, 2004.

Reference Books:
1. E.O. Doebelin, Measurement Systems, McGraw Hill, Seventh ed., 2019.
2. D. Patranabis, Principle of Industrial Instrumentation, Tata McGraw Hill, Second ed., 1999.
3. ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
4. Juran J. M., Quality Handbook, McGraw Hill Publications
5. Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.

Online Education resources: viz. NPTEL website:
1. https://archive.nptel.ac.in/courses/112/106/112106138/

2. www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html;
3. www.me.iitb.ac.in/~rame`sh/courses/ME338/metrology6
4. nptel.ac.in/courses/112106179

Course Name	**Machine Design**	**L**	**T**	**P**
Course Code	**23PCME503**	**3**	**1**	**-**
Prerequisites	Engineering Mechanics, Strength of Materials.			

Course Objectives: To make students

1. To design simple machine elements subjected to static loads.
2. To compute the torque transmission capacity by the given power screw.
3. To analyze the machine elements subjected to fluctuating loads.
4. To apply A.S.M.E. code for shaft design.
5. To calculate the size of a mechanical joint, subjected to eccentric load.
6. To determine the spring dimensions for a given requirement.

Course Outcomes: After successful completion of the course, student will be able to

1. design simple machine elements subjected to static loads.
2. compute the torque transmission capacity by the given power screw.
3. analyze the machine elements subjected to fluctuating loads.
4. apply A.S.M.E. code for shaft design.
5. calculate the size of a mechanical joint, subjected to eccentric load.
6. design helical spring for given requirements.

Unit/Module: 1	**Introduction to Design Engineering**	

Phases and interactions in the design process, design considerations, design tools and resources, design engineer's professional responsibilities, standards and codes, economic aspects. Design for Sustainability, Digital Tools, Industry 4.0 in Design.

Unit/Module: 2	**Failure Prevention: Design against static load**	

Modes of failures, principal stresses, failure theories and their selection, eccentric loading, design of machine elements subjected to static loading.

Unit/Module: 3	**Failure Prevention: Design against fluctuating load**	

Fatigue failure, endurance limit, and its modifying factors; endurance strength; design for infinite and finite life under completely reversed and fluctuating loads. Fracture Mechanics Fundamentals. Case Studies of Real-World Failures (e.g., fatigue failure in aircraft/automotive components)

Unit/Module: 4	Design of Transmission Shafts	

Shaft design is based on strength, deflection considerations, torsional and lateral rigidity, the ASME code for shaft design, the critical speed of shafts, and the design of keys and splines. Composites as Shaft Materials

Unit/Module: 5	Design of Mechanical Springs and Power Screws	

Stress and deflection analysis of helical springs, design for static and fatigue loading, springs in combination, leaf springs. Optimum design of helical springs.
Torque analysis of power screws, standard threads, thread and collar friction, efficiency and stresses in power screws. Ball Screws-features, advantages and applications

Unit/Module: 6	Design of Mechanical Joints	

Bolts of uniform strength, fastener stiffness and member stiffness, threaded joints subjected to axial loading and eccentric loading in different planes.
Strength of butt and fillet welded joints in torsion and bending, sizing of welded joints subjected to direct and eccentric loads. Adhesive bonding & hybrid joints, 3D-Printed Joints

Reference Books:	
1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw HillPublication Co. Ltd
2.	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements" ,Prentice Hall International.
3.	Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
4.	Willium C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
5.	"Design Data",P.S.G. College of Technology, Coimbatore.
6.	Juvinal R.C,"Fundamentals of Machine Components Design",John Wiley and Sons.
7.	Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum"s Outline Series.
8	Robert L. Norton, "Machine Design", Pearson Publication.
9.	Michael Nikowitz, „Advanced Hybrid and Electric Vehicles, System Optimization and Vehicle Integration", Springer International Publishing Switzerland 2016.
10	Iqbal Husain, „Electric and Hybrid Vehicles, Design Fundamentals", CRC PRESS.

Text Books:	
1.	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.

Course Name	Computer Aided Engineering (CAE)	L	T	P
Course Code	23PCME504	3	-	-
Pre-requisite	Engineering Mechanics, Strength of Materials, Basic programming			

Course Objectives: To make students

1.   To impart knowledge of geometric modeling and transformations in computer graphics.
2.   To introduce and apply finite element methods for structural and thermal engineering problems.
3. To understand practical aspects of FEM such as type of analysis and meshing strategies etc

Course Outcomes:

Students will be able to
After successful completion of the course, students will be able to
1. Apply geometric transformations and projections in the CAD system.
2. Apply finite element methods to solve 1D structural problems such as axial bars, trusses, and springs.
3. Compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods to solve 2D structural problems
4. Formulate and implement the finite element method for thermal analysis
5. Understand application of computer-aided engineering tools in CFD, durability, crash and NVH.

Unit: 1	Computer Graphics	

2D Transformations: Introduction, Formulation, Translation, Shear, Rotation, Scaling, Reflection, Homogeneous representation, Concatenated transformation, Mapping of geometric models, Inverse transformations, Introduction to 3D transformation
Projections: Orthographic, Isometric, Perspective projections

Unit: 2	One-Dimensional Finite Element Analysis	

Introduction: Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads, and constraints), General FEM procedure, Applications of FEM in various fields, Advantages and disadvantages of FEM.
One-Dimensional Problem: Finite element modeling, coordinate and linear shape function, Element stiffness matrix (Direct and Potential Energy approach), Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, (spring, stepped bar), Temperature Effects, Penalty approach.
Trusses: Introduction, 2D Trusses, Element stiffness matrix for truss, Assembly of Global Stiffness Matrix, load vector

Unit: 3	Two-Dimensional Finite Element Analysis	

Basic concepts of plane stress and plane strain, 2D element types – three/six node triangle (CST, LST), 4-noded rectangular (Q4/LSR), derive the constant-strain triangular (CST) element stiffness matrix and equations, determine the stiffness matrix and stresses for a constant strain element, body and surface forces for two-dimensional elements, evaluate the explicit stiffness matrix for the constant-strain triangle element, perform a detailed finite element solution of a plane stress problem, derive the bilinear four-noded rectangular (Q4) element stiffness matrix

Unit: 4	Thermal Analysis using FEM	

Basic differential equation for one-dimensional heat conduction, inclusion of heat transfer by convection in one-dimensional heat transfer model, typical units – thermal conductivities, heat transfer coefficients, one-dimensional finite element formulation using a variational method for heat transfer for rod and plane wall.

Unit: 5	Applications for Computer-Aided Engineering	

Computational Fluid Dynamics (CFD): Introduction, Three dimensions of Fluid Dynamics, Equilibrium Equation for a fluid, Conservation form of Fluid flow equation, Integral form of the Conservation Laws.
Durability Analysis: Durability, Reliability and Fatigue, FEA-based fatigue analysis viz: Stress-Life approach (S-N method) and Strain-Life approach (E-N method).
Crash Analysis: Introduction, Explicit time integration schemes, implicit integration schemes.
Noise Vibration and Harshness (NVH) Analysis: NVH Concepts, Terminology, FEA for Structural Dynamics.

Textbooks:
1. Ibrahim Zeid and R. Sivasubramanian, CAD/CAM - Theory and Practice, Tata McGraw Hill Publishing Co. 2010
2. Daryl Logan, A First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd., 6th Edition 2017
3. Seshu P., Textbook of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
4. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

Reference Books:
1. J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw Hill, 2003
2. Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering – Prentice Hall India

Course Name	**Programme Elective-I** **Introduction to Hydraulic Systems**	L	T	P
Course Code	**23PECME501A**	3	-	2
Pre-requisite	Physics, Engineering Mathematics, Fluid Mechanics			

Course Objectives:

1. Provide opportunity for students to gain appreciation and understanding of a typical intelligent hydraulic system comprised of electro-hydraulic components – this is the confluence of mechanical, hydraulics and electrical/electronic disciplines
2. Prepare students for an interdisciplinary approach and use the latest tools to solve problems
3. Provide comprehensive knowledge of different electro-hydraulic components, circuits, applications and trends
4. Prepare students to draw intelligence out of a typical EH circuit for diagnosis and prediction
5. Encourage self-learning

Course Outcomes:

1. Ability to understand, identify and select electro-hydraulics components
2. Analyse circuits and understand failure modes
3. Ability to model and decide design components for an intelligent hydraulic system
4. Enhancement in application knowledge of hydraulics, electronics and programming

Unit :- 1	**Introduction to Fluid Power**	

Evolution of fluid power systems, components of fluid power, introduction to work and power in hydraulics. Hydraulic fluids: purpose of the fluid, compressible and incompressible fluids, Fluid properties, SAE grades and ISO viscosity numbers, selection of fluid, sources of fluids and additives, Analogies with electrical components, Merits and Demerits of fluid power systems

Unit :- 2	**Actuators and Motors**	

Introduction to Hydraulic Actuators, Linear actuators, Rotary actuators, Performance characteristics of hydraulic actuators,

Unit :- 3	**Hydraulic Valves**	

Introduction, Construction and application of control valves, proportional valves, and servo valves

Unit :- 4	**Hydraulic Pumps and Fittings**	

Introduction, construction, operation, and application of hydraulic pumps

Fluid conductors, material considerations, installation recommendations, compatibility of hydraulic fluids with hose material, design parameters (cover, tube & reinforcement) and manufacturing processes, governing standards (performance & reliability test for hoses). Determining pipe size requirements, velocity in pipes

Unit :- 5	**System accessories and design of simple hydraulic systems**	

Introduction to hydraulic accessories such as hydraulic accumulators, hydraulic reservoirs, Filters and Coolers, Performance analysis of hydraulic accumulators and hydraulic reservoirs Build a simple hydraulic system to protect and control the system. Demonstrate and use valves, actuators, pumps and motors in simple hydraulic systems.

Text Books:	
1.	Peter Rohner, "Industrial Hydraulic Control", 4th Edition
2.	Andrew Parr, "Hydraulics and Pneumatics".
3.	Peter Chappel, "Principles of Hydraulic Systems Design"

Course Name	Programme Elective-I	L	T	P
	EV Architecture and Energy Storage			
Course Code	**PECME501B**	3	-	-
Pre-requisite	Thermodynamics, Mathematics, Mechanics			

Course Objectives: To make students

1. Compare architectural frameworks and performance metrics .
2. Calculate power requirements, energy consumption, and dynamic forces for electric/hybrid vehicles under real-world driving conditions
3. Design battery packs for specific vehicle applications
4. Develop battery management strategies (BMS) to optimize performance and safety
5. Evaluate the feasibility of supercapacitors and fuel cells (PEMFC/SOFC) as alternative energy storage solutions

Course Outcomes: Students will be able to

1. Define, Compare, and Classify Vehicle Architectures.
2. Analyze Vehicle Dynamics and Energy Requirements.
3. Characterize, Model, and Design Battery Systems
4. Design Battery Management and Thermal Systems.
5. Evaluate Alternative Energy Storage Systems for EVs

Unit: 1	**Introduction to Hybrid and Electric vehicles:**

EV Terminology and Architectures, Comparison of ICEV and BEV, Environmental Considerations, EV : micro to mild to PHEV to HEV to REEV to EV - Hybrid-Electric Vehicle Power trains, Vehicle Energy Storage Systems, Motors & motive power splitting concepts, and interface within power train system

Unit: 2	**Vehicle Dynamics**

Forces Acting on a Rolling Vehicle, Power Required for Rolling Motion, Modeling Real-World Conditions, Drive Cycles, Energy and Power Requirement Calculations

Unit: 3	**Battery: Fundamentals and Pack Design**

Energy storage requirements, Storage technologies and metrics for comparison, Distribution of Energy, Storage Form of Energy, Ragone Plot, Battery Types, Chemistry, Lithium Ion Battery Chemistries, Electrical Characteristics of a Battery, SOC, SOH, Battery Pack Sizing/Design, Battery Modelling and Simulations

Unit: 4	**Battery Management: Electrical and Thermal Management**

Battery Management Systems (BMS), Lithium-Ion Batteries Aging Effects. Battery characterization and testing systems, Thermal management & Battery life cycle, Modular

Packaging, Thermal control, Cooling Systems:Types and Design, Charging Systems and Infrastructure	
Unit: 5	**Supercapacitor and Fuel Cells**
Materials and Construction, Basic Model, Specific Behavior of Supercapacitors, Design of a Super-capacitive Bank, Series and Parallel Connections, Thermal Aspects, Hydrogen Generation and Storage of Hydrogen, Conversion from Hydrogen to Electricity, Low and Medium Temperature Fuel Cells: AFC, PEMFC, AND PAFC, High-Temperature Fuel Cells: MCFC AND SOFC.	
Reference Books:	
1.	Electric Vehicle Engineering, Per Enge et al., McGraw Hill Publications
2.	Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell vehicles-Fundamentals - Theory and Design", CRC Press
3.	Energy storage (A new approach) by Ralph Zito Wiley Publication
4.	Energy Storage Systems, Alfred Rufer, CRC Press
5.	Energy Storage by Robert A. Huggins, Springer Publication

Course Name	Programme Elective-I	L	T	P
	Electronic Packaging and Manufacturing			
Course Code	**PECME501C**	3	-	-
Pre-requisite	-			

Course Objectives: To make students

1. Describe electronic packaging levels and wafer fabrication processes.
2. Design PCB layouts and compare chip-carrier interconnection methods.
3. Evaluate advanced packages (CSP, SiP, SoC) for specific applications.
4. Solve mechanical vibration/thermal challenges using heat sinks and analysis tools.
5. Propose reliability improvements using failure analysis and accelerated testing.

Course Outcomes: Students will be able to

1. Describe electronic packaging levels and wafer fabrication processes.
2. Design PCB layouts and compare chip-carrier interconnection methods.
3. Evaluate advanced packages (CSP, SiP, SoC) for specific applications.
4. Solve mechanical vibration/thermal challenges using heat sinks and analysis tools.
5. Propose reliability improvements using failure analysis and accelerated testing.

Unit: 1	Introduction	

Electronic Packaging, Levels of Packaging, Wafer fabrication, Recap of Basic Electronics

Unit: 2	Packaging

First level packaging – Package Taxonomy, Chip and chip carrier, lead frame, Interconnection types and methods, Flip-Chip bonding, area arrays, Second level packaging - Design and manufacture of Printed Wiring Boards, Types of circuit boards, Component placement, Routing, Lamination, Solder Masks, Third level packaging and System level integration – cables, connectors, chassis, display

Unit: 3	Advanced Packaging

Chip Scale Packaging, Multi-chip Module, Stacked Package, System in package (SIP), system on chip (SOC) Specialized packages (RF, MEMS, Sensors, Harsh Environments, Wearable/Flexible)

Unit: 4	Mechanical and Thermal Design

Mechanical Design - Vibration analysis, Theorem of Castigliano; Fatigue and creep analysis, Thermal Design - Basics of heat transfer, Thermal Resistance, Thermal Interface Materials, Heat spreaders and Heat sinks, System level thermal challenges, modelling and analysis

Unit: 5	Reliability

Design for reliability, Life cycle, Failure Modes and Mechanisms, Reliability Metrology and Analysis, Accelerated Degradation Modelling, Environmental Stress Screening.

Reference Books:

1.	Packaging of Electronic Systems, Dally James W
2.	Fundamentals of Microsystems Packaging, Rao R. Tummala
3.	Practical Guide to the Packaging of Electronics Thermal and Mechanical Design and Analysis, By Ali Jamnia

Course Name	Programme Elective-I IOT	L	T	P
Course Code	PECME501D	3	-	-
Pre-requisite	--			

Course Objectives: To make students

1. Explain fundamental IoT concepts, architectures, and enabling technologies.
2. Design IoT systems using appropriate sensors, actuators, and processing topologies.
3. Implement cloud-based solutions for IoT data management and analytics.
4. Analyze real-world IoT case studies across industries like healthcare and automotive.
5. Evaluate emerging IoT trends and propose innovative solutions for future application

Course Outcomes: Students will be able to

1. Explain fundamental IoT concepts, architectures, and enabling technologies.
2. Design IoT systems using appropriate sensors, actuators, and processing topologies.
3. Implement cloud-based solutions for IoT data management and analytics.
4. Analyze real-world IoT case studies across industries like healthcare and automotive.
5. Evaluate emerging IoT trends and propose innovative solutions for future application

Unit: 1	Introduction to IoT

Basics of Networking: Introduction, Network Types, Layered Network Models Emergence of IoT: Introduction, Evolution of IoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components

Unit: 2	Sensors and actuators

IoT Sensing and Actuation: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuator Types, Actuator Characteristics.

Unit: 3	IoT Processing Topologies

IoT Processing Topologies and Types: Data Format, Importance of Processing in IoT, Processing Topologies, IoT Device Design and Selection Considerations, Processing Offloading.

Unit: 4	Cloud Computing

Introduction, Virtualisation, Cloud Models, Service-Level Agreement in Cloud Computing, Cloud Implementation, Sensor-Cloud: Sensors-as-a-Service.

Unit: 5	IoT Case Studies and Future Trends

Vehicular IoT – Introduction, Case Studies, Healthcare IoT – Introduction, Case Studies, IoT Analytics – Introduction, Case Studies

Reference Books:

1.	Sudip Misra, Anandarup Mukherjee, Arijit Roy, "Introduction to IoT", Cambridge University Press, 2021.

2.	S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
3.	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014.
4.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.

Course Name	Introduction to Artificial Intelligence and Machine Learning	L	T	P
Course Code	23MDm501	3	-	2
Pre-requisite	Engineering Mathematics, Statistics and Probability			

Course Objectives: Students will be able to:

1. Understand the fundamental mathematical concepts (Linear Algebra, Optimization) that form the backbone of AI/ML algorithms.
2. Learn key unsupervised learning techniques such as dimensionality reduction and clustering.
3. Explore supervised learning methods, including regression, classification, and ensemble techniques.
4. Develop an understanding of neural networks and their applications in regression and classification.
5. Study AI search methods for problem-solving and optimization.
6. Apply theoretical concepts to real-world machine learning problems through hands-on exercises.

Course Outcomes: Students will be able to

1. Apply linear algebra (PCA, SVD) and optimization techniques (gradient descent, Lagrange multipliers) to solve machine learning problems.
2. Implement unsupervised learning methods (K-means, Kernel PCA) for clustering and dimensionality reduction.
3. Develop supervised learning models (Regression, SVM, Decision Trees, Neural Networks) for classification and prediction tasks.
4. Utilize ensemble techniques (Bagging, Boosting) and regularization (Ridge/LASSO) to enhance model performance.
5. Design AI search algorithms (DFS, BFS, A*) for problem-solving and optimization.

Unit :- 1	**Mathematical Foundations**	

Inner Product, Outer Product, Eigenvalues and eigenvectors, Derivatives of Matrices, Singular value decomposition (SVD), Unconstrained Optimization, Method of Lagrange Multipliers

Unit :- 2	**Supervised Learning-Regression and Classification**	

Regression - Least Squares, Bayesian view, Regression - Ridge/LASSO,
Classification - K-NN, Decision tree, Generative Models - Naive Bayes, Discriminative Models - Perceptron; Logistic Regression, Support Vector Machines, Evaluation of Parameters, Case study of machining time predictions

Unit :- 3	**Unsupervised Learning**	

Representation learning - PCA, Kernel PCA, Clustering - K-means/Kernel K-means, Unsupervised Learning - Estimation - Maximum Likelihood Estimation, Bayesian estimation, Gaussian Mixture Model - EM algorithm, Case study of machining defects.		
Unit :- 4	**Supervised Learning- Ensemble Methods and ANN**	
Ensemble methods - Bagging and Boosting (Adaboost), Multilayer Perceptron, Artificial Neural networks: Regression and Multiclass classification, Case study of condition monitoring.		
Unit :- 5	**AI: Search Methods**	
Search spaces, Examples, State space search, Depth First, Breadth First, Finding optimal paths. Algorithm A*		
Books:		
1.	Mathematics for Machine Learning, *Marc Peter Deisenroth et al.* Cambridge University (2020)	
2.	Pattern Recognition and Machine Learning, *Christopher Bishop*, Springer	
3	Pattern Classification by David G. Stork, Peter E. Hart, and Richard O. Duda, John Wiley	
4.	The Elements of Statistical Learning, *Hastie, Tibshirani, Friedman,* Springer	
5	Artificial Intelligence: A Modern Approach, *Stuart Russell & Peter Norvig,* Prentice Hall	

Course Name	Heat Transfer Lab	L	T	P
Course Code	**23PCME501L**	-	-	2
Pre-requisite	Physics, Calculus, Fluid Mechanics			

Course Objectives:

1. To conduct experiments involving the steady-state heat transfer phenomenon.
2. To analyse and process experimental data to calculate the rate of heat transfer.
3. To illustrate the results in a graphical form.
4. Compare the results with available theoretical /experimental results and conclude.
5. To study the heat exchanger construction and working.

Course Outcomes: Students will be able to

1. Determine the thermal conductivity of insulating materials and analyse heat transfer through composite solids.
2. To investigate temperature distribution along extended surfaces (fins) and evaluate heat transfer coefficients in natural and forced convection.
3. To study the enhancement of forced convection heat transfer using twisted tape inserts and compare performance.
4. To measure surface emissivity and verify the Stefan-Boltzmann constant through radiation experiments.
5. To analyse the performance of parallel and counterflow heat exchangers and understand industrial heat exchanger applications.

Lab Work

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of the materials in the composite wall.
3. Determination of temperature distribution along the fin length.
4. Determination of heat transfer coefficient in natural convection.
5. Determination of heat transfer coefficient in forced convection.
6. Determination of heat transfer coefficient in forced convection with insertion of twisted tape
7. Determination of the emissivity of a test surface.
8. Determination of Stefan-Boltzmann constant.
9. Trial on parallel and counter flow heat exchangers.
10. Visit to the industry for the study of heat exchangers.

Text Books /References:

1.R.C.Sachdeva, "Fundamentals of Engineering Heat and Mass Transfer " New age international publishers.

2.R.K.Rajput " Thermal Engineering", Laxmi Publications

Course Name	**Measurement & Quality Control (MQC)**	L	T	P
Course Code	**23PCME502L**	-	-	2
Pre-requisite	Manufacturing Process, Machine Drawing	**Syllabus Version V:1**		

Course Objectives:

1. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments for industrial inspection etc.
2. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the working of different sensors and transducers for the typical application.
4. Understand the process of use of Quality Control Technique in engineering industries
5. Understand Quality Management Systems.

Course Outcomes: Students will be able to

1. Demonstrate the use of different linear and angular dimension measuring instruments and comparators.
2. Calibrate the measuring instrument and design the limit / inspection gauges
3. Comprehend the working of different sensors and transducers for the typical application
4. Select and apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
5. Apply Statistical Quality Control tool(s) to analyse and interpret the inspection data.

Part [A] Experiment no. 1 and 6 are mandatory. Perform any three from experiment no. 2 to 5 & any three from experiment no. 7 to 10.

Expt. No.1	Measurement of linear and angular dimensions using standard measuring instruments.
Expt. No.2	Verification of dimensions & geometry of given components using Mechanical comparator.
Expt. No.3	Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)
Expt. No.4	Design of Inspection Gauges – As per ASME Y14.5 - GD&T Standard
Expt. No.5	Error determination of measuring instruments of linear and angular dimensions of given part, MSA (Gauge R & R)
Expt. No.6	Determination of geometry & dimensions of given composite object / single point tool, using profile projector and tool maker's microscope.
Expt. No.7	Measurement of Spur Gear parameters using Gear Tooth Vernier Caliper OR Measurement of thread parameters using floating carriage Micrometer.
Expt. No.8	Demonstration of surfaces inspection using optical flat/interferometers.

Expt. No.9	Machine tool alignment testing on machine tool – Lathe / Drilling / Milling.	
Expt. No.10	Demo of use of sensors and transducers for the typical application [Case study presentation]	
Part [B] Statistical Quality Control (SQC) (Any Two assignments) Note - Use of computational tools [such as Minitab / Matlab / MS Excel] are recommended		
Assignment1	Note: For completing this assignment.... 1. The templates ('.excel format') for drawing/developing Pareto Chart, Cause and Effe t Diagram, FMEA sheet, 5S Sheet & Kaizen Sheet. 2. Make a screenshot and paste it in the '.ppt format' are made available on Google Classroom. Part - I: Select any product / process and complete following steps... i. Identify & enlist its Quality Characteristics, ii. Identified Failure Modes [related to identified Quality Characteristics], iii. Prepare Check Sheet, iv. Draw Pareto Chart to prioritize quality characteristics, v. Draw Cause and Effect Diagram, vi. Develop FMEA Sheet	Out of the class activity. As per selected task for completing this assignment
	Part - II: Study any reference / case study available with you (in books or downloaded from internet) related to 5S activity & Kaizen activity then use attached formats of 5S & Kaizen Sheets, prepare it accordingly & add it (ie. its screenshot) in the same template file attached in '.ppt format' to complete this assignment... [Note: Any opportunity of implementing 5S & Kaizen activity at any possible work place like, industry, workshops, shops, your home etc... you are most welcome. Only you need to explain it properly in the given format].	
Assignment 2	Q.1. Instructions... for Variable type data-set... Refer excel sheet for data one variable & two attribute data sets, 1. Select appropriate type of charts, 2. Calculate three sigma limits for specific charts, 3. Plot Control Charts of Variables 4. Interpret the meaning, 5. Determine process capability, 6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not ?	Out of the class activity. [As per selected task for completing this assignment]

	Q.2. Instructions... for Attribute type data-set... Refer excel sheet for data one variable & two attribute data sets, 1. Select appropriate type of charts, 2. Calculate three sigma limits for specific charts, 3. Control Charts of Attribute,
	4. Interpret the meaning, 5. Determine process capability, 6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not ? Q. 3. Differentiate between single, double & multiple sampling plans.

Text Books:

1	Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
2	I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.
3	Jain R.K., Engineering Metrology, Khanna Publication.
4	Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
5	IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
6	Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.
7	Basterfield D. H., Quality control, Pearson Education India, 2004.
8	Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.

Reference Books:

1.	ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
2.	Juran J. M., Quality Handbook, McGraw Hill Publications.
3.	Online Education resources: viz. NPTEL web site: (1) nptel.ac.in/courses/112106179 (2) www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html; (3) www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/; (4) freevideolectures.com › Mechanical › IIT Madras (5) nptel.ac.in/courses/112107143/37.

Course Name	Computer Aided Engineering (CAE) Laboratory	L	T	P
Course Code	22ME504L	-	-	2
Pre-requisite	Strength of Materials, Solid modelling, Basic programming			

Course Objectives:

1. To prepare a program in the MATLAB/OCTAVE tool for finding transformations of CAD objects
2. To formulate a 1D FEM problem for static structural analysis
3. To use finite element tools to solve bar, beam, and truss problems of static structural analysis.
4. To use finite element tools for static structural analysis of mechanical components

Course Outcomes: After successful completion of the course, students will be able to

1. Develop a program in MATLAB for finding transformations of CAD objects.
2. Compute stresses, strains, and deflection of bar/beam/truss/mechanical components under static loading using the FEA tool.
3. Interpret the stresses, strains, and deflection results of bar/beam/truss/mechanical components obtained through the FEA tool.
4. Write a program to formulate a 1D FEM problem for static structural analysis.

Laboratory Work:

(Assignments no. 1, 8, 9 are compulsory, and any 5 from 2 to 7)
1. Write a program to perform and visualize concatenated 2D and 3D transformations (translation, rotation, scaling) on basic geometric entities.
2. Perform static structural analysis of a stepped bar using commercial FEA software.
3. Perform static structural analysis of trusses using commercial FEA software.
4. Perform static structural analysis of a beam using commercial FEA software.
5. Perform static structural analysis of a plate with a hole, L-bracket, or similar using 2D elements.
6. Perform static analysis of a 3D model of any mechanical component (e.g., piston, hook, bracket) using 3D elements.
7. Perform steady-state heat transfer analysis through the composite wall using FEA software.
8. Write a program to perform static structural analysis of a stepped bar using 1D finite elements and compare the results with those of a commercial tool (A2).
9. Write a program to perform static structural analysis of a stepped truss using 1D finite elements and compare the results with those of a commercial tool (A3).

Textbooks/References:

1. Nitin S. Gokhale, Practical Finite Element Analysis, Finite to Infinite; First edition

2. ANSYS user guide https://www.ansys.com/academic/learning-resources

Course Name	Multidisciplinary Minor Course 2 Lab	L	T	P
	AI and ML Laboratory			
Course Code	23MDm501L	-	-	2

Course Objectives:

1. Implement and compare regression techniques (Linear, Polynomial, Regularized) using gradient descent (batch/stochastic) in Python.
2. Develop classification models (Binary & Multiclass) using Logistic Regression, SVM, and Decision Trees with scikit-learn
3. Apply ensemble methods (Random Forests, Boosting) to improve model performance and interpret results.
4. Design and train Neural Networks for regression/classification tasks using scikit-learn.
5. Implement AI search algorithms (DFS, BFS, A*) in Python to solve pathfinding problems

Course Outcomes: Students will be able to:

1. Implement regression models (linear, polynomial, regularized) using gradient descent variants in Python.
2. Build and evaluate classification systems (logistic regression, SVM, decision trees) for binary/multiclass problems.
3. Apply ensemble techniques (random forests, boosting) to enhance model performance.
4. Design neural networks using scikit-learn for basic prediction tasks.
5. Solve pathfinding problems by implementing search algorithms (DFS, BFS, A*) in Python.

Scikit-learn machine learning framework shall be used for implementing the following machine learning algorithms on **jupyter notebook/Google colab.** Standard toy datasets shall be used for assignments and real life problem shall be attempted in the mini-project.

1. Regression on scikit-learn - Linear regression Gradient descent - batch and stochastic.

2. Polynomial regression, Regularized models

3. Logistic regression

4. Classification on scikit-learn - Binary classifier/Multiclass classifier

5. Support Vector Machines using scikit-learn

6. Decision Trees, Ensemble Learning and Random Forests

7. Neural networks models in scikit-learn

8. DFS, BFS Implementation in Python

9. A* Implementation in Python

10. Mini project/competition: A Kaggle competition problem for each student

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Text/Reference Books:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems

2. Sklean documentation: https://scikit-learn.org/0.21/documentation.html