PAAVAI ENGINEERING COLLEGE, NAMAKKAL

B.E. MECHANICAL ENGINEERING

REGULATIONS 2023

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM & SYLLABUS

SEMESTER – V

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	ME23501	Design of Machine Elements	3	1	0	4
2	PC	ME23502	Dynamics of Machinery	3	1	0	4
3	PC	ME23503	Metrology and Measurements	3	0	0	3
4	PC	ME23504	Additive Manufacturing	3	0	0	3
5	PC	ME23505	Automobile Engineering	3	0	0	3
6	PE	ME2315*	Professional Elective-I	3	0	0	3
Practical							
7	PC	ME23506	Metrology and Measurements Laboratory	0	0	2	1
8	PC	ME23507	Dynamics Laboratory	0	0	2	1
9	EE	ME23508	Industrial Training	0	0	2	1
10	EE	GE23501	Professional Development III	0	0	2	1
TOTAL				**18**	**2**	**8**	**24**

VERTICAL – IV
THERMAL ENGINEERING

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23451	Power Plant Engineering	3	0	0	3
2	PE	ME23452	Refrigeration and Air conditioning	3	0	0	3
3	PE	ME23453	Gas Dynamics and Jet Propulsion	3	0	0	3
4	PE	ME23454	Computational Fluid Dynamics	3	0	0	3
5	PE	ME23455	Turbo Machines	3	0	0	3
6	PE	ME23456	Design of Heat Exchangers	3	0	0	3
7	PE	ME23457	Advanced Internal Combustion Engines	3	0	0	3

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Mechanical Engineering
AUTONOMOUS

VERTICAL – V
ROBOTICS AND AUTOMATION

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23551	Microprocessor and Artificial Intelligence for Industry	3	0	0	3
2	PE	ME23552	Machine Learning in Automation	3	0	0	3
3	PE	ME23553	Measurements and Controls	3	0	0	3
4	PE	ME23554	Predictive Analytics in Industry 4.0	3	0	0	3
5	PE	ME23555	Automation in Manufacturing	3	0	0	3
6	PE	ME23556	Real time Embedded Systems	3	0	0	3
7	PE	ME23557	Electrical Drives and Actuators	3	0	0	3

VERTICAL – VI
AUTOMOTIVE ENGINEERING

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23651	Vehicle Dynamics and control	3	0	0	3
2	PE	ME23652	Electric Vehicle Technology	3	0	0	3
3	PE	ME23653	Smart Mobility and Vehicle Systems	3	0	0	3
4	PE	ME23654	Thermochemical Energy Systems	3	0	0	3
5	PE	ME23655	Sheet metal and Composite Material design	3	0	0	3
6	PE	ME23656	Automotive Engine and Subsystems	3	0	0	3
7	PE	ME23657	Intelligent vehicle system	3	0	0	3

MINOR
MANUFACTURING TECHNOLOGY

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23851	Basics of Manufacturing Technology	3	0	0	3
2	PE	ME23852	Fundamentals of Additive Manufacturing	3	0	0	3
3	PE	ME23853	Non-Traditional Manufacturing Processes	3	0	0	3
4	PE	ME23854	Smart Manufacturing and Industry 4.0	3	0	0	3
5	PE	ME23855	Product design and Innovation	3	0	0	3
6	PE	ME23856	Lean and sustainable Manufacturing systems	3	0	0	3

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
B.E. MECHANICAL ENGINEERING
REGULATIONS 2023
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CURRICULUM
VERTICAL – I
ENGINEERING DESIGN

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23151	Design for Manufacture and Assembly	3	0	0	3
2	PE	ME23152	Design of Jigs, Fixtures and Press Tools	3	0	0	3
3	PE	ME23153	Machine Tool Design	3	0	0	3
4	PE	ME23154	Ergonomics in Design	3	0	0	3
5	PE	ME23155	Geometric Modelling	3	0	0	3
6	PE	ME23156	Engineering Tribology	3	0	0	3
7	PE	ME23157	Failure Analysis and Design	3	0	0	3

VERTICAL – II
MANUFACTURING

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23251	Non-Traditional Machining	3	0	0	3
2	PE	ME23252	Welding Technology	3	0	0	3
3	PE	ME23253	Process planning and cost estimation	3	0	0	3
4	PE	ME23254	Computer Integrated Manufacturing	3	0	0	3
5	PE	ME23255	Advanced Casting and forming processes	3	0	0	3
6	PE	ME23256	Lean Manufacturing	3	0	0	3
7	PE	ME23257	Industrial Robotics	3	0	0	3

VERTICAL – III
INDUSTRIAL ENGINEERING

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME23351	Operational Research	3	0	0	3
2	PE	ME23352	Engineering Economics	3	0	0	3
3	PE	ME23353	Industrial Safety	3	0	0	3
4	PE	ME23354	Logistics and Supply Chain Networks	3	0	0	3
5	PE	ME23355	Plant Layout and Materials Handling	3	0	0	3
6	PE	ME23356	Supply Chain Management	3	0	0	3
7	PE	ME23357	Enterprise Resource Planning	3	0	0	3

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Mechanical Engineering
31/12/24
AUTONOMOUS

ME23501	DESIGN OF MACHINE ELEMENTS	3	1	0	4

COURSE OBJECTIVES

To enable the students to

1	learn the designing of machine elements subjected to static and variable loads.
2	study and understand the basics of designing shafts and couplings for various application
3	attain good understanding on design of bolted and welded joints for various kinds of loads and applications.
4	acquire knowledge on designing of helical and torsional springs subjected to constant and variable loads
5	understand design procedure for bearings and selection of appropriate sliding and rolling contact bearings for different applications.

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN **12**

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending and torsional loading- Combined loads – Principal stresses – Eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety- theories of failure for ductile and brittle materials– Stress concentration - Fluctuating stresses -Endurance limit – design for finite and infinite life under variable loading – Soderberg, Goodman and Gerber relations - Exposure to standards.

UNIT II DESIGN OF SHAFT AND COUPLINGS **12**

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of Keys and splines – Design of Rigid and flexible couplings - AI-Enabled Material Selection for Shaft and coupling Manufacturing.

UNIT III DESIGN OF TEMPORARY AND PERMANENT JOINTS **12**

Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints- Cotter joints, Welded joints – Butt, Fillet and parallel transverse fillet welds – welded joints subjected to combined loads.

UNIT IV DESIGN OF ENERGY STORING ELEMENTS **12**

Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs, spring design for static loading - Flywheels considering stresses in rims and arms for engines and presses - Solid and Rimmed flywheels

UNIT V DESIGN OF BEARINGS **12**

Rolling contact and sliding contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs - Application of AI in Analyzing Sommerfeld Number for Hydrodynamic Bearing Performance - Selection of Rolling Contact bearings -Causes and failures of bearings.

TOTAL PERIODS:60

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	design various machine elements subjected to simple and variable loads	Analysing (K4)
CO2	design shafts and couplings for various applications as per procedure	Understanding (K2)

CO3	design bolted and welded joints for various kinds of loads and applications	Applying (K3)
CO4	design energy storing elements like helical and leaf springs, flywheels for various applications.	Understanding (K2)
CO5	design different types of bearings and also select sliding and rolling contact bearings appropriately for different applications.	Analysing (K4)

TEXT BOOKS

1. Bhandari V B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2017
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill , 2015.

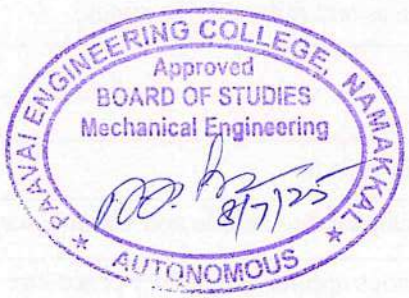
REFERENCES

1. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine component Design",6th Edition, Wiley, 2017.
2. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, 6th Edition John Wiley and Sons, New Delhi, 2017
3. Design Data Hand Book", PSG College of Technology, Coimbatore, 2013
4. Norton R.L., "Design of Machinery", 5th Edition, Tata McGraw Hill, New Delhi, 2012.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	-	-	-	2	2	3
CO2	3	3	3	3	-	-	-	1	-	-	-	2	2	3
CO3	3	3	3	3	-	-	-	1	-	-	-	2	2	3
CO4	3	3	3	3	-	-	-	1	-	-	-	2	2	3
CO5	3	3	3	3	-	-	-	1	-	-	-	2	2	3



ME23502	DYNAMICS OF MACHINERY	3	1	0	4

COURSE OBJECTIVES

To enable the students to

1	understand the force-motion relationship in components subjected to external forces and analysis of standard mechanism.
2	familiarize the concept of static and dynamic mass balancing
3	get introduced to the approaches and mathematical models used in dynamical analysis of free vibration
4	know the analysis of forced vibrations and vibration transmissibility
5	learn various control mechanism for governors and gyroscopes

UNIT I	FORCE ANALYSIS AND FLYWHEELS	12

Static forces analysis of mechanism – dynamic force analysis in reciprocating engines – gas forces – inertia effect of connecting rod – bearing loads – crank shaft torque – engine shaking forces –turning moment diagrams – flywheels of engines and punch press.

UNIT II	BALANCING	12

Static and dynamic balancing - balancing of rotating masses - Balancing of single cylinder engines - Balancing of Multi-cylinder engines- V-engines – Partial balancing in engines.

UNIT III	FREE VIBRATION	12

Basics of vibratory systems - Degrees of freedom - single degree of freedom - free vibration- equation of motion - natural frequency – types of damping - damped free vibration – whirling of shaft and critical speed – torsional system – natural frequency of two and three rotor systems.

UNIT IV	FORCE VIBRATION	12

Response to periodic forcing – harmonic forcing – unbalanced forced vibration – support motion – logarithmic decrement –magnification factor – vibration isolation and transmissibility.

UNIT V	MECHANISM FOR CONTROL	12

Governors - types – centrifugal governors – watt, porter and proell governors- controlling force- characteristics, gyroscopes – basic concepts gyroscopic law – gyroscopic couple – gyroscopic stabilization – gyroscopic effects in automobiles , ships and airplanes.

TOTAL PERIODS:60

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	analyze forces acting in mechanisms and determine bearing loads and shaking forces.	Analysing (K4)
CO2	apply balancing techniques for rotating and reciprocating systems.	Applying (K3)
CO3	solve problems involving free vibrations and determine natural frequencies.	Analysing (K4)
CO4	evaluate forced vibration response and apply vibration isolation principles.	Evaluating (K5)

CO5	understand the function and analysis of governors and gyroscopic effects.	Understanding (K2)

TEXT BOOKS

1. Rattan, S.S, "Theory of Machines", 5th Edition, Tata McGraw-Hill, 2019
2. Uicker, J.J., Pennock, G.R. and Shigley, J.E., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2014.

REFERENCES

1. J. S. Brar, R. K. Bansal A Text Book of Theory of Machines, Laxmi Publication,2004
2. Bevan Theory of Machines, 3rd Edition, Pearson publishing, 2009
3. R.S. KhurmI, "Theory of Machines", S Chand publication, 2020
4. Sadhu Singh, Theory of Machines: Kinematics and Dynamics 3rd Edition, 2011

CO - PO MAPPING

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COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	1	-	-	-	-	-	-	-	1	2	2

ME23503	METROLOGY AND MEASUREMENTS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand metrology, measurement systems, and the basics of geometric dimensioning and tolerancing.
2	learn the method of linear and angular measurements and provides working skill in suitable devices.
3	provide knowledge on form measurements using suitable instruments.
4	learn about techniques and instruments used to measure power, flow and temperature.
5	know about the laser and advances in metrology.

UNIT I BASICS OF METROLOGY **9**

Definition of metrology - units and standards - tolerance analysis - metrological characteristics of measuring instrument: accuracy, precision, resolution, sensitivity, drift, reproducibility, linearity stability, range, uncertainty - stages of generalized measurement system - sources of error - error analysis, classification of errors - factors considered in selection of instruments - principle of high precision measurement - interchangeability.

UNIT II LINEAR AND ANGULAR MEASUREMENTS **9**

Linear measuring instruments: Vernier, micrometer, slip gauges, height gauge - comparators: mechanical, pneumatic and electrical comparators - angular measurements: sine bar, sine center, bevel protractor, angle dekkor, auto collimator - applications.

UNIT III FORM MEASUREMENTS **9**

Need of form measurements - measurement of screw thread - external thread measurement - measurement of major, minor diameter - measurement of Gears: runout, pitch, profile, lead, backlash - straightness measurement – flatness measurement - roundness measurement - surface finish measurement - stylus based - tomlinson surface meter and Taylor-Hobson Talysurf.

UNIT IV MEASUREMENT OF POWER, FLOW AND TEMPERATURE **9**

Power: mechanical, pneumatic, hydraulic, electrical type – flow measurement: venture, orifice, rotameter, pitot tube - AI calibration models for pitot tube-based flow meters - temperature measurement: Methods of measuring temperature - bimetallic strip, thermocouples, pyrometer, resistance temperature detectors.

UNIT V LASER AND ADVANCES IN METROLOGY **9**

Precision instruments based on laser Principles - laser interferometer- laser application in measurements and machine tool metrology - coordinate measuring machine (CMM): need, construction, types, AI-Based adaptive control in CMM and applications- computer aided inspection - machine Vision- applications of machine vision in inspection - importance of nano dimension - XRD.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	understanding the metrology, measurement systems, and basic GD&T.	Analysing (K4)

CO2	practice the appropriate linear and angular measurements using precision measuring instruments.	Understanding (K2)
CO3	examine the major terminologies for screw thread, gear and roundness measurement.	Applying (K3)
CO4	have an in-depth knowledge of using appropriate instruments and techniques for the measurements of power, flow and temperature.	Understanding (K2)
CO5	gain knowledge on working principle of laser devices and coordinate measuring machine.	Analysing (K4)

TEXT BOOKS

1. Jain R.K., "Engineering Metrology", Khanna Publishers, 21st Edition, 2012.
2. Raghavendra N V, Krishnamurthy L, "Engineering metrology and measurements", Oxford university press, New Delhi, 2021.

REFERENCES

1. Gupta S.C, "Engineering Metrology", Dhanpat Rai Publications, 2018.
2. Bewoor, Vinay Kulkarni, Metrology & Measurement, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2009.
3. Thomas G.Beckwith, Roy D.Marangoni, John H.Lienhard V, "Mechanical Measurements", Pearson Education, 6th Edition, 2006.
4. Holman.J.P., "Experimental Methods for Engineers" MCGraw-Hill Companies, Inc, 2012.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

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COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	-	2	-	-	-	-	-	-	2	-	-	-	1
CO2	2	-	1	-	-	-	-	-	-	2	-	-	-	-
CO3	2	1	-	--	2	-	-	-	-	2	-	-	-	-
CO4	2	2	-	-	-	-	-	1	2	1	-	1	1	-
CO5	2	2	-	-	2	-	-	1	2	1	-	1	1	-

ME23504	ADDITIVE MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce the fundamentals of Additive Manufacturing and its impact on modern product development.
2	understand the unique capabilities of AM and learn key concepts in design, data processing, and file preparation for quality part production.
3	interpret the principles, materials, processes, advantages, and applications of SLA, DLP, LOM, and UAM additive manufacturing techniques.
4	comprehend the principles, processes, materials, and applications of FDM, SLS, SLM, and EBM additive manufacturing technologies.
5	explore the principles, processes, materials, and applications of Binder Jetting, Material Jetting, and LENS additive manufacturing techniques.

UNIT I	INTRODUCTION	9

Introduction to Additive Manufacturing - Impact of AM on Product Development - Historical development, benefits of AM, commonly used terms, process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, Classification of AMT process, Applications to various fields.

UNIT II	DESIGN FOR ADDITIVE MANUFACTURING	9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM

UNIT III	VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES	9

Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications. Laminated Object Manufacturing (LOM): Working Principles – Process and parameters. Ultrasonic Additive Manufacturing (UAM) – Process – AI - Based Print Parameter Optimization for Photopolymer Curing and its Applications.

UNIT IV	MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES	9

Fused deposition Modelling (FDM): Working Principles - Process - Materials and Applications. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications - AI - Enabled Digital Twin for SLM/EBM

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.		
		TOTAL PERIODS:45
COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	explain the AM process chain, classify AM technologies, and identify their applications across various industries.	Understanding (K2)
CO2	apply design principles such as part orientation, support structures, and slicing to improve part quality in extrusion-based AM.	Applying (K3)
CO3	describe the working principles, material usage, and benefits of SLA, DLP, LOM, and UAM processes and identify their industrial applications.	Understanding (K2)
CO4	discuss the working principles, material selection, and industrial relevance of FDM, SLS, SLM, and EBM processes.	Remembering (K1)
CO5	differentiate between 3DP, MJM, and LENS processes based on their working principles, material compatibility, and application suitability.	Analysing (K4)

TEXT BOOKS

1. Chua C.K, Leong K.F and Lim C.S, Rapid Prototyping: Principles and Applications, second edition, World Scientific, 2005.
2. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 2nd Edition, 2015

REFERENCES

1. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2016.
2. Ben Redwood, Brian Garret, FilemonSchöffer, and Tony Fadel, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017.
3. Bandyopadhyay, A.& Bose.S. Additive Manufacturing, second edition, CRC Press, 2019
4. Milan Brandt. "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	-	-	-	2	2	2
CO2	3	-	3	-	3	-	-	-	-	-	-	-	2	2
CO3	3	-	-	2	2	-	-	-	-	-	-	-	2	2
CO4	3	2	-	2	3	-	-	-	-	-	-	-	2	2
CO5	3	-	2	-	3	-	-	-	-	-	-	2	2	2

ME23505	AUTOMOBILE ENGINEERING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the construction and working principles of various parts of an automobile
2	study the practice for assembling and dismantling of engine parts and transmission system
3	gain knowledge about different types of transmission systems
4	learn the concepts and working principles of steering, brakes and suspension systems
5	acquire knowledge on alternate energy sources in automobiles

UNIT I VEHICLE STRUCTURE AND ENGINES — **9**

Types of Automobiles, Types of Chassis layout, with reference to Power Plant drive location. Types of Frames and Body, IC engines – components - functions and materials, variable valve timing (VVT). - Turbo Chargers - Superchargers - Turbo Lag, Introduction to Electronic Engine Management System.

UNIT II ENGINE AUXILIARY SYSTEMS — **9**

Carburetion and Simple Carburetor - Electronically controlled gasoline injection system for SI engines, electronically controlled diesel injection system (Unit injector system, Rotary distributor type and CRDI system), AI-Based Optimization of Fuel Injection Timing in SI and CI Engines - Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Engine Emission control by 3-Way catalytic convertor system, Emission norms (Euro and BS).

UNIT III TRANSMISSION SYSTEMS — **9**

Clutch – Types and Construction, Gear Boxes - Manual and Automatic, Gear Shift Mechanisms – Over Drive, Transfer Box, Fluid flywheel, Torque converter, Propeller shaft, Slip Joints, universal joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS — **9**

Steering Geometry and Types of steering gear box – Power Steering - AI-Enhanced Power Steering Assistance, Types of Front Axle, Types of Suspension systems, stabilizer bar, damper, air suspension system - pneumatic and hydraulic braking systems, Antilock braking system (ABS), Electronic brake force distribution (EBD) and traction control.

UNIT V ALTERNATIVE ENERGY SOURCES — **9**

Electric and hybrid Vehicles – Introduction, types, series hybrid, parallel hybrid vehicles. Solar Powered Vehicles Autonomous Vehicle - Fuel Cells - Use of Natural Gas, Liquefied petroleum gas (LPG), Bio-diesel, Bio-ethanol, Gasohol and hydrogen in Automobiles – Engine modification required – performance, Combustion and Emission characteristics of SI and CI engines with these alternate fuels

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	demonstrate knowledge on vehicle construction and IC Engine components	Analysing (K4)

CO2	describe the principle and working of CRDI, MPFI, electronic fuel injection system, ignition system and 3-way catalytic converter system	Understanding (K2)
CO3	illustrate knowledge on the construction and functionality of clutch, gear box, rear axle drives, fluid flywheel, and torque converter	Applying (K3)
CO4	demonstrate knowledge on parts like the wheels, tyres, steering gear box, suspension system-telescopic, and leaf spring.	Understanding (K2)
CO5	motivated to update knowledge on recent trends in automobile engineering like alternate fuels, and electric vehicles	Analysing (K4)

TEXT BOOKS

1. Gupta R B , "Automobile Engineering", 1st Edition, Satya Prakashan Publishers, New Delhi, 2016
2. Kirpal Singh , "Automobile Engineering Vol I and II", 13th Edition, Standard Publishers, New Delhi, 2017

REFERENCES

1. Crouse William H. and Anglin Donald L. , "Automotive Mechanism", 10th Edition, Tata McGraw-Hill, New Delhi, 2017
2. Ganesan V. "Internal Combustion Engines", Fourth Edition, Tata McGraw-Hill, 2017
3. Iqbal Husain, "Electric and Hybrid Vehicles", 3rd Edition, CRC Press, 2021
4. Rajput R.K., "A Text book of Automobile Engineering", 2nd Edition, Laxmi Publication, New Delhi, 2017

CO - PO MAPPING

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COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1	-	-	-	-	-	-	2	3	2
CO2	3	2	3	1	1	-	-	-	-	-	-	2	3	2
CO3	3	2	3	1	1	-	-	-	-	-	-	2	3	2
CO4	3	2	3	1	1	-	-	-	-	-	-	2	3	2
CO5	3	2	3	1	1	-	-	-	-	-	-	2	3	2

ME23506	METROLOGY AND MEASUREMENTS LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	understand the precision measurement and calibration processes of instruments.
2	familiarize with different measuring equipment and their usage in industries for measurement and inspection.
3	practice measurement of different parameters like length, angle, torque, pressure and temperature.
4	carry out form measurements on gear teeth and screw thread and also straightness of surface.

LIST OF EXPERIMENTS

1. Calibration of precision instrument: Vernier Caliper / Micrometer / Dial Gauge
2. Measurements of Gear Tooth Dimensions using optical profile projector
3. Measurement of straightness using Autocollimator
4. Checking limits of dimensional tolerance using comparators (Mechanical / Electrical)
5. Measurement of Temperature using Thermocouple
6. Calibration of Linear Variable Differential Transformer (LVDT) using displacement measuring setup
7. Measurement of Force using strain gauge
8. Measurement of Torque using strain gauge
9. Measurement of Vibration
10. Measuring screw thread dimensions using Tool Makers Microscope

TOTAL PERIODS :30

COURSE OUTCOMES At the end of the course, the students will be able to		**BT MAPPED** (Highest level)
CO1	handle different precision measurement tools with appropriate measuring techniques and also carry out calibration processes.	Analyzing (K4)
CO2	study and analyze the characteristics of precision instruments	Analyzing (K4)
CO3	use contact and non-contact measuring instruments, limit gauges and comparators for measurements, checking and inspection	Applying (K3)
CO4	demonstrate practical knowledge on geometrical parameters like straightness, flatness, roundness, parallelism.	Analyzing (K4)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	1	1	-	2	2	3
CO2	3	2	-	-	-	-	-	-	1	1	-	2	2	3
CO3	3	2	-	-	-	-	-	-	1	1	-	2	2	3
CO4	3	2	-	-	-	-	-	-	1	1	-	2	2	3

ME23507	DYNAMICS LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	familiarize with mass moment of inertia of Flywheel, axle system and symmetric bodies using Turn Table apparatus.
2	understand the concept of balancing of machinery and mechanisms
3	learn the working principles and analyze the mechanism of gyroscope, governor and cams
4	understand the fundamental concepts of various types of vibrating systems and their elements

LIST OF EXPERIMENTS

1. a) Determination of Mass moment of inertia of Fly wheel and Axle system.
   b) Determination of Mass Moment of Inertia of axis symmetric bodies using Turn Table apparatus.
2. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
3. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
6. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
   b) Multi degree freedom suspension system – Determination of influence coefficient.
7. Vibration of Equivalent Spring mass system – undamped and damped vibration.
8. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
9. a) Balancing of rotating masses
   b) Balancing of reciprocating masses
10. a) Transverse vibration of Free-Free beam – with and without concentrated masses
    b) Determination of transmissibility ratio using vibrating table.

TOTAL PERIODS :30

COURSE OUTCOMES At the end of the course, the students will be able to		**BT MAPPED** (Highest level)
CO1	determine the mass moment of inertia of flywheel, axle and axis symmetric bodies and internalize the calculations and the elements considered in such tests.	Analyzing (K4)
CO2	practically gain knowledge and demonstrate how Mechanical systems get balanced by design	Analyzing (K4)
CO3	describe the working principles and mechanisms involved in the functioning of gyroscopes, governors and cams	Applying (K3)

CO4	analyze and explain various vibrating systems and different factors associated with the systems	Analyzing (K4)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	1	1	-	2	2	3
CO2	3	2	1	-	-	-	-	-	1	1	-	2	2	3
CO3	3	2	1	-	-	-	-	-	1	1	-	2	2	3
CO4	3	2	1	-	-	-	-	-	1	1	-	2	2	3

ME23508	INDUSTRIAL TRAINING	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	observe the rules and regulation, standards of the industry
2	appreciate organizational set up from top executive to workmen level
3	observe the end product, various Components/ materials used in the production and identify their source.
4	develop an Understanding of various stages involved in processing, sequential arrangement of different equipment.

DESCRIPTION

Industrial Training provides work experience relevant to their field of specialization, before graduation, and it is an essential component for the development of practical and professional skills required for an engineering graduate and supports for prospective employment.

At the end of the industrial training, students should be able to improve their knowledge and skills relevant to their areas of specialization where they have been trained. The students should also be able to relate, apply, and adapt the relevant knowledge, concepts, and theories within an industrial organization, and also to practice the general workplace behaviour and interpersonal skills.

The student (either in group or single) should undergo industrial training for a minimum period of two weeks during the summer vacation after the completion of fourth semester as specified in the curriculum in any research organization/university/industry of State/National and International level industry relevant to their branch of specialization, after getting proper approval from the Head of the Institution.

On the completion of the industrial training for the specified period, the student has to submit the industrial training report (at least 25-30 pages) containing the following details, along with the certificate obtained from the industry for the period of training undergone.

1. Introduction of the industry.
2. Industry layout and its various operations with its infrastructure facilities.
3. Formulation of practical problems, data required to formulate the problems and its analysis.
4. Suggestions and recommendations for the above problems

During the period of training, the student has to abide the rules and regulations enforced by the organization and to ensure FULL attendance during the period of industrial training and uphold the discipline and decorum of the institution.

On the completion of the industrial training, the End Semester Examinations shall be conducted by the Office of the Controller of Examinations at the end of the fifth semester. A three-member committee constituted by the Head of the Institution, consisting of (1) a senior faculty member at the Professor level, (2) senior faculty member at the Associate Professor and (3) faculty member from outside the department, will evaluate the industrial training undergone by the student. The evaluation shall be made based on the report submitted along with the presentation and a Viva voce Examination.

TOTAL PERIODS :30

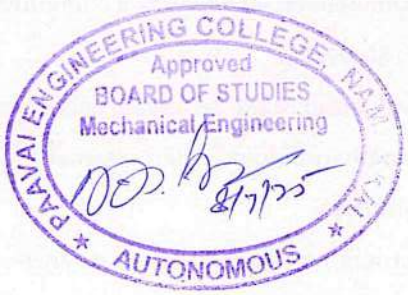
COURSE OUTCOMES At the end of the course, the students will be able to		BT MAPPED (Highest level)
CO1	appreciate the organizational setup and hierarchy	Analysing (K2)
CO2	practice the use of resource optimization techniques	Understanding (K2)
CO3	develop core engineering skills	Applying (K3)
CO4	develop an understanding of solutions for environmental issues in the industry	Understanding (K4)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	2	1	3
CO2	1	-	-	-	-	-	-	-	-	-	-	2	1	3
CO3	2	2	-	-	-	-	-	-	-	-	-	3	2	3
CO4	3	2	2	2	2	-	-	-	-	-	-	3	3	3



GE23501	PROFESSIONAL DEVELOPMENT III	0	0	2	1

COURSE OBJECTIVES

To enable students to

1.	enhance their Resume writing skills and improving corporate vocabularies to survive in the corporate world.
2.	evaluate their interview skills and improve their interview presentation.
3.	solve the quantitative aptitude problems and improve their mental ability.
4.	improve critical thinking and reasoning skills.

UNIT I	RESUME WRITING SKILLS	6

Updated Resume Building III – Self Introduction III – Dressing Etiquette – JAM V – Corporate Vocabulary.

UNIT II	INTERVIEW SKILLS	6

Interview skills – General guidelines - Work Ethics – Group Discussion III – JAM VI – Presentation Competence – Mock Interview.

UNIT III	QUANTITATIVE APTITUDE	9

Cube Root and Square Root - Time and Work - Ages - Permutation and Combination - Probability – Calendar.

UNIT IV	LOGICAL REASONING	9

Series Completion - Blood Relations - Coding and Decoding - Data Sufficiency - Statements and Assumptions.

TOTAL PERIODS:	30

COURSE OUTCOMES Upon completion of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	excel in drafting Resumes and speaking.	Applying (K3)
CO2	demonstrate the participative skills in group discussions and Interviews.	Applying (K3)
CO3	solve problems based on quantitative aptitude.	Applying (K3)
CO4	enhance their logical and verbal reasoning.	Analyzing (K4)

TEXTBOOKS

1. Aggarwal, R. S. A Modern Approach to Verbal & Non-Verbal Reasoning. Revised ed., 2024–25, S. Chand & Company Ltd., 2024.
2. Aggarwal, R. S. Objective General English: Fully Revised Video Edition. S. Chand & Company Ltd., 2022.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hil1.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
3. Johnson, D.W. Reaching out — Interpersonal Effectiveness and self- actualisation. Boston: Allyn and Bacon.2019.
4. Infosys Campus Connect Program — students' guide for soft skills.2015.

CO/PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3

ME23151	DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications.
2	learn design consideration principles of forming in the design of extruded, stamped, and forged products.
3	acquire design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
4	explore techniques for reducing welding time, improving automation, and optimizing material usage.
5	gain an understanding of the assembly process and its impact on product design.

UNIT I	INTRODUCTION AND CASTING	9

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mould cast parts.

UNIT II	FORMING	9

Design for Forming: Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III	MACHINING	9

Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws -Reduction of machined area- simplification by separation – simplification by amalgamation - Design for machinability.

UNIT IV	WELDING	9

Arc welding – Design considerations for Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for Spot – Seam – Projection – Flash & Upset weldment.

UNIT V	ASSEMBLY	9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly - design for robot assembly, Design for manufacture and Computer aided design.

	TOTAL PERIODS:45
COURSE OUTCOMES	**BT MAPPED** (Highest level)
At the end of the course, the students will be able to	
CO1 recognize how different factors (e.g., material, volume, complexity, tolerance, and finish) influence the choice of casting method.	Analysing (K4)

CO2	design consideration principles of forming in the design of extruded, stamped, and forged products.	Understanding (K2)
CO3	understand the principles of turning operations, including lathe-based processes.	Applying (K3)
CO4	identify the key design considerations for optimizing arc welding processes in terms of cost, quality, and structural integrity.	Understanding (K2)
CO5	know the importance of assembly-oriented design in reducing manufacturing and assembly costs.	Analysing (K4)

TEXT BOOKS

1. Geoffrey Boothroyd, Petre Dewhurst, Winston A Knight, "Product Design for Manufacture and Assembly", CRC Press, Taylor & Francis Group, 2010.
2. P.N. Rao, "Manufacturing Technology Foundry, Forming and Welding", Tata McGraw-Hill, New Delhi, 2013.

REFERENCES

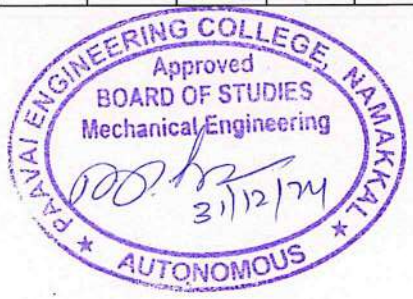
1. A.K. Chitale, R.C. Gupta, Product Design and Manufacturing Prentice Hall of India, 2007.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. S. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2014.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	1	-	-	-	-	-	-	-	1	2	2



ME23152	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study the functions and design principles of Jigs, fixtures and press tools
2	gain proficiency in the development of required views of the final design
3	familiarize in fundamental press working terminologies
4	introduce the basic principles of bending, forming, and drawing operations
5	provide the knowledge forming techniques and evaluation

UNIT I	LOCATING AND CLAMPING PRINCIPLES	9

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

UNIT II	JIGS AND FIXTURES	9

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

UNIT III	PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES	9

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

UNIT IV	BENDING FORMING AND DRAWING DIES	9

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

UNIT V	FORMING TECHNIQUES AND EVALUATION	9

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

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	define the functions and design principles of Jigs, fixtures and press tools	Remembering (K1)
CO2	explain the development of required views for the final design	Understanding (K2)
CO3	apply the principles of various types of presses and various design elements of die.	Applying (K3)
CO4	illustrate the various types of bending dies and drawing dies	Understanding (K2)
CO5	Inference the various forming techniques and evaluation	Analysing (K4)

TEXT BOOKS

1. Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill.
2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile South Asia.

REFERENCES

1. Donaldson, Lecain and Goold "Tool Design", 5th Edition, Tata McGraw Hill, 2017.
2. K. Venkataraman, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.
3. Joshi, P.H. "Press Tools" – Design and Construction", Wheels publishing, 2010.
4. Hoffman "Jigs and Fixture Design" – Thomson Delmar Learning, Singapore, 2004.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	1	-	-	-	-	-	-	-	1	2	2

ME23153	MACHINE TOOL DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the concepts of machine tool design.
2	know the concepts of regulation of speeds
3	apply machine tool structures in design of static and dynamic.
4	design the guide ways and power screws
5	familiarize the function of spindles and support

UNIT I	INTRODUCTION TO MACHINE TOOL DESIGN	9

Introduction to Machine Tool Drives and Mechanisms, Constructional and operational features, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission, mechanical, hydraulic and electric drives.

UNIT II	REGULATION OF SPEEDS AND FEEDS	9

Aim of Speed and Feed Regulation, Layout of Speed Change Gears, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design, Digital Twin Technology for Speed and Feed Simulation.

UNIT III	DESIGN OF MACHINE TOOL STRUCTURES	9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Static and Dynamic Stiffness, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.

UNIT IV	DESIGN OF GUIDEWAYS AND POWER SCREWS	9

Functions and Types of Guideway s, Design of Guideway s, Clearance adjustment in slide ways, Design of Aero static Slide ways, Design of Anti-Friction Guide ways, Combination Guide ways, Design of Power Screws and Recirculating ball screws.

UNIT V	DESIGN OF SPINDLES AND SPINDLE SUPPORT	9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Anti-friction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness, Effects of vibration, Stability Analysis.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	select the different machine tool mechanisms.	Understanding (K2)
CO2	construct the multi speed gear box and feed drives.	Understanding (K2)
CO3	design the machine tool structures with known features.	Analyzing (K4)
CO4	select the various guide ways and power screws.	Applying (K3)

CO5	use the design requirements for spindles and bearings.	Analyzing (K4)

TEXT BOOKS

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010.
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.

REFERENCES

1. D. K Pal, S. K. Basu, "Design of Machine Tools", 5th Edition. Oxford IBH, 2008.
2. N. S. Acherkhan, "Machine Tool Design", Vol. I, II, III and IV, MIR publications, 2006.
3. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 2011.
4. F. Koenigsberger, Machine Tool Structures, Pergamon Press, 2010.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2	2	-	-	-	-	-	1	2	1
CO2	2	1	2	1	2	2	-	-	-	-	-	1	2	1
CO3	3	3	3	1	2	2	-	-	-	-	-	1	3	3
CO4	3	3	3	1	2	2	-	-	-	-	-	1	3	3
CO5	3	3	3	1	2	2	-	-	-	-	-	1	3	3

ME23154	ERGONOMICS IN DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce to industrial design based on ergonomics.
2	consider ergonomics concept in manufacturing
3	apply ergonomics in design of controls and display.
4	apply environmental factors in ergonomics design.
5	develop aesthetics applicable to manufacturing and product

UNIT I	INTRODUCTION	9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT II	ERGONOMICS AND PRODUCTION	9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT III	DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS	9

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT IV	ENVIRONMENTAL FACTORS	9

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT V	AESTHETIC CONCEPTS	9

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	identify the need of ergonomics in the industrial design.	Understanding (K2)
CO2	apply ergonomics in creation of manufacturing system	Applying (K3)
CO3	discuss on design of controls and display.	Analyzing (K4)
CO4	consider the environmental factors in ergonomics design.	Applying (K3)
CO5	identify the importance of aesthetics to manufacturing system and product	Understanding (K2)

TEXT BOOKS

1. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.
2. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006.

REFERENCES

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002.
2. Brain Shakel, "Applied Ergonomics Hand Book", Butterworth Scientific London 2011.
3. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares Francisco Rebelo, 2017.
4. Ergonomics in Product Design by Send points Publishing Co. Ltd, 2006.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	-	1	3	-	2	-	3	-	1	-	-	1	1	3
CO2	-	1	3	-	2	-	3	-	1	-	-	1	1	3
CO3	-	1	3	-	2	-	3	-	1	-	-	1	1	3
CO4	-	1	3	-	2	-	3	-	1	-	-	1	1	3
CO5	-	1	3	-	2	-	3	-	1	-	-	1	1	3

ME23155	GEOMETRIC MODELLING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the concepts of geometric modelling.
2	know the concepts of surface modelling and volumetric modelling
3	apply CAD data representation and properties of geometric models
4	design the graph theoretic models and representation of design
5	familiarize the function of automated assembly planning

UNIT I	OVERVIEW OF CAD SYSTEMS AND GRAPHICS TRANSFORMATION	9

Conventional and computer aided design processes; Subsystems of CAD: CAD hardware and software, graphics packages, CAD workstations; Networking of CAD systems; Generative, cognitive and image processing graphics, static and dynamic data graphics; Transport of graphics data; Graphic standards, generation of graphic primitives, display and viewing, transformations customizing graphics software.

UNIT II	MATHEMATICAL REPRESENTATION OF CURVES AND SURFACES	9

Wireframe modelling 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.

UNIT III	MATHEMATICAL MODELLING OF SOLIDS	9

Properties of solid model, Solid modelling Techniques - Boundary representation, Constructive Solid Geometry, Analytical Solid Modelling, Sweep representation schemes. Solid Manipulation Techniques.

UNIT IV	TRANSFORMATION AND PROJECTION TECHNIQUES:	9

Introduction to computer graphics, Non-interactive Vs interactive computer graphics, applications, graphics system configuration. 2D and 3D transformation techniques - Translation, Rotation, Scaling and Reflection principles. Principle of concatenated transformation. Orthographic and Perspective Projections of Geometric Models.

UNIT V	GRAPHIC STANDARDS AND MODE OF DATA TRANSFER:	9

Definition of graphics standard, geometrical data, direct and indirect data transfer. Neutral file formats - Data Exchange Format (DXF) and Initial Graphics Exchange Specification (IGES).

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	select the different geometric modelling.	Understanding (K2)
CO2	construct cylindrical and spherical coordinate systems	Understanding (K2)
CO3	design the analytical curve modelling	Analyzing (K4)

CO4	select the Synthetic Surface modelling.	Applying (K3)
CO5	use the design of Solid Manipulation Techniques	Analyzing (K4)

TEXT BOOKS

1. Ibrahim Zeid , "CAD/CAM Theory and Practice", 2nd Edition, McGraw Hill Inc, New Delhi, 2009.
2. Groover M.P, Zimmers, E.W. , "CAD/CAM: Computer Aided Design and Manufacture", Prentice Hall, 2003.

REFERENCES

1. Radhakrishnan P, Subramanyan S and Raju V, "CAD/CAM/CIM", New Age International, 2012.
2. Radhakrishnan P and Kothandaraman C , "Computer Graphics and Design", Dhanpat Rai and Sons, 2015.
3. Rogers D F, Adams, J. A , "Mathematical Elements for Computer Graphics", 2nd Edition, McGraw Hill Education, New Delhi, 2002.
4. Michael E Mortenson , "Geometric Modeling", John Wileyand Sons Inc, 2006.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	2	-	-	-	-	-	1	2	2
CO2	2	1	2	2	2	2	-	-	-	-	-	2	3	2
CO3	3	3	3	1	2	2	-	-	-	-	-	1	3	3
CO4	3	2	3	2	2	3	-	-	-	-	-	3	2	3
CO5	2	3	2	1	3	2	-	-	-	-	-	1	3	3

ME23156	ENGINEERING TRIBOLOGY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	measure the different types of surface features associated with the friction of metals and non-metals
2	study the different types of wear mechanism and surface modification techniques.
3	analyse the various types of lubricants and lubrication system in the tribology.
4	develop the methodology for deciding lubricants and lubrication regimes for different operating conditions.
5	study the different types of high-pressure contacts and rolling bearings

UNIT I	ENGINEERING SURFACES AND FRICTION	9

Introduction – Measurement methods – Surface Profilometry, Optical and Electron Microscopy – Non-conforming surface contact geometry – Stresses in Non-conforming contacts – Contact of rough surfaces – Numerical Surface Contact Models – Friction of Metals – Friction of Non-metallic Materials

UNIT II	WEAR AND SURFACE TREATMENT	9

Types of wear mechanism – Laws of wear –Theoretical wear models- Abrasive wear – Adhesive wear – Fatigue wear – fretting wear – Cavitation wear - Wear of Metals and Non-metals – Surface treatments – Surface modifications –Surface coatings – Selection of Surface Treatments and Surface coatings

UNIT III	LUBRICANTS AND LUBRICATION REGIMES	9

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication

UNIT IV	THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION	9

Reynolds Equation-Assumptions and limitations-One and two dimensional Reynolds Equation Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects

UNIT V	HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION	9

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts- Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory Soft and hard EHL Reynolds equation for Elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation

	TOTAL PERIODS:45
COURSE OUTCOMES	**BT MAPPED** (Highest level)
At the end of the course, the students will be able to	
CO1 develop the knowledge on the surface features and its role on the friction behaviour of metals and non-metals	Understanding (K2)

CO2	understand the various types of wear mechanism and surface modification techniques	Applying (K2)
CO3	familiarize the different types of lubricants and lubrication systems in the tribology	Analysing (K4)
CO4	methodology for deciding lubricants and lubrication regimes for different operating conditions	Understanding (K2)
CO5	ability to understand the different types of high pressure contacts and rolling bearings	Analysing (K4)

TEXT BOOKS

1. Prasanta Sahoo, "Engineering Tribology", Prentice –Hall of India Pvt Ltd, New Delhi, 2011
2. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005

REFERENCES

1. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005
2. Rabinowicz.E, "Friction and Wear of materials", John Willey & Sons, UK, 2010.
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 2011.
4. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 2003.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	2	1	2	-	-	-	-	1	3	3
CO2	3	2	1	-	2	1	2	-	-	-	-	1	3	3
CO3	3	2	1	-	2	1	2	-	-	-	-	1	3	3
CO4	3	3	1	-	2	1	2	-	-	-	-	1	3	3
CO5	3	3	1	-	2	1	2	-	-	-	-	1	3	3

ME23157	FAILURE ANALYSIS AND DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	provide a comprehensive understanding of failure analysis, material evaluation techniques
2	understand deformation mechanisms and adopt a general approach to failure analysis
3	study various models of SCC mechanisms to comprehend failure processes
4	know the different types of wear and their mechanisms..
5	apply failure analysis methodologies to identify root causes of material failures in engineering components.

UNIT I INTRODUCTION **9**

Introduction, causes of failures, classification, steps in failure analysis, tools, sample selection and treatment, materials analysis, equipments, Metallography, commonly used NDT methods. Machine condition monitoring techniques and condition monitoring of gearboxes.

UNIT II ANALYSIS OF FAILURE **9**

Deformation and general approach to analysis of failure; Fracture aspects: Type of fracture, ductile, brittle and mixed mode fractures, models of nucleation and growth of cracks, fractography. Determination of chemical composition by various analytical techniques; determination of mechanical properties like tensile, hardness, bend tests of failed components.

UNIT III ENVIRONMENT ASSISTED FAILURES **9**

Basic principles of aqueous corrosion and high temperature corrosion and oxidation, causes and their remedies. Stress corrosion cracking (SCC)- introduction and history of SCC, material/environment combinations where SCC occurs, characteristics of SCC, introduction to various models of SCC mechanism.

UNIT IV WEAR FAILURES **9**

Types of wear, different methods of wear measurement, analysis of wear failures, wear at elevated temperatures, wear of different materials, role of friction on wear, stick slip friction, creep, stress rupture, elevated temperature fatigue, environment induced failure.

UNIT V CASE STUDIES ON FAILURE ANALYSIS **9**

Application and case studies on Failure analysis: Failures of welded railroad rails, failures of large air-conditioning fan blade and failure of broken wire cutters.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	understand the principles and importance of failure analysis in engineering	Understanding (K2)
CO2	know the general approach to analysis of failure	Analyzing (K4)
CO3	examine the environment assisted failures	Applying (K3)

CO4	identify and classify different types of wear mechanisms	Applying (K3)
CO5	analyse the failed engineering components	Analyzing (K4)

TEXT BOOKS

1. Charlie R. Brooks & Ashok Choudhury, Failure Analysis of Engineering Materials, 1st Edition, McGraw-Hill Education 2002.
2. Anderson T L, "Fracture Mechanics: Fundamentals and Applications", 4th Edition, Taylor and Francis, 2017.

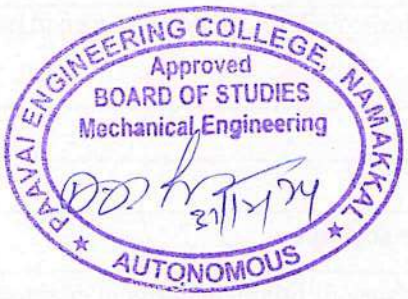
REFERENCES

1. Jack A.Collins, Failure of Materials in Mechanical Design, 2nd Edition, Wiley Inter science Publishers, 2013.
2. Surjya Kumar Maiti, "Fracture Mechanics - Fundamental and Applications", Cambridge University Press, Delhi 2015.
3. Prashant Kumar, "Elements of Fracture Mechanics", Seventh Reprint, Tata Mc Graw Hill publishers, 2014.
4. Michael Janssen, Jan Zuidema, Fracture Mechanics: An Engineering Primer - 2nd Edition 2024.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	2	-	-	-	-	-	-	-	1	2	2



ME23251	NON-TRADITIONAL MACHINING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
2	differentiate chemical and electro chemical energy-based processes.
3	describe thermo-electric energy-based processes.
4	explain nano finishing processes.
5	introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes.

UNIT I	INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES	9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II	CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES	9

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.

UNIT III	THERMO-ELECTRIC ENERGY BASED PROCESSES	9

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV	NANO FINISHING PROCESSES	9

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetor heological finishing, Magneto rheological abrasive flow finishing.

UNIT V	HYBRID NON-TRADITIONAL MACHINING PROCESSES	9

Introduction - Various hybrid non-traditional machining processes, their working principles, equipment's, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

	TOTAL PERIODS:45

COURSE OUTCOMES	BT MAPPED (Highest level)
At the end of the course, the students will be able to	
CO1 formulate different types of non-traditional machining processes	Applying (K3)

CO2	illustrate chemical and electro chemical energy based processes.	Understanding (K2)
CO3	evaluate thermo-electric energy based processes.	Analysing (K4)
CO4	interpret Nano-finishing processes.	Understanding (K2)
CO5	analyse hybrid non-traditional machining processes and differentiate non-traditional machining processes.	Analysing (K4)

TEXT BOOKS

1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009.
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCES

1. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 2005.
2. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2006.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017
4. Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	1	-	1	-	1	1	-	2	2	2
CO2	3	-	1	-	1	-	1	-	1	1	-	2	2	2
CO3	3	-	1	-	1	-	1	-	1	1	-	2	2	2
CO4	3	-	2	-	1	-	1	-	1	1	-	2	2	2
CO5	3	-	3	-	3	-	1	-	1	1	-	3	3	3

ME23252	WELDING TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand welding process of gas and arc welding.
2	learn the concepts of resistance welding and various resistance welding processes
3	gain knowledge of solid state welding process for engineering applications
4	acquire knowledge on special welding processes and modes of welding
5	know about different testing methods of weldability and specific materials

UNIT I	GAS AND ARC WELDING PROCESSES	9

Classifications of Welding Processes - Power Sources - characteristics- V-I Gas Welding: Air Acetylene welding, Oxy-acetylene welding Arc Welding: Shielded metal arc welding - Submerged arc welding - TIG welding - MIG welding - Plasma arc welding - Electro slag welding processes - advantages, limitations and applications.

UNIT II	RESISTANCE WELDING PROCESSES	9

Spot welding - Projection welding - Seam welding - High frequency resistance welding processes - Resistance Butt welding - Flash Butt welding - Percussion welding - advantages, limitations and applications

UNIT III	SOLID STATE WELDING PROCESSES	9

Forge welding - Friction welding - Diffusion bonding - Ultrasonic welding - Explosion welding - Cold pressure welding - advantages, limitations and applications.

UNIT IV	SPECIAL WELDING PROCESSES AND MODES OF WELDING	9

Thermit welding - Electron beam welding - Laser Beam welding- wet under water welding -Surfacing and Thermal Spraying Processes – Material joining processes – Modes of welding.

UNIT V	TESTING OF WELDABILITY AND SPECIFIC MATERIALS	9

Destructive Tests: Tensile Test, Toughness Test, And Fatigue Test -Non-Destructive Test: Visual Inspection, Liquid Penetrant Test, Magnetic Particle Test, Radiographic Test, Ultrasonic Testing, Weldability of Steel, Aluminium alloys, Copper alloys and other non-ferrous metals.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	demonstrate knowledge on gas and arc welding processes	Applying (K3)
CO2	illustrate the fundamental principles of several resistance welding processes	Understanding (K2)
CO3	discuss solid state welding processes and identify their applications	Analysing (K4)
CO4	explain the need for special welding processes and modes of welding	Understanding (K2)
CO5	appraise the destructive and non-destructive testing of weldability through	Analysing (K4)

	different techniques	

TEXT BOOKS

1. Dr.R.S.Parmer, "Welding Processes and Technology", 3rd edition, Khanna Publishers, New Delhi, 2014.
2. Baldev Raj, V.Shankar, A.K.Bhaduri, "Welding Technology for Engineers", ASM International, 2006

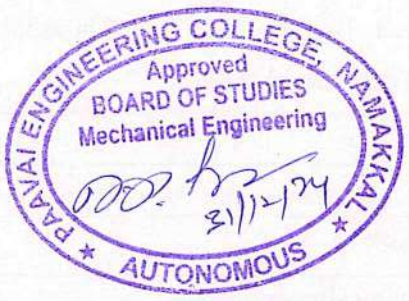
REFERENCES

1. Little R.L., "Welding and Welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2. K.S.Yadav. "Advanced Welding Technology", Standard Book House Publishers, 2017
3. O.P.Khanna, "Welding Technology", DhanpatRai Publications, 2013
4. Nadkarni S.V. "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO2	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO4	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO5	3	3	-	-	-	-	-	-	-	-	-	2	2	3



ME23253	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	simplify the steps involved in preparing a process plan for a given Product.
2	provide an overview for cost estimation of a given product.
3	relate the allocation of overhead costs in manufacturing.
4	understand the procedure to estimate the cost of castings and forging products.
5	clarify the costs involved in machining and estimate the machining cost.

UNIT I PROCESS PLANNING **9**

Defining process planning –Drawing interpretation –Material selection process Factors to be considered in selecting Processes; Process Sequencing; Operation Sequencing; Equipment & Tool Selection; Tool Holding Devices; Measuring Instruments –Computer Aided Process Planning – Retrieval / Variance CAPP and Generative CAPP - Case Study in Process Planning and methods –Selection of Production Processes from Tables – Selection of Process Parameters from Tables.

UNIT II FUNDAMENTAL OF ESTIMATING AND ELEMENTS OF COST **9**

Concept and Purpose of Estimating, Functions of Estimating Department, Concept of Costing Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Elements of Cost – Introduction, Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost).

UNIT III OVERHEADS AND DEPRECIATION **9**

Overheads , Allocation or Distribution of Overhead Cost , Depreciation and Methods to Calculate it, Interest on Capital, Idleness Costs, Repair and Maintenance Cost

UNIT IV ESTIMATION OF CASTING, FORGING & WELDING COSTS **9**

Estimation of cost for Casting processes, Welding processes and Forging processes.

UNIT V ESTIMATION OF MACHINING TIME AND COST **9**

Estimation of Machining Time and Cost – Lathe operations, Drilling, Milling, Shaping Planning, and Grinding operations.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	create a process plan for a given product.	Applying (K3)
CO2	identify cost elements for a given product.	Understanding (K2)
CO3	allocate overhead to different departments in manufacturing a product.	Analysing (K4)

CO4	estimate cost for casting and forging products.	Analysing (K4)
CO5	analyze the costs for machining a product.	Analysing (K4)

TEXT BOOKS

1. Adithan, M, Process Planning and Cost Estimation, New Age International Publishers, 2015.
2. Peter Scallan, Process planning, The Design/Manufacture Interface, Butterworth Heinemann, 2008.

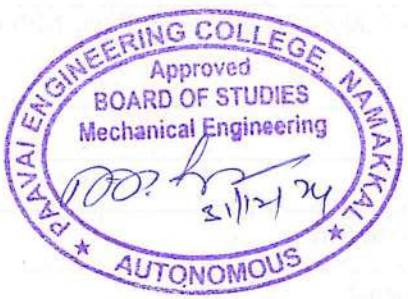
REFERENCES

1. Chitale A. K., and Gupta R. C., "Product Design and manufacturing", Prentice Hall of India, New Delhi, 2011
2. Gideon Halevi, "Process and operation planning", Kluwer academic publishers (Printed e-book), 2008
3. Narang G.B.S. & Kumar .V, "Production and Costing", Khanna Publishers, 2010
4. Phillip F. Ostwald & Jairo Munoz, "Manufacturing Processes and Systems", 9th Edition, Wiley student edition, 2008.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	1	1	1	-	1	1	2	2
CO2	3	3	2	2	-	1	1	1	-	-	1	1	3	3
CO3	3	3	2	2	-	1	1	1	-	-	1	1	3	3
CO4	3	3	2	2	-	1	1	1	-	-	1	1	3	3
CO5	3	3	2	2	2	1	1	1	-	-	1	1	3	3



ME23254	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know the basic concepts and elements in manufacturing process.
2	understand the production planning and process planning techniques.
3	familiarize the group technology and cellular manufacturing methodologies.
4	comprehend the types of FMS and AGVs.
5	define the various models in CIM and communication methods.

UNIT I	INTRODUCTION	9

Introduction to CAD and CAM- CAD/CAM integration. Concurrent Engineering-CIM concepts – Computerised elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance –Product development cycle-Concurrent engineering Examples.-Lean Production and Just-In-Time Production. manufacturing automation protocol

UNIT II	PRODUCTION PLANNING AND CONTROL & COMPUTERISED PROCESS PLANNING	9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III	GROUP TECHNOLOGY & CELLULAR MANUFACTURING	9

Group Technology (GT), Part Families – Parts Classification and coding – DCLASS, MICLASS and OPITZ coding systems. – Facility design using G.T. Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV	FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS)	9

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V	CIM IMPLEMENTATION AND DATA COMMUNICATION	9

System modelling tools- ICAM definition (IDEF) models, The Siemens model of CIM, Activity cycle diagram, CIM open system architecture (CIMOSA) - manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) –Networking in manufacturing-Network file systems-ATM Networks.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	assess CAD/CAM integration for changing manufacturing and management systems.	Remembering (K1)
CO2	use the planning and control methods in production technology.	Understanding (K2)
CO3	construct a machine cell using the concepts of Group Technology and Cellular manufacturing.	Analysing (K4)
CO4	select the suitable material handling and storage system for Flexible Manufacturing Systems	Understanding (K2)
CO5	choose the suitable CIM implementation and data communication techniques.	Applying (K3)

TEXT BOOKS

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2008.

REFERENCES

1. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach", 2010.
2. Singh. N, "Systems Approach to Computer-Integrated Design and Manufacturing", Wiley India Pvt Ltd., 2011.
3. Groover. M.P Automation, production system and Computer Integrated Manufacturing System- Prentice Hall, 2014.
4. P.N. Rao, CAD/CAM Principles and Applications-Tata McGraw Hill 3rd edition, 2007.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	3	-	-	-	-	-	-	2	2	2
CO2	2	1	2	2	3	-	-	-	-	-	-	2	2	2
CO3	3	1	2	2	3	-	-	-	-	-	-	2	2	2
CO4	3	1	2	2	3	-	-	-	-	-	-	2	2	2
CO5	3	2	2	3	3	-	-	-	-	-	-	2	2	2

ME23255	ADVANCED CASTING AND FORMING PROCESSES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	gain the knowledge about principles of foundry
2	gain the knowledge about principles of casting technology
3	know the advanced casting technology.
4	provide overview of various sheet metal forming process
5	study the powder metallurgy techniques and Special metal forming processes.

UNIT I PATTERN MAKING, MOULDING AND CORE MAKING **9**

Pattern materials-Pattern allowances-Pattern layout, pattern making – Moulding sands – Ingredients – Specification and testing of moulding sands – classification of moulding sands –Sand conditioning –Characteristics of cores and core sands – types of cores

UNIT II SOLIDIFICATION AND GATING **9**

Solidification principles – planar and dendritic solidification – constitutional super cooling - Freezing of a pure metal –Freezing of alloys – Properties related to freezing mechanism- Directional solidification – progressive solidification - Gates and risers-their functions – types-design principles, design of gating and riser - illustrative problems in riser and gating design

UNIT III ADVANCES IN CASTING **9**

Rheocasting - Thixo casting - magnetic moulding - Impulse moulding- high pressure moulding – Stir casting - Squeeze casting – Application of ultrasonic cavitation's to develop composites - mechanization and automation of foundries –Application of computers in foundries- product design and analysis- casting design and simulation – software packages for foundry use- pollution control in foundries – energy saving in foundries.

UNIT IV SHEET METAL FORMING **9**

Formability studies – Conventional processes – High energy rate forming (HERF) techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application – Incremental forming.

UNIT V POWDER METALLURGY AND SPECIAL FORMING PROCESSES **9**

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold iso-static pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	imply the techniques to make the pattern, core and moulding.	Applying (K3)

CO2	evaluate the process parameters involved in casting processes.	Understanding (K2)
CO3	grasp the significance of advanced casting process and its applications.	Analysing (K4)
CO4	understand the conventional sheet metal forming process and various high energy rate forming technique	Understanding (K2)
CO5	understand the powder metallurgy forming technique.	Analysing (K4)

TEXT BOOKS

1. Heine R W, Loper C R,Rosenthal P C "Principles of Metal Casting", Tata McGraw Hill, New Delhi, 2012
2. Altan T, Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2010.

REFERENCES

1. Jain P L, "Principles of Foundry Technology", Tata McGraw Hill, New Delhi, 5th Edition, 2007.
2. Ramana Rao T V, "Metal Casting: Principles and Practice", New Age International Publishers, New Delhi, 2006
3. Nagpal G.R, Metal Forming Processes, Khanna publishers, 2005
4. Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,1st Edition, 2008.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	1	1	1	-	1	1	2	2
CO2	3	3	2	2	-	1	1	1	-	-	1	1	3	3
CO3	3	3	2	2	-	1	1	1	-	-	1	1	3	3
CO4	3	3	2	2	-	1	1	1	-	-	1	1	3	3
CO5	3	3	2	2	2	1	1	1	-	-	1	1	3	3

ME23256	LEAN MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce the basics of 6 SIGMA
2	learning about the lean manufacturing tools
3	study about the deeper understanding methodologies of Lean manufacturing
4	study the lean concepts and its elements
5	learn implementation and challenges of lean manufacturing

UNIT I BASICS OF 6 SIGMA — **9**

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

UNIT II INTRODUCTION TO LEAN MANUFACTURING TOOLS — **9**

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP and PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements - Introduction to Value Stream Mapping – steps, symbols, application, and relevance to Lean tools like FMEA and APQP.

UNIT III DEEPER UNDERSTADING METHODOLOGIES — **9**

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples and Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT IV LEAN ELEMENTS — **9**

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects.

UNIT V IMPLEMENTATION AND CHALLENGES — **9**

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	discuss the basics of 6 SIGMA	Applying (K3)
CO2	elaborate the lean manufacturing tools	Understanding (K2)
CO3	illustrate about the deeper understanding methodologies of Lean manufacturing	Analysing (K4)
CO4	discuss lean concepts and its elements	Understanding (K2)
CO5	describe the implementation and challenges of lean manufacturing	Analysing (K4)

TEXT BOOKS

1. Lean Manufacturing, "Fundamentals, Tools, Approaches, and Industry 4.0 Integration" S. Vinodh, CRC Press, 2024.
2. "How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", Eric Ries, Crown Business, 2011.

REFERENCES

1. Quality Council of India https://qcin.org/ & its library. https://qcin.org/nbqp/knowledge_bank/
2. Lean Production Simplified, "A Plain-Language Guide to the World's Most Powerful Production System", Pascal Dennis, Productivity Press, 2015.
3. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, Jeffrey K. Liker. Publisher: McGraw-Hill, 2004
4. Banish Waste and Create Wealth in Your Corporation, James P. Womack and Daniel T. Jones. Publisher: Simon & Schuster, 2003.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO2	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO3	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO4	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO5	1	1	2	1	1	-	-	-	1	-	3	1	1	2

ME23257	INDUSTRIAL ROBOTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the functions of the basic components of a Robot.
2	study the use of various types of End of Effectors and drives
3	know the use of sensors and vision systems in automation systems.
4	impart knowledge in Robot Kinematics and Programming.
5	gain knowledge on the different methods of material handling, robot safety issues and economics.

UNIT I	FUNDAMENTALS OF ROBOT	9

Robot– History of robot, Basic concepts of robotics (Laws of robotics, robotic systems), RIA Definition–Robot Anatomy–Co-ordinate Systems, Work Envelope, types and classification–Functions Specifications Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – functions– Need for Robots-Selection of robots–Different Applications.

UNIT II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors - Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers.

UNIT III	SENSORS AND MACHINE VISION	9

Requirements of a sensor, Principles and Applications of the following types of sensors – Position of 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), -Introduction to Machine vision – functional block diagram of machine vision system - Sensing and Digitizing – Image processing and analysis.

UNIT IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Degrees of Freedom (In 2 Dimensional),– Introduction to DH Matrices -Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs

UNIT V	IMPLEMENTATION AND ROBOT ECONOMICS	9

RGV, AGV ; Implementation of Robots in Industries–Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots- Economic analysis, basic data required methods of Economic analysis – Pay back Method, EUAC Method, and Rate of Return Method.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	differentiate the various types of Industrial Robots and their architecture.	Understanding (K2)
CO2	apply the working of various robot drive systems and end effectors	Applying (K3)
CO3	describe the working principle of various sensors	Analyzing (K4)
CO4	write robot programming for specific applications	Creating (K5)
CO5	apply the knowledge of implementation of robotics in industries	Applying (K3)

TEXT BOOKS

1. Groover, M.P. "Industrial Robotics– Technology, Programming and Applications", McGraw-Hill, 2014
2. Fu. K.S, Gonzalez. R.C, Lee. C.S.G "Robotics – Control, Sensing, Vision, and Intelligence", McGraw Hill, 2015

REFERENCES

1. Funk's. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co.,2008
2. Deb, S.R. "Robotics Technology and Flexible Automation" Tata McGraw Hill, 2013.
3. Janakiraman.P.A., "Robotics and Image Processing", Tata McGraw-Hill, 2005
4. Richard. K. Miller, "Industrial Robot Handbook", Springer, 2013.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO2	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO3	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO4	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO5	1	1	2	1	1	-	-	-	1	-	3	1	1	2

ME23351	OPERATIONAL RESEARCH	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	learn Selecting the constraints on the availability of resources and developing a model and rendering an optimal solution for the given circumstances.
2	study Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits
3	learn Planning the purchase/ manufacturing policies, managing the spares/ stocks and meeting the customer demands.
4	analysing the queue discipline and exploring the avenues for better customer service
5	investigating the nature of the project and offering methodical assistance towards decision making in maintenance.

UNIT I	INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING	9

Operation Research: Definition – Models – Steps – Important topics – Scope - Tools. Linear Programing (LP): Introduction – Concept (Problem mix, Assumption, Properties) –Development (Problem formulation) – Problems in: Graphical method, Simplex methods, Big M method.

UNIT II	TRANSPORTATION, ASSIGNMENT AND PRODUCTION SCHEDULING PROBLEMS	9

Transportation problems: Introduction, Model, Types – Problems in: Initial Basic (feasible) solution: Northwest Corner Cell method; Least Cost Cell method; Vogel's Approximation method and Optimal solution MODI (U-V) method. Assignment problems: Introduction, Types, Problems in Hungarian method. Production Scheduling problems: Introduction –Problems in Single Machine Scheduling: SPT; WSPT, EDD methods – Problems in Johnson's Algorithm: n job 2 machines, n job 3 machines.

UNIT III	INVENTORY CONTROL MODELS & SYSTEMS	9

Inventory Control: Introduction, Models – Problems in Purchase and Production (Manufacturing) models with and without shortages – Theory on types of inventory control systems: P& Q, ABC, VED, FNS, XYZ, SDE and HML.

UNIT IV	QUEUING THEORY	9

Queuing Theory: Introduction; Applications; Terminology, Poisson process and exponential distribution – Problems in Single Server and Multi Server Queuing Models –Case study on simulation using Monte Carlo technique.

UNIT V	PROJECT MANAGEMENT AND REPLACEMENT MODELS	9

Project Management: Introduction; Guidelines for Networking AOA Diagrams – Problems in Critical Path Method (CPM) & Program Evaluation Review Technique (PERT) – Differences of CPM & PERT. Replacement Problems:

Types – Problems in: Determination of Economic Life of an Asset – Problems in: Individual and Group Replacement Policies , Apply OR software	
	TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	discuss the selection of the constraints on the availability of resources, develop a model and render an optimal solution for the given circumstances.	Analysing (K4)
CO2	explain the appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.	Understanding (K2)
CO3	explain plan the purchase/ manufacturing policies, manage the spares/ stocks, and meet the customer demands	Applying (K3)
CO4	analyze the queue discipline and explore the avenues for better customer service.	Understanding (K2)
CO5	investigate the nature of the project and offer methodical assistance towards decision making in maintenance.	Analysing (K4)

TEXT BOOKS

1. Pannerselvam R, "Operations Research", 2nd Edition, PHI, 2009
2. Hamdy A. Taha, "Operations Research an Introduction", 10th Edition, PHI/Pearson Education, 2017.

REFERENCES

1. Ravindran, Phillips and Solberg, "Operations Research Principles and Practice", 2nd Edition, Wiley India, 2007
2. Srinivasan G, "Operations Research Principles and Applications", 3rd Edition EEEPHI, 2017
3. Sharma J K, "Operations Research Theory and Applications", 5th Edition, Macmillan India, 2013.
4. Premkumar Gupta and D.S.Hira, "Problems in Operations Research", S.Chand, 2009.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	2	1	1	1	1	1	2	2	2	2
CO2	2	3	3	2	2	1	1	1	1	1	2	2	2	2
CO3	2	3	3	2	2	1	1	1	1	1	2	2	2	2
CO4	2	3	3	2	2	1	1	1	1	1	2	2	2	2
CO5	2	3	3	2	2	1	1	1	1	1	2	2	2	2

ME23352	ENGINEERING ECONOMICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understanding of the fundamental principles of economics in the context of engineering.
2	identify financial principles such as time value of money, compound interest, and economic evaluation methods.
3	interact the financial metrics, such as present worth, future worth, equivalent annual cost, and rate of return.
4	comprehend the principles of replacement and maintenance analysis to make informed decisions about asset management.
5	have an awareness about the business and marketing function

UNIT I	FUNDAMENTALS OF ECONOMICS	9

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

UNIT II	VALUE ENGINEERING	9

Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT III	CASH FLOW	9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram),equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT IV	REPLACEMENT AND MAINTENANCE ANALYSIS	9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

UNIT V	FORMS OF BUSINESS AND MARKETING	9

Features, merits and demerits of Sole Proprietorship, Partnership and Joint Stock Company- Public Enterprises and their types. Marketing Management: Functions of marketing and Distribution Channels.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	appraise analyse complex engineering problems, considering both technical and economic factors	Applying (K3)
CO2	analyse the cost-effective engineering solutions based on economic analysis.	Understanding (K2)
CO3	formulate the economic and environmental impacts of engineering decisions	Analysing (K4)
CO4	assess the replacement and maintenance activities of machine	Understanding (K2)
CO5	interpret business and marketing function of management in economics	Analysing (K4)

TEXT BOOKS

1. R. Panneerselvam Engineering Economics ,2nd edition PHI Learning 2014
2. N.Gregory manikw , Principles of Economics 8th edition Thomson Learning , New Delhi 2017

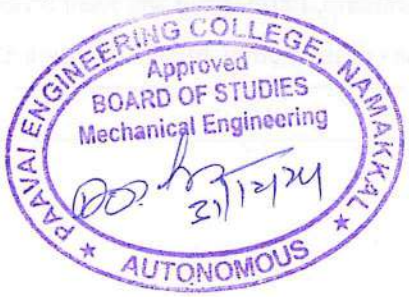
REFERENCES

1. William boyes and Michael Melvin , Text book of Economics , Biztantra 7th edition 2008.
2. Paul A. Samuelson William D.Nordhaus , Sudip Chaudhuri and Anindya sen, Economics , 19th edition , Tata McGraw Hill , New Delhi 2011
3. Richard lipsey and Alec Chrystal Economics , 13th edition , Oxford University Press , New Delhi 2015
4. Karl.E Case and Ray C. Fair Principle of Economics .12th edition, Pearson, Education Asia , New Delhi 2017

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	2	-	-	-	-	-	-	-
CO2	2	-	-	-	-	3	-	-	2	-	-	-	-	2
CO3	3	-	2	-	-	-	-	-	-	-	-	-	1	2
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	1
CO5	1	-	-		-	-	-	2	1	-	-	-	-	-



ME23353	INDUSTRIAL SAFETY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study the fundamental concept and principles of industrial safety
2	study the principles of maintenance engineering.
3	analyzing the wear and its reduction.
4	study the faults in various tools, equipment's and machines.
5	study the periodic maintenance procedures in preventive maintenance.

UNIT I INDUSTRIAL SAFETY **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment and methods.

UNIT II MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THE IR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication and Side feed lubrication, Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing- concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, Any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection - concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance, Repair cycle concept and importance.

		TOTAL PERIODS:45
COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	explain the fundamental concept and principles of industrial safety	Understanding (K2)
CO2	apply the principles of maintenance engineering.	Applying (K3)
CO3	analyse the wear and its reduction.	Analyzing (K4)
CO4	evaluate faults in various tools, equipment's and machines	Applying (K3)
CO5	apply periodic maintenance procedures in preventive maintenance.	Understanding (K2)

TEXT BOOKS

1. LM Deshmukh, Industrial Safety Management, Tata Mc Graw -Hill Education, New edition, 2017.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2013

REFERENCES

1. Edward Ghali, V.S.Sastri, M.Elboujdaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
2. Garg, HP, Maintenance Engineering, S.Chand Publishing, 2015.
3. JMaiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017
4. R.Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	-	-	2	1	-	-	-	-	1	1	2
CO2	2	1	2	-	-	2	1	-	-	-	-	1	1	2
CO3	2	1	2	-	-	2	1	-	-	-	-	1	1	2
CO4	2	1	2	-	-	2	1	-	-	-	-	1	1	2
CO5	2	1	2	-	-	2	1	-	-	-	-	1	1	2

ME23354	LOGISTICS AND SUPPLY CHAIN NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the strategic role of logistics and supply chain management.
2	compare and contrast the various modes of logistics operations.
3	acquaint with the functions and techniques of containerization, from the international perspective.
4	ascertain the role and functions of packaging for domestic and international sales.
5	familiarize with the export logistics and documentation process.

UNIT I INTRODUCTION LOGISTICS AND SUPPLY CHAIN **9**

Supply Chain - Definition, Evolution Logistics and, Importance. The concepts of logistics and Supply Chain Management, Key Drivers of Supply Chain Management and Logistics relationships. Differences Between Logistics and Supply Chain.

UNIT II TRANSPORTATION AND ITS FUNCTIONALITY **9**

Basics of Transportation, Transportation Functionality and Principles; Multimodal Transport: Modal Characteristics; Modal Comparisons; International Air Cargo Transport; Coastal and Ocean transportation, Characteristics of shipping transport- Types of Ships.

UNIT III CONCEPT OF LOGISTICS **9**

Logistics: Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking.

UNIT IV WAREHOUSING **9**

Concept and types, Warehousing strategy, Warehouse facility location & network design, Reverse logistics, Outsourcing- Nature and concept, Strategic decision to Outsourcing, Third party logistics(3PL), Fourth party logistics(4PL).

UNIT V SUPPLY CHAIN AND CRM **9**

Supply Chain and CRM- Linkage, IT infrastructure used for Supply Chain and CRM, Functional components for CRM, Green supply chain management, Supply Chain Sustainability.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	understand supply chain based on the participants.	Applying (K3)
CO2	appraise the traditional physical distribution activity against the modern one, for sustainable competitive advantage.	Understanding (K2)
CO3	execute the implementation of logistics based on the drivers.	Analysing (K4)

CO4	examine the effectiveness of the traditional vs modern packaging methods.	Understanding (K2)
CO5	intercept and apply his knowledge in domestic vs export logistics management.	Analysing (K4)

TEXT BOOKS

1. Ashley McDonough. Operations and Supply Chain Management: Vibrant Publishers,1st Edition, 2020.
2. F.Robert Jacobs,Ravi Shankar, Richard.B Chase, Operations and Supply Chain Management, Mc Graw Hill, 17th Edition 2023.

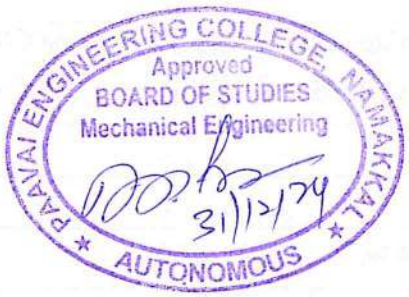
REFERENCES

1. Bowersox, Closs, Cooper, Supply Chain Logistics Management, McGraw Hill, 2019.
2. Burt, Dobbler, Starling, World Class Supply Management, Tata McGraw-Hill, 2003.
3. Donald J Bowersox, David J Closs, Logistical Management, TMH, 2010.
4. Pierre David, "International Logistics", Biztantra, 2013.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	-	2	-	1	-	-	-	-	-	-	-	1	2
CO2	-	-	-	-	1	-	-	-	-	2	-	-	-	-
CO3	3	1	-	-	-	2	-	1		-	-	-	1	-
CO4	1	-	-	-	2	-	2	-	-	2	-	-	-	2
CO5	-	1	-	-	1	-	2	2	-	-	-	-	-	-



ME23355	PLANT LAYOUT AND MATERIALS HANDLING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	provided with the knowledge of the process of analysing and developing information to produce a plant layout based on the locations and working conditions.
2	educate the students about the basic things of work conditions which includes ventilation, comfort, lighting and its effect based on various nature of work.
3	provide knowledge on effective and safe layout design of an industry.
4	learn about the different types material handling methods, paths equipment's and functions
5	get the idea about the material handling systems.

UNIT I	PLANT LOCATION	9

Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions Safe location of chemical storages, LPG, LNG, CNG, acetylene, ammonia, chlorine, explosives and propellants.

UNIT II	PLANT LAYOUT	9

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers. Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works – Process Layout.

UNIT III	WORKING CONDITIONS	9

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application. Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards- Housekeeping, principles of 5S - Smart Environmental Monitoring Systems for Ventilation and Lighting.

UNIT IV	MANUAL MATERIAL HANDLING AND LIFTING TACKLES	9

Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects – accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – personal protection – ergonomic considerations.

UNIT V	MECHANICAL MATERIAL HANDLING	9

Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications - Autonomous Material Handling Systems (AMHS) and Smart Conveyors.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	the students will be able to Identify equipment requirements for a specific process and for various locations and working conditions.	Applying (K3)
CO2	the students will be able to Design an efficient material handling system	Understanding (K2)
CO3	understand the difficulties during the design and implementation of the plant layout	Analysing (K4)
CO4	know about material handling requirements and methods	Understanding (K2)
CO5	understand the inspection and maintenance techniques.	Analysing (K4)

TEXT BOOKS

1. "Accident prevention manual for industrial operations" N.S.C., Chicago, 2019.
2. Alexandrov. M.P. "Material handling equipment" Mir Publishers, Moscow, 2010.

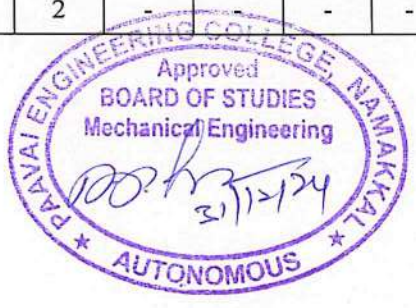
REFERENCES

1. APPLE M. JAMES "Plant layout and material handling", 3rd edition, John Wiley and sons, 2015.
2. "Encyclopedia of occupational safety and health", ILO Publication, 2011.
3. Facility layout & location an analytical approach /RL FRANCIS /LF Mc Linnis Jr ,White /PHI, 2011.
4. Production and operations management / R Panneerselvam /PHI, 2015.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	1	3	2	-	-	-	-	-	-	-	2	3	3
CO2	3	1	3	1	-	2	-	1	-	-	-	2	3	3
CO3	3	1	3	-	-	-	-	-	-	-	-	2	3	3
CO4	3	1	3	-	-	-	2	-	-	-	-	2	3	3
CO5	3	1	3	2	2	-	-	-	-	-	-	2	3	3



ME23356	SUPPLY CHAIN MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals and strategic importance of supply chain and logistics management.
2	analyze the design and structure of supply chain networks and their impact on business performance.
3	evaluate logistics components including transportation, distribution, and inventory in the context of the supply chain.
4	examine sourcing decisions, supplier relationships, and the importance of coordination across the supply chain.
5	explore the role of information technology and emerging trends in enhancing supply chain efficiency.

UNIT I	INTRODUCTION	9

Role of Logistics and Supply chain Management: 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 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.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	apply the concepts and frameworks of supply chain management in business scenarios.	Applying (K3)
CO2	explain the fundamental principles and functions of supply chain and logistics.	Understanding (K2)

CO3	analyze the performance drivers and coordination issues in supply chain networks.	Analysing (K4)
CO4	interpret the significance of sourcing strategies and supplier collaboration.	Understanding (K2)
CO5	assess the impact of information technology in supply chain operations.	Analysing (K4)

TEXT BOOKS

1. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and Operation", Pearson Education, 2010.
2. Simchi-Levi, Kaminsky, and Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, McGraw-Hill Education, 2007.

REFERENCES

1. Jeremy F.Shapiro, "Modeling the Supply Chain", Thomson Duxbury, 2002.
2. Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management, PHI, 2010
3. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics", PHI 2002.
4. James B.Ayers, "Handbook of Supply Chain Management", St.Lucle press, 2000.

CO - PO MAPPING

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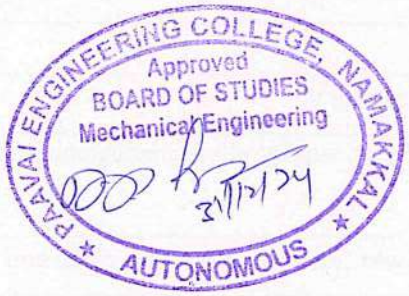
CO2	1	1	-	1	2	1	1	-	2	-	2	2	1	-
CO3	1	1	-	1	2	-	1	-	2	-	2	1	1	-
CO4	1	1	-	1	2	1	1	-	2	-	2	2	-	2
CO5	1	1	1	1	2	1	1	-	2	-	2	2	-	2



ME23357	ENTERPRISE RESOURCE PLANNING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the risks and benefits of implementing ERP in an organization.
2	appraise the worth of ERP software solutions and the various ERP modules.
3	interpret the implementation of ERP methodology.
4	acquaint with the intricacies in ERP implementation and management.
5	assess the latest development in the area of enterprise resource planning.

UNIT I INTRODUCTION 9

Introduction, Evolution of ERP, need for ERP, ERP Implementation methodology, Benefits of an ERP System, Factors affecting ERP Implementation -Role of ERP in Operations planning and control -Operations planning Insights from the TOC school of thought.

UNIT II ERP FUNCTIONAL MODULES 9

Overview of ERP software solutions -ERP Modules -Finance -Manufacturing (Production) -Human Resource -Plant Maintenance -Materials Management -Quality Management -Sales and Distribution.

UNIT III ERP IMPLEMENTATION 9

Planning Evaluation and selection of ERP systems -Implementation life cycle -ERP implementation, Methodology and Frame work-Training -Data Migration. People Organization in implementation - Consultants, Vendors and Employee.

UNIT IV POST IMPLEMENTATION 9

Maintenance of ERP-Organizational and Industrial impact- Success and Failure factors of ERP implementation. Maintenance- Service Recovery Model- Computer Application in Industry.

UNIT V EMERGING TREND ON ERP 9

Extended ERP systems and ERP add-ons -CRM, SCM, Business analytic Future trends in ER systems -web enabled, Wireless technologies, cloud computing. Emerging Trends in Startup Funding -Central and State Government schemes -NGO funding -Crowd funding -Angel investors -Hedge funds -Commercial banks.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	interpolate the issues in planning and implementation of cross functional integrated ERP systems.	Understanding (K2)
CO2	evaluate the various functional modules of ERP.	Evaluating (K5)
CO3	focus on identifying the constraints in ERP implementation	Understanding (K2)

CO4	ensure the successful implementation of ERP software's, into the business process system.	Analyzing (K4)
CO5	interfer the awareness of recent developments in ERP.	Analyzing (K4)

TEXT BOOKS

1. Sinha P. Magal and Jeffery Word, Essentials of Business Process and Information System, Wiley India, 2013.
2. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill, 2014.

REFERENCES

1. Alexis Leon, Enterprise Resource Planning, 4th edition, Tata McGraw-Hill, 2011.
2. Mahadeo Jaiswal and Ganesh Vanapalli, ERP Macmillan India, 2010.
3. Vinod Kumar Grag and N.K. Venkitakrishnan, ERP-Concepts and Practice, Prentice Hall of India, 2016.
4. Enterprise Resource Planning, Veena Bansal, 2013 Pearson India.

CO - PO MAPPING

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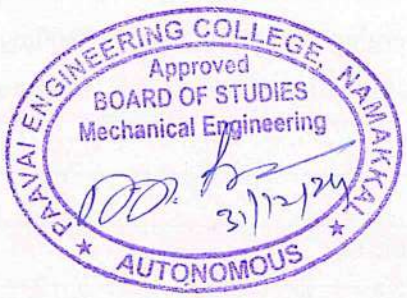
CO1	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO2	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO3	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO4	1	1	2	1	1	-	-	-	1	-	3	1	1	2
CO5	1	1	2	1	1	-	-	-	1	-	3	1	1	2



ME23451	POWER PLANT ENGINEERING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	acquire knowledge about steam power plant and its components
2	get exposed to the working principle of nuclear power plant and its elements
3	understand the operation of diesel and gas turbine power plants
4	attain knowledge about different renewable energy power sources
5	learn the concept of power plant economics

UNIT I	COAL BASED THERMAL POWER PLANTS	9

Layout and types of Steam Power Plants – Rankine cycle - Boilers -High pressure and supercritical boilers, Fluidised Bed Combustion Boiler (FBC) - Mechanical stokers – Pulverizers - Fuel handling system – combustion Equipment for burning coal — Electrostatic precipitator - Ash handling systems – Draught – different types, condenser types, Cooling tower.

UNIT II	NUCLEAR POWER PLANT	9

Nuclear energy - Fission, Fusion reaction - Layout of nuclear power plants - Types of reactors, pressurized water reactor - Boiling water reactor - Gas cooled reactor - Fast breeder reactor – Waste disposal and safety.

UNIT III	DIESEL AND GAS TURBINE POWER PLANT	9

Layout and types of Diesel power plants and components, selection of engine type, applications. Gas Turbine power plant – Layout - Fuels, gas turbine material, types of combustion chambers - reheating, regeneration and inter-cooling - Performance calculations.

UNIT IV	POWER FROM RENEWABLE ENERGY	9

Hydro-electric power plant – components, stand alone and pumped storage, working of solar photo voltaic (PV) – solar thermal power plants and components, Wind power plant – components, construction and working of wind power system – Magneto Hydro Dynamic (MHD), Geothermal, Fuel cell, Tidal and Bio gas power plant.

UNIT V	ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS	9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits and demerits, capital and operating cost of different power plants. Pollution control technologies including waste disposal options for coal and nuclear power plants.Application of Artificial Intelligence in Power Plants – AI-based load forecasting, energy demand prediction and emission monitoring

	TOTAL PERIODS:45
COURSE OUTCOMES	**BT MAPPED** (Highest level)
At the end of the course, the students will be able to	
CO1 explain the layout, components, and working principles of coal-based steam power plants, including boilers, draught systems, condensers, and cooling towers.	Understanding (K2)

CO2	discuss the construction, types, working, and safety aspects of nuclear power plants and reactors.	Understanding (K2)
CO3	apply the working principles of diesel and gas turbine power plants to analyze their components, cycles, and performance.	Applying (K3)
CO4	explain the basic working principles, components, and operation of various renewable energy sources such as hydro, solar, wind, MHD, tidal, geothermal, fuel cells, and biogas.	Understanding (K2)
CO5	analyze the economic and environmental aspects of power generation, including tariff structures, cost analysis, site selection, and pollution control technologies.	Analyzing (K4)

TEXT BOOKS

1. Arora S.C. and Domkundwar.S, "A Course in Power Plant Engineering", Dhanpat Rai, 2001
2. Nag P.K, "Power Plant Engineering", Fourth Edition, Tata-McGraw Hill, 2017.

REFERENCES

1. Frank D.Graham, 'Power Plant Engineers Guide', D.B. Taraporevala Sons and Co., New Delhi,2003
2. T.Morse Frederick, "Power Plant Engineering", Third Edition, Prentice Hall of India, 2002.
3. R.K.Rajput, "Power Plant Engineering", Fifth Edition, Laxmi Publications, 2016.
4. G.D.Rai, "Introduction to Power Plant Technology" , Reprint, Khanna Publishers, 2010

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	1	3	-	-	1	-	1	3	2
CO2	3	2	2	2	2	2	3	1	-	1	-	2	3	2
CO3	3	2	2	2	3	1	2	-	-	1	1	1	3	3
CO4	3	2	3	2	2	2	3	-	-	1	-	2	3	2
CO5	3	3	2	2	2	2	3	1	-	2	3	3	3	3

ME23452	REFRIGERATION AND AIR CONDITIONING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	perform basic calculations related to the performance of various refrigeration's cycles and air conditioning processes.
2	know about different types of compressors and condensers and expansion devices used in refrigeration system.
3	study of the thermodynamic properties of moist air (a mixture of dry air and water vapor) and its behavior under varying environmental conditions.
4	understand the controlling the temperature, humidity, purity, and distribution of air to meet the comfort or specific environmental requirements of a space.
5	analyse the air conditioning load refers to the total amount of heat (sensible + latent) that must be removed or added to maintain a desired indoor environment.

UNIT I	REFRIGERATION CYCLE	9

Introduction to Refrigeration - Review of thermodynamic principles of refrigeration. Air cycle refrigeration system. Vapour compression refrigeration cycle - use of P-H charts - multistage and multiple evaporator systems – cascade system - COP comparison. Ammonia - water systems, three fluid systems. Water - lithium bromide system - Comparison –Steam jet refrigeration.

UNIT II	REFRIGERATION SYSTEM COMPONENTS AND REFRIGERANTS	9

Compressors: Types – based on operation and based on arrangement. Condensers: Types-air cooled, water cooled and evaporative condensers. Evaporators: Flooded and dry expansion types. Expansion devices: Capillary tube, Automatic expansion valve, Thermostatic expansion valve. Refrigerants: Properties, Eco - friendly refrigerants, Selection of Refrigerants. Ozone Depletion Potential (ODP) and Global Warming Potential (GWP).

UNIT III	PSYCHROMETRIC PROPERTIES AND PROCESSES	9

Review of fundamental properties of psychrometry, Properties of moist Air-Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Wet bulb temperature- Psychrometric chart, Psychrometry properties calculation-Psychometric processes, Bypass factor, Apparatus Dew Point (ADP) temperature, mixing of air steams

UNIT IV	AIR CONDITIONING SYSTEMS	9

Air conditioning systems – definition, standards of temperature, humidity and air motion, components of air conditioning system - effective temperature - comfort conditions. Summer, winter and year-round air conditioners, Window, Split air conditioners, Central air conditioner systems. Air distribution system. Thermal insulation of air conditioning systems- applications.

UNIT V	COOLING LOAD CALCULATIONS	9

Air conditioning loads - Outside and inside design conditions - design of space cooling load - heat transmission

through building. Solar radiation - infiltration - internal heat sources (sensible and latent) - outside air and fresh air load - estimation of total load - Domestic, commercial and industrial systems.	
	TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	explain the basic concepts of Refrigeration	Understanding (K2)
CO2	explain the Vapor compression Refrigeration systems and to solve problems	Understanding (K2)
CO3	calculate the Psychrometric properties and its use in psychrometric processes	Applying (K3)
CO4	explain the concepts of Air conditioning systems and properties	Understanding (K2)
CO5	explain the concepts of Air conditioning loads and to solve problems	Analysing (K4)

TEXT BOOKS

1. Manohar Prasad , "Refrigeration and Air Conditioning", New Age International Publishers, 2011.
2. Stoecker W F, Jones J W, "Refrigeration and Air Conditioning", McGraw-Hill India, 2014.

REFERENCES

1. Arora C P, "Refrigeration and Airconditioning", Tata McGraw Hill, 2017.
2. Carter Stanfield, David Skaves, "Fundamentals of HVACR", Pearson, 2012.
3. Roy J Dossat, Thomas J Moran, "Principles of Refrigeration", Pearson, 2001.
4. Jones W P, "Air Conditioning Engineering", Butterworth-Heinemann, 2001.

CO - PO MAPPING

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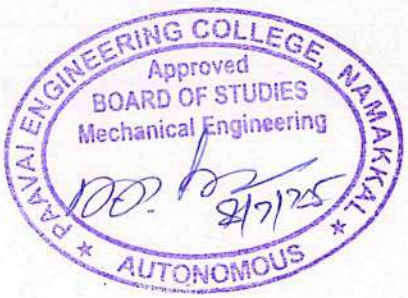
CO1	3	3	3	1	-	-	1	-	-	-	-	1	2	2
CO2	3	3	3	1	-	-	1	-	-	-	-	1	2	2
CO3	3	3	3	1	-	-	1	-	-	-	-	1	2	2
CO4	3	3	3	1	-	-	1	-	-	-	-	1	2	2
CO5	3	3	3	1	-	-	1	-	-	-	-	1	2	2



ME23453	GAS DYNAMICS AND JET PROPULSION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the basic difference between incompressible and compressible flow
2	acquire knowledge on Rayleigh and Fanno flow
3	know the concepts of phenomenon of shock waves and its effect on flow
4	gain basic knowledge about Jet Propulsion
5	learn basic concepts about Rocket Propulsion

UNIT I	BASIC CONCEPTS AND ISENTROPIC FLOWS	9

Energy and momentum equations of compressible fluid flows – Stagnation state - Critical State – Mach number – References Velocities – Various Regions of F low – Mach Cone – Isentropic flow through variable area Ducts: T-s and h-s Diagrams for Nozzle and Diffusers – Use of Gas tables.

UNIT II	FLOW THROUGH CONSTANT AREA DUCT	9

Flow through constant area ducts: Flow in constant Area Ducts with Friction – Fanno Curves and Fanno Flow Equation – variation of flow properties – Rayleigh Line and Rayleigh Flow Equation-Flow in Constant Area Ducts with Heat Transfer.

UNIT III	NORMAL AND OBLIQUE SHOCKS	9

Wave Motion - Steep, Non-steep Finite Pressure Waves - Governing equations – Variation of flow parameters. Across the normal and oblique shocks – Prandtl – Meyer relations – Use of table and charts – Applications.

UNIT IV	JET PROPULSION	9

Basics of jet propulsion – Thrust, thrust power, and propulsive efficiency – Working principles of ramjet, turbojet, turbofan, and turboprop engines – Applications in Indian missile systems: BrahMos (ramjet), Nirbhay (turbojet), and Astra (solid rocket) – Engine types used in Indian cruise and anti-ship missiles.

UNIT V	SPACE PROPULSION	9

Types of rocket engines: solid and liquid propellant rockets and hybrid propellant rocket – Theory of Rocket propulsion – Staging and performance analysis –Applications in Indian space systems –Solid and liquid propulsion in PSLV, GSLV and Gaganyaan mission stages – Hybrid propulsion research by ISRO.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	apply basic concepts and various flow characteristics to study different types of flow	Applying (K3)
CO2	analyze the compressible flow through constant area ducts to study the change in properties	Analysing (K4)

CO3	apply different types of governing equations of Normal Shock and Oblique Shock and Prandtl- Meyer equation for flow studies	Applying (K3)
CO4	illustrate the concepts of jet propulsion and different types of Jet engines application	Understanding (K2)
CO5	demonstrate knowledge on fundamentals of space propulsion and Indian space systems	Understanding (K2)

TEXT BOOKS

1. Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, 2016.
2. Anderson, J.D., "Modern Compressible flow", McGraw Hill, 3rd Edition, 2013

REFERENCES

1. Hill P.and Peterson C., "Mechanics and Thermodynamics of Propulsion", Addison – Wesley Publishing company, 2001
2. Zucrow. N.J, "Aircraft and Missile Propulsion", vol. Iand II, John Wiley, 2005.
3. Balachandran. P, "Fundamentals of Compressible Fluid Dynamics", PHI Learning, New Delhi,2012
4. Sutton G.P, "Rocket Propulsion Elements", John Wiley, New York, 2013

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CO3	3	3	-	1	2	-	-	-	-	1	-	-	1	3
CO4	3	2	2	-	-	1	-	-	-	1	-	3	1	2
CO5	3	2	2	-	-	1	-	-	-	3	-	3	-	2

ME23454	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	realize the fundamental principles of conservation of mass, momentum, and energy in fluid flow and heat transfer.
2	comprehend the basic principles of numerical discretization methods used in fluid flow analysis.
3	study the steady and unsteady state diffusion type problems using finite volume method.
4	impart one dimensional and two dimensional elements in finite element techniques for fluid flow problems.
5	optimize CFD models for real-world engineering applications, integrating design constraints.

UNIT I	GOVERNING EQUATIONS OF FLUID FLOW AND HEAT TRANSFER	9

Derivation of governing equations of fluid flow: conservation of mass, momentum and energy, relationship between mathematical terms and characteristics of fluid flow; mathematical classification of flow: hyperbolic, parabolic, elliptic and mixed flow.

UNIT II	DISCRETIZATION SCHEMES AND METHODS OF FLUID FLOW ANALYSIS	9

Choice of grid, finite difference method, finite volume method, forward, backward and central difference schemes, explicit and implicit methods, properties of numerical solution methods, stability analysis, error estimation.

UNIT III	FINITE VOLUME METHOD	9

Basic rules for FV Discretization. Finite Volume (FV) Discretization of one and two dimensional steady state diffusion type problems - 1-D convection-diffusion type problem - Unsteady flows – implementation of boundary conditions in Finite Volume. Solution of discretized equations. Solution algorithm for Pressure Velocity coupling in steady flows - Pressure-velocity coupling - SIMPLE scheme.

UNIT IV	FINITE ELEMENT METHOD IN FLUIDS	9

Over view of Finite Element Techniques in Computational Fluid Dynamics. Weighted residual and Variational formulations. Finite element interpolation. One and two dimensional elements. Steady state conduction and incompressible potential flow problems.

UNIT V	CFD APPLICATIONS IN TURBULENCE AND COMBUSTION	9

Introduction, Turbulence models Concepts, Applications, advantages, limitations - One equation, two equations models of RSM, DNS, LES. Combustion models - Applications, advantages, limitations - Simple chemical reacting system model, Eddy break up model and probability distribution function model.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	compare the governing equations and boundary conditions for fluid dynamics	Analysing (K4)
CO2	apply various discretization techniques such as finite difference, finite volume, and finite element methods to fluid flow problems.	Understanding (K2)

CO3	relate finite volume equations for steady and unsteady state diffusion type problems.	Applying (K3)
CO4	apply the finite element methods for fluid flow problems.	Understanding (K2)
CO5	explain the concepts, advantages and limitations of various turbulence models and combustion models.	Analysing (K4)

TEXT BOOKS

1. John D Anderson , "Computational Fluid dynamics – The Basics with Applications", TATA McGraw Hill, 2016.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition, 2008.

REFERENCES

1. Jiri Blazek , "Computational Fluid Dynamics: Principles and Applications", Butterworth-Heinemann, 2015.
2. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
4. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 2012.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	-	2	-	-	-	-	-	-	2	-	-	-	1
CO2	2	-	1	-	-	-	-	-	-	2	-	-	-	-
CO3	2	1	-	--	2	-	-	-	-	2	-	-	-	-
CO4	2	2	-	-	-	-	-	1	2	1	-	1	1	-
CO5	2	2	-	-	2	-	-	1	2	1	-	1	1	-

ME23455	TURBO MACHINES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study energy transfer mechanisms in rotor and stator parts of turbo machines.
2	understand the roles of different components in centrifugal fans and blowers
3	describe the function and construction of centrifugal fans and blowers
4	analyzing flow behavior and flow losses in axial flow compressor
5	examine various types and the operational behavior of axial and radial flow turbines

UNIT I	TURBOMACHINERY PRINCIPLES	9

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

UNIT II	CENTRIFUGAL FANS AND BLOWERS	9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

UNIT III	CENTRIFUGAL COMPRESSOR	9

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation. Blade Angle Estimation and Flow Deflection.

UNIT IV	AXIAL FLOW COMPRESSOR	9

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow. Blade Loading and Diffusion Factor.

UNIT V	AXIAL AND RADIAL FLOW TURBINES	9

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	explain the energy transfer in rotor and stator parts of the turbo machines.	Understanding (K2)
CO2	describe the function of various elements of centrifugal fans and blowers	Understanding (K2)
CO3	apply the working and performance of centrifugal compressor	Applying (K3)
CO4	analyze flow behavior and flow losses in axial flow compressor.	Analysing (K4)

CO5	discuss the types and working of axial and radial flow turbines	Understanding (K2)

TEXT BOOKS

1. Ganesan, V., "Gas Turbines", 3rd Edition, Tata McGraw Hill, 2011.
2. Gopalakrishnan. G and Prithvi Raj. D," A Treatise on Turbomachines", Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008

REFERENCES

1. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", 7th Edition, Butterworth Heinemann, 2014.
2. Yahya, S.M., "Turbines, Compressor and Fans", 4th Edition, Tata McGraw Hill, 2011.
3. Saravanamutto, Rogers, Cohen, Straznicky., "Gas Turbine Theory" 6th Edition, Pearson Education Ltd, 2009.
4. Lewis, R.I., "Turbomachinery Performance Analysis" 1st Edition, Arnold Publisher, 2015

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO4	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO5	3	2	3	2	-	-	-	-	-	-	-	1	2	2

ME23456	DESIGN OF HEAT EXCHANGERS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	know the types of heat exchangers and the classification features
2	learn design consideration principles of heat exchangers.
3	acquire knowledge in double pipe and contact heat exchangers under various arrangements.
4	explore design techniques in shell and tube heat exchangers.
5	gain an understanding on the heat transfer in condensers and evaporators.

UNIT I	INTRODUCTION TO HEAT EXCHANGERS	9

Heat Exchangers–Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators.

UNIT II	DESIGN METHODS OF HEAT EXCHANGERS	9

Heat transfer correlations, Overall heat transfer coefficient, LMTD, sizing of finned tube heat exchangers, U tube heat exchangers, fouling factors, pressure drop calculations, Effectiveness-NTU Method for Heat Exchanger Analysis

UNIT III	DOUBLE PIPE AND COMPACT HEAT EXCHANGERS	9

Film coefficient for fluids in annulus, fouling factors, calorific temperature, Average fluid temperature, Calculation of double pipe exchanger, double pipe exchangers in series parallel arrangements. Temperature Effectiveness and Heat Balance in Multi-Pass Exchangers

UNIT IV	SHELL AND TUBE HEAT EXCHANGERS	9

Shell and Tube heat exchangers – Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers, Flow-Induced Vibration and Mechanical Design Considerations. Baffle Design and its Impact on Heat Transfer and Pressure Drop.

UNIT V	CONDENSORS AND EVAPORATORS	9

Types of Condensers-Air cooled condenser –Water-cooled condensers Evaporative condensers, Types of Evaporators-Heat transfer in Evaporators, Capacity and Efficiency Calculations for Condensers and Evaporators, Overall Heat Transfer Coefficient in Condensers and Evaporators

		TOTAL PERIODS:45
COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	give an overview of the types of heat exchangers	Understanding (K2)
CO2	understand the key design principles involved in heat exchanger systems	Analysing (K4)
CO3	gain insight into double-pipe and direct-contact heat exchangers across different flow configurations	Applying (K3)

CO4	explore various design methods applied to shell and tube heat exchangers.	Analysing (K4)
CO5	develop a solid understanding of heat transfer mechanisms in condensers and evaporators.	Understanding (K2)

TEXT BOOKS

1. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2003.
2. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill,

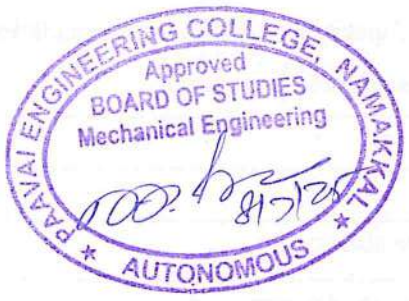
REFERENCES

1. Arthur, P. Frass, Heat Exchanger Design, John Wiley and Sons, 2010
2. E.A.D. Sanders, Heat Exchangers, Selection Design and Construction Layman
3. R.K.Shah, Heat Transfer Equipment design, hemisphere Publishing Corporation, 2011.
4. Holgar martin, Heat transfer, hemisphere Publishing Corporation, 2012.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	-	-	-	-	-	-	1	2	2
CO2	3	3	3	2	1	-	-	-	-	-	-	1	2	2
CO3	3	3	3	2	1	-	-	-	-	-	-	1	2	2
CO4	3	3	3	2	1	-	-	-	-	-	-	1	2	2
CO5	3	3	3	1	1	-	-	-	-	-	-	1	2	2



ME23457	ADVANCED INTERNAL COMBUSTION ENGINES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the underlying principles of operation of Spark Ignition Engines and its components
2	get educated about the principles and operation of Compression Ignition Engines and its components
3	gain knowledge on pollutant formation and control methods
4	acquire knowledge on various alternate fuels available to replace non-renewable energy
5	update knowledge on recent trends and developments in IC engines

UNIT I	SPARK IGNITION ENGINES	9

Mixture requirements – Fuel injection systems – Mono point, Multipoint and Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers, Ignition Systems and Spark Timing Control

UNIT II	COMPRESSION IGNITION ENGINES	9

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

UNIT III	POLLUTANT FORMATION AND CONTROL	9

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – BS6 Emission norms -and Driving cycles.

UNIT IV	ALTERNATIVE FUELS	9

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications, Performance and Emission Characteristics of Alternative Fuels, Storage and Handling of Alternative Fuels.

UNIT V	RECENT TRENDS	9

Air assisted Combustion, Homogeneous charge compression ignition engines – Reactivity Controlled Compression Ignition (RCCI) - Gasoline Compression Ignition - Variable Geometry turbochargers –Common Rail Direct Injection Systems - Hybrid Electric Vehicles – Solar Vehicles – Cruise Control –Turbocharged Engine - NOx Adsorbers - Onboard Diagnostics.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	describe knowledge on the operations of Spark Ignition Engine and its components	Analysing (K4)

CO2	discuss in detail the operations of Compression Ignition Engine and its components	Understanding (K2)
CO3	illustrate knowledge about pollutants developed from various fuel sources and apply controlling techniques	Applying (K3)
CO4	demonstrate knowledge on alternate fuels and engine design modifications required to use them	Understanding (K2)
CO5	keep trend with the latest developments in I.C engines like rail direct injection systems, On- board diagnostics and hybrid vehicles.	Analysing (K4)

TEXT BOOKS

1. Ganesan.V, "Internal Combustion Engines", IV Edition, McGraw-Hill, 2017
2. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", III Edition, Scitech Publications, 2018

REFERENCES

1. Kirpal Singh "Automobile Engineering", 13th Edition, Standard Publishers, New Delhi, 2020
2. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines"., Dhanpat Rai and Sons 2007
3. Ed May, "Automotive Mechanics", VIII Edition, Tata McGraw-Hill,2016
4. John B. Heywood, "Internal Combustion Engine Fundamentals", I Edition, Mc Graw - Hill, 2017

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
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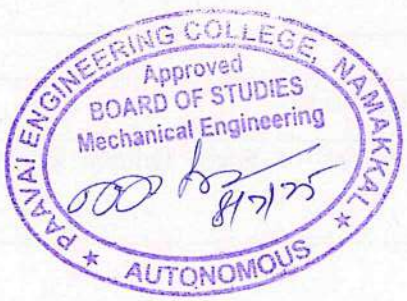
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	-	-	-	-	-	2	3	2
CO2	3	2	2	1	1	1	-	-	-	-	-	2	3	2
CO3	3	2	2	1	1	1	-	-	-	-	-	2	3	2
CO4	3	2	2	1	1	1	-	-	-	-	-	2	3	2
CO5	3	2	2	1	1	1	-	-	-	-	-	2	3	2



ME23551	MICROPROCESSOR AND ARTIFICIAL INTELLIGENCE FOR INDUSTRY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the architecture and programming basics of microprocessors and microcontrollers
2	learn interfacing techniques and communication protocols for industrial device integration.
3	introduce the fundamentals of artificial intelligence and machine learning concepts.
4	apply AI techniques for industrial automation, predictive maintenance, and quality control.
5	explore Industry 4.0 technologies, digital twins, and ethical aspects of AI in industries.

UNIT I	MICROPROCESSOR AND MICROCONTROLLER ARCHITECTURE	9

8085 and 8086 microprocessors – Architecture – Working principle – Instruction set classification – Addressing modes – Timing diagram – Interrupts – DMA process – Assembly language programming basics – Microcontroller introduction – 8051 and ARM architecture – Constructional features and comparison with microprocessors.

UNIT II	INTERFACING OF MICROPROCESSOR WITH INDUSTRIAL DEVICES	9

Microprocessor interfacing with ADC, DAC, sensors, motors – Input/output interfacing techniques – Communication protocols: UART, SPI, I2C, CAN – Data transfer methods – Real-time industrial control – PLC architecture – SCADA system overview – Applications in automation and process industries.

UNIT III	ARTIFICIAL INTELLIGENCE FUNDAMENTALS	9

Definition and scope of AI – History and industrial applications – Supervised and unsupervised learning – Neural networks – Fuzzy logic systems – AI in sensor data analysis – Machine vision basics – Speech and image processing – Role of AI in enhancing industrial decision-making systems.

UNIT IV	AI FOR INDUSTRIAL AUTOMATION	9

Predictive maintenance using AI – Data-driven fault detection – AI in robotic arms and CNC machines – Computer vision for quality control and defect detection – Integration of AI with IIoT – Smart control and monitoring – Automation using intelligent systems – Real-time analytics and optimization.

UNIT V	INDUSTRY 4.0 FRAMEWORK	9

Industry 4.0 overview – Role of AI in smart manufacturing – Cyber-physical systems – Digital twins – Case studies: AI-enabled production line, AGV navigation, real-time defect identification – Ethics in AI deployment – Industrial safety standards – Legal and regulatory aspects of AI in industries.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	describe the architecture and instruction set of microprocessors and microcontrollers.	Understanding (K2)
CO2	develop interfacing solutions using microprocessors for industrial devices.	Analysing (K4)

CO3	understand AI principles and how they relate to industrial environments.	Understanding (K2)
CO4	implement AI-based automation solutions for predictive control and monitoring.	Analysing (K4)
CO5	analyze real-world AI-integrated systems for industrial transformation.	Analysing (K4)

TEXT BOOKS

1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, PHI.
2. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson.

REFERENCES

1. Mazidi & Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson.
2. David A. Patterson & John L. Hennessy, Computer Organization and Design, Morgan Kaufmann.
3. Sutton & Barto, Reinforcement Learning: An Introduction, MIT Press.
4. Bhim Singh, Industrial Automation and Robotics, Khanna Publishers.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
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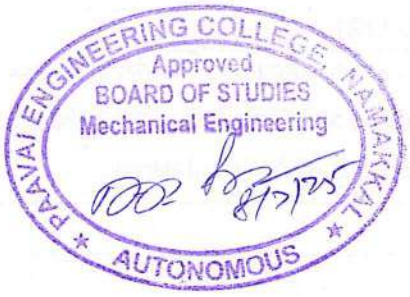
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	-	-	3	2
CO2	3	3	3	2	3	-	-	-	-	-	-	-	3	3
CO3	2	2	3	2	3	1	-	-	-	-	-	1	2	2
CO4	2	3	3	3	3	-	-	-	1	-	-	2	2	3
CO5	2	2	3	3	3	1	1	1	1	2	1	3	2	2



ME23552	MACHINE LEARNING IN AUTOMATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce the fundamentals and types of machine learning and their integration with automation systems
2	impart knowledge on supervised learning models and their role in automation tasks
3	explore decision tree learning concepts and their relevance in machine learning workflows.
4	learn about basics of neural networks and neuro fuzzy networks
5	study the concepts and applications of recurrent neural networks and reinforcement learning

UNIT I	INTRODUCTION TO MACHINE LEARNING AND AUTOMATION	9

Fundamentals of Machine Learning (ML) - Definitions, Types (Supervised, Unsupervised, Reinforcement) - Relationship between ML and automation - Applications of ML in industrial automation, smart manufacturing, robotics - ML Workflow: Data collection, pre-processing, training, testing.

UNIT II	SUPERVISED LEARNING TECHNIQUES FOR AUTOMATION	9

Linear and Logistic Regression - Decision Trees and Random Forests - Support Vector Machines (SVM) - Evaluation Metrics - Confusion matrix, precision, recall, F1-Score, ROC - Case Studies - Predictive maintenance, fault detection in machines, Energy usage prediction.

UNIT III	DECISION TREE LEARNING	9

Decision tree representation – Appropriate problems for Decision tree learning – Decision tree algorithm - Hypothesis space search- Inductive Bias – Restriction bias and Preference bias - Issues in Decision tree learning.

UNIT IV	NEURAL NETWORKS	9

Mathematical Models of Neurons - ANN architecture, Learning rules - Multi-layer Perceptron - Back propagation - Introduction of Neuro-Fuzzy Systems - Architecture of Neuro Fuzzy Networks - Application Case Study of Neural Networks in Robotics.

UNIT V	REINFORCEMENT LEARNING	9

Unfolding Computational Graphs - Recurrent neural networks - Application Case Study of recurrent networks in Robotics - Reinforcement learning - Examples for reinforcement learning - Markov decision process - Major components of RL – Q Learning - Application Case Study of reinforcement learning in Robotics.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	explain the types of machine learning and identify their applications in industrial automation	Understanding (K2)
CO2	apply supervised learning techniques like regression and classification to real-world automation problems	Applying (K3)

CO3	analyze and interpret decision tree structures to support intelligent decision-making in automated systems	Analysing (K4)
CO4	summarize the concepts of neural networks and neuro fuzzy networks	Understanding (K2)
CO5	analyze and implement reinforcement learning algorithms for robotic control tasks and assess their effectiveness through case studies	Analysing (K4)

TEXT BOOKS

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Science / Engineering / Math, 1997.
2. Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011.

REFERENCES

1. Simon Haykin, "Neural Networks and Learning Machines: A Comprehensive Foundation", Third Edition, Pearson, 2016.
2. Timothy J Ross, "Fuzzy Logic with Engineering Applications", 4th Edition, Chichester, 2011, Sussex Wiley.
3. Francis X. Govers, "Artificial Intelligence for Robotics", Packt Publishing Ltd, 2018.
4. Bruno Siciliano, Oussama Khatib, "Handbook of Robotics", 2nd Edition, Springer, 2016.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
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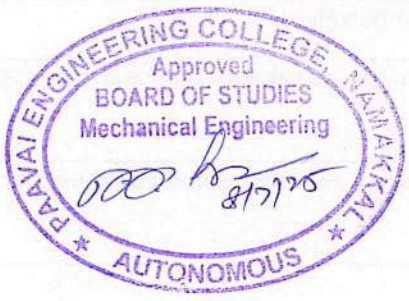
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	-	-	-	2	2	2
CO2	3	2	1	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	1	2	-	-	-	-	-	-	-	2	2	2
CO4	3	2	1	2	-	-	-	-	-	-	-	2	2	2
CO5	3	2	1	2	-	-	-	-	-	-	-	2	2	2



ME23553	MEASUREMENTS AND CONTROLS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	identify measurement parameters and analyse errors of measurements.
2	select and apply suitable transducer for a particular measurement.
3	identify measurement parameters and select the appropriate sensor for it.
4	explain the working of various types of control systems of apply for specific applications
5	apply the principle of automatic control systems to control various parameter.

UNIT I	MEASUREMENTS AND ERROR ANALYSIS	9

General concepts – Units and standards – Measuring instruments –sensitivity, readability, range, accuracy, precision – static and dynamic response – repeatability hysteresis – systematic and random errors –Statistical analysis of experimental data – Regression analysis – Curve fitting - calibration and Uncertainty.

UNIT II	INSTRUMENTS	9

Computer Integrated Manufacturing (CIM)- Flexible Manufacturing Systems (FMS)- Industrial Automation: Sensors, Actuators, Controllers- Robotics in Manufacturing (Types, Kinematics, Cobots)- CNC Machines and their Role in Industry 4.0

UNIT III	PARAMETERS FOR MEASUREMENT	9

Dimension, displacement, velocity, acceleration, Impact – Force, torque, power- Pressure, Temperature, Heat Flux, Heat Transfer Coefficients, Humidity – Flow – Velocity - Time, frequency and phase angle – noise and sound level.

UNIT IV	ADVANCED TOOLS AND DATA ANALYTICS	9

Basic elements – feedback principle, implication of measurements – Error detectors – final actuating elements – Two position, multi-position, floating, proportional controls – relays – servo amplifiers – servo motors – Electrical, magnetic, electronic control systems.

UNIT V	APPLICATION OF CONTROL SYSTEMS	9

Governing of speed, kinetic and process control – pressure, temperature, fluid level, flow-thrust and flight control – photo electric controls – designing of measurement and control systems for different applications.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	identify measurement parameters and analyze errors of measurements.	Understanding (K2)
CO2	select and apply suitable transducer for a particular measurement.	Applying (K3)
CO3	identify measurement parameters and select the appropriate sensor for it.	Applying (K3)
CO4	explain the working of various types of control systems of apply for specific applications.	Understanding (K2)
CO5	apply the principle of automatic control systems to control various parameter(s).	Applying (K3)

TEXT BOOKS

1. Venkateshan S P, Mechanical Measurements, 2ndEdition, John Wiley & Sons, Ltd, 2015.
2. William Bolton, Instrumentation and Control Systems, 2ndEdition, Newnes, 2015.

REFERENCES

1. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Pearson, 2013.
2. Ernest Doebelin and DhaneshManik, Measurement Systems, McGraw Hill InternationalEdition, 2017.
3. Holman J P, "Experimental Methods for Engineers", McGraw Hill Int. Edition, 7th Ed., 2017.
4. Nagrath I J, "Control Systems Engineering", New Age International Publishers, 2018.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	1	-	-	-	-	-	-	-	1	2	2

ME23554	PREDICTIVE ANALYTICS IN INDUSTRY 4.0	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamental concepts of regression analysis and its application in management decision-making.
2	explain time series forecasting methods and key machine learning models used for predictive analysis.
3	describe the components and technologies involved in Industry 4.0, including cyber-physical systems and smart factories.
4	analyze sustainability challenges in supply chain management and the role of smart factories in Industry 4.0.
5	evaluate the concept, architecture, and benefits of digital twins in smart manufacturing and Industry 4.0 applications.

UNIT I	REGRESSION ANALYSIS	9

Simple Regression Analysis: Concept Fundamentals of Regression Analysis - Requirements in Regression Model Building - Model Diagnostics - Interpretation of Regression results for Management Decision. Multiple Regression Analysis: Concept - Significance of Multiple Regression Analysis - Structure of Model Estimation - Testing Rule of Multiple Regression Analysis.

UNIT II	FORECASTING AND MACHINE LEARNING	9

Time Series Forecasting: Concept - Forecasting Techniques - Measures of Forecast Error - Trend Analysis - Time Series Models - Auto Regressive Model - Applications of Time Series Models. Machine Learning: Concept - Predictive Analysis under Machine Learning - Model of Artificial Neural Networks (ANN) - Model of Random Forest - Model of Support Vector Machine - Assumptions under Machine Learning.

UNIT III	INTRODUCTION TO INDUSTRY 4.0	9

Introduction: Sensing & actuation, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories; Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis.

UNIT IV	SUSTAINABILITY ASSESSMENT AND SMART FACTORIES	9

Sustainability – Supply Chain Management- Information and Communication Technology- Introduction To Emerging Issues; Introduction to Industry 4.0 and its role in smart manufacturing; Smart factory concepts and their applications in Industry 4.0; Case studies of smart factories and Industry 4.0 in different industries.

UNIT V	DIGITAL TWIN AND ITS IMPORTANCE IN INDUSTRY 4.0	9

Concept of Digital Twin – Key Components and Architecture of Digital Twin – Integration with IoT, AI, and Big Data – Role of Digital Twins in Predictive Maintenance and Real-time Monitoring – Benefits and Challenges in Implementing Digital Twins – Applications of Digital Twin in Smart Manufacturing – Case Studies of Digital Twin Use in Industry 4.0 across Sectors.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	apply regression analysis techniques to build and interpret models for real-world business data.	Understanding (K2)
CO2	demonstrate the ability to select and use appropriate forecasting and machine learning models for time-dependent data.	Understanding (K2)
CO3	identify and explain the emerging technologies and principles underlying Industry 4.0 and smart manufacturing.	Applying (K3)
CO4	assess sustainability factors and ICT integration in supply chain management through case studies of smart factories.	Analyzing (K4)
CO5	implement digital twin concepts to improve predictive maintenance, monitoring, and decision-making in manufacturing processes.	Analysing (K3)

TEXT BOOKS

1. Introduction to Linear Regression Analysis by Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Wiley, 2012, 5th Edition.
2. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, Apress, 2016, 1st Edition.

REFERENCES

1. Forecasting: Principles and Practice by Rob J Hyndman, George Athanasopoulos, OTexts, 2018, 3rd Edition.
2. The Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer, 2009, 2nd Edition.
3. Artificial Intelligence: A Guide to Intelligent Systems by Michael Negnevitsky, Pearson Education, 2011, 3rd Edition.
4. Internet of Things: Principles and Paradigms edited by Rajkumar Buyya, Amir Vahid Dastjerdi, Morgan Kaufmann, 2016, 1st Edition.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	1	-	-	-	-	1	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	2	3	3	3	-	1	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	1	-	1	1	-	3	3	3

ME23555	AUTOMATION IN MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	illustrate the basic concepts of automation
2	analyze single model assembly lines and line balancing algorithms.
3	demonstrate the importance of automated material handling and storage systems.
4	explain the concepts of automated assembly systems.
5	describe design for manufacturing and just in time production systems.

UNIT I	INTRODUCTION	9

Introduction to Automation: Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Manufacturing operations, Production Concepts and Mathematical Models. Costs of Manufacturing Operations, Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation.

UNIT II	MANUAL ASSEMBLY LINES AND LINE BALANCING	9

Manual Assembly Lines: Fundamentals of manual assembly lines, assembly workstations, manual work transport system And mechanised work transport system: continuous transport, synchronous transport, asynchronous transport; line pacing. Analysis of Single Model Assembly Lines: Line balancing problem, Line balancing algorithms- Largest candidate rule, Kilbridge and Wester method, Ranked positional weights method. (Simple problems using the mentioned algorithms)

UNIT III	AUTOMATED PRODUCTION LINES AND ANALYSIS OF TRANSFER LINES	9

Automated Production Lines: Fundamentals of automated production lines- work part transport, system configurations: in-line, segment in-line, rotary; work part transfer mechanisms: linear transfer system, rotary indexing mechanisms - Geneva mechanism. Analysis of Transfer Lines: Analysis of flow lines with no internal parts storage: cycle time analysis, processing time, production time, line frequency; performance measure- actual and ideal production rate, line efficiency. (simple problems)

UNIT IV	AUTOMATED ASSEMBLY SYSTEMS AND INSPECTION	9

Automated Assembly Systems: Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems. Inspection: Types of Inspection, Inspection Procedure, Automated Inspection, Off-line and Online Inspection, Contact Vs Non-contact Inspection techniques, Coordinate measuring machines(CMM)- Construction, Operation and Programming, CMM Applications and Benefits.

UNIT V	PROCESS PLANNING AND CONCURRENT ENGINEERING	9

Process Planning and Concurrent Engineering: Computer aided process planning, retrieval CAPP system, generative CAPP system; Concurrent engineering and design for manufacturing: principles of design for manufacturing and assembly, other product design objectives- design for product quality, cost, life cycle; advanced manufacturing planning. Just-In-Time Production Systems: Pull system of production control - production kanban and transport

kanban, setup time reduction for smaller batch sizes, stable and reliable production operations - stable schedule, on-time delivery, zero defect, work force and supplier base.

		TOTAL PERIODS:45
COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	describe automation principles and strategies.	Applying (K3)
CO2	analyze single model assembly lines.	Analysing (K4)
CO3	design automated production lines.	Analysing (K4)
CO4	analyze automated assembly systems.	Applying (K3)
CO5	describe concurrent engineering and process planning.	Applying (K3)

TEXT BOOKS

1. Automation, Production systems and computer integrated manufacturing, Mikel P. Groover/ Pearson Education.
2. CAD CAM: Principles, Practice and Manufacturing Management / Chris Mc Mohan, Jimmie Browne / Pearson edu. (LPE)

REFERENCES

1. Yoram Koren, Computer control of Manufacturing Systems, McGraw-Hill Education, International Edition, 2017.
2. P. Radhakrishnan and S. Subramanyam, V. Raju, CAD/CAM/CIM, New Age International Pvt Ltd., 3rd Edition, 2009. Design Data Hand Book", PSG College of Technology, Coimbatore, 2013
3. Automation for Productivity, Luke H.D, John Wiley & Sons, New York, 1972.
4. Industrial Automation in the Industry 4.0 Era Performance Analysis and Applications , John Soldatos – multiple publications in automation, 2019.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	-	-	-	2	-	-	-	2	2	3
CO2	2	2	3	2	-	-	-	2	-	-	-	2	2	3
CO3	2	2	3	2	-	-	-	2	-	-	-	2	2	3
CO4	2	2	3	2	-	-	-	2	-	-	-	2	2	3
CO5	2	2	3	2	-	-	-	2	-	-	-	2	2	3

ME23556	REAL TIME EMBEDDED SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the concept of embedded system design and analysis.
2	learn the architecture of ARM processor
3	learn the Programming of ARM processor
4	expose the basic concepts of embedded programming.
5	learn real time operating systems

UNIT I	INTRODUCTION TO EMBEDDED SYSTEM DESIGN	9

Complex systems and microprocessors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows - Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques - Designing with computing platforms – consumer electronics architecture – platform-level performance analysis.

UNIT II	ARM PROCESSOR AND PERIPHERALS	9

ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

UNIT III	EMBEDDED PROGRAMMING	9

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

UNIT IV	REAL TIME SYSTEMS	9

Structure of a Real Time System — Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

UNIT V	PROCESSES AND OPERATING SYSTEMS	9

Introduction – Multiple tasks and multiple processes – Multirate systems- Pre emptive realtime operating systems-Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance-power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. - Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example - Audio player, Engine control unit – Video accelerator.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	summarize Architecture and programming of ARM processor.	Understanding (K2)
CO2	applying the concepts of embedded systems and its features	Applying (K3)

CO3	analyze various Real Time Operating system is used in Embedded System	Analysing (K4)
CO4	design the flow &Techniques to develop Software for embedded system networks.	Applying (K3)
CO5	analyze Real-time applications using embedded System Products.	Analysing (K4)

TEXT BOOKS

1. Jane W.S.Liu,‖ Real Time Systems‖, Pearson Education, Third Indian Reprint, 2003.
2. Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012

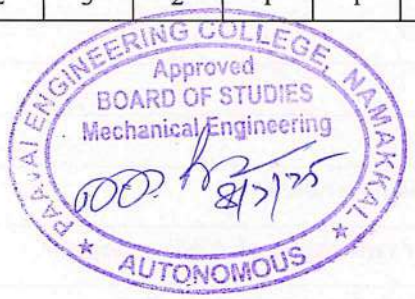
REFERENCES

1. Lyla B.Das, —Embedded Systems : An Integrated Approach‖ Pearson Education, 2013
2. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012
3. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison Wesley Professional, 2007
4. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2005.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO3	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO4	3	2	3	3	3	-	-	-	1	-	-	2	3	3
CO5	3	2	3	2	3	2	1	1	1	1	-	3	3	3



ME23557	ELECTRICAL DRIVES AND ACTUATORS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	familiarize the different power semiconductor devices and drivers circuits.
2	get a knowledge on electric drive and their characteristics.
3	obtain the knowledge on DC motors drives by using power electronics converter.
4	study about AC motors controlling technique.
5	know about the stepper and switched reluctance motor construction and operation.

UNIT I	POWER SEMI-CONDUCTOR DEVICES	9

Switching devices and V-I characteristics - BJT, SCR, TRIAC, GTO, MOSFET, IGBT; Triggering circuit - Introduction to driver and snubber circuits.

UNIT II	DRIVE CHARACTERISTICS	9

Electric drive - Equations governing motor load dynamics, steady state stability; Multi quadrant dynamics - Acceleration, deceleration, torque, and direction starting and stopping; Selection of motor.

UNIT III	DC MOTORS AND DRIVES	9

DC motors and their performance - Separately excited motor, shunt motor, series motor, compound motor, universal motor, permanent magnet motor, DC servo motor; Starting - Braking; Speed control – Single phase fully controlled rectifier fed DC drives, step down chopper controlled DC drives.

UNIT IV	AC MOTORS AND DRIVES	9

Three phase induction motor construction, operation and their characteristic; Speed control of three phase induction motor – Stator voltage control , stator frequency control, stator voltage and frequency control, static rotor resistance control, slip power recovery control; Starting-direct online starter, auto transformer starter.

UNIT V	STEPPER AND SWITCHED RELUCTANCE MOTOR DRIVES	9

Stepper motors - Variable reluctance stepper motor, permanent magnet stepper motor, drive circuits for stepper motors; Switched reluctance motor – construction and modes of operation, torque equation, drive circuits.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	recognize the construction and working power electronics components.	Analysing (K4)
CO2	explain the working and characteristics of various drives.	Understanding (K2)
CO3	apply the solid state switching circuits to operate various types of DC motors and drivers	Applying (K3)
CO4	interpret the performance of AC motors and drives.	Analysing (K4)
CO5	describe the concept stepper and switched reluctance motors and drivers for applications.	Understanding (K2)

TEXT BOOKS

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, Fourth Edition,2021.
2. Bimbhra B.S., "Power Electronics", Kanna Publishers, New Delhi, Fifth Edition, 2012.

REFERENCES

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", Narosal Publishing House, New Delhi, Second Edition, Reprint 2017.
2. Theraja B.L. and Theraja A.K., "A Text Book of Electrical Technology", S.Chand& Co. Ltd., New Delhi, Second Edition, Reprint 2018.
3. Singh M.D. and Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, Second Edition, Reprint 2018.
4. Mehta V.K. and Rohit Mehta, "Principles of Electrical Machines", S.Chand & Co. Ltd., New Delhi, Reprint Edition, 2016.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO3	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	2	3	-	-	-	-	-	-	2	3	3
CO5	3	2	2	1	2	-	-	-	-	-	-	1	3	3

ME23651	VEHICLE DYNAMICS AND CONTROL	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	develop physical and mathematical models that accurately predict the dynamic response of vehicles under various operating conditions.
2	apply vehicle design performance criteria and utilize these benchmarks effectively to assess and improve vehicle performance and safety.
3	integrate dynamic analysis methods into the vehicle design process, enhancing the accuracy of simulations and the reliability of vehicle behavior predictions.
4	understand the fundamental principles of lateral dynamics, including steering, cornering, and stability, for improved control and maneuverability.
5	evaluate the longitudinal dynamics and control systems in automobiles, focusing on acceleration, braking, and traction control for optimal performance and safety.

UNIT I	CONCEPT OF VIBRATION	9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT II	TYRES	9

Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre.

UNIT III	VERTICAL DYNAMICS	9

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. Design and analysis of Passive, Semi active and Active suspension using Quarter car, Bicycle Model, half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

UNIT IV	LONGITUDINAL DYNAMICS AND CONTROL	9

Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT V	LATERAL DYNAMICS	9

Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics.

Steering dynamics. Direction control of vehicles. Roll center, Roll axis. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Minuro Plot for Lateral Transient Response.	
	TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	develop physical and mathematical models to predict the dynamic response of vehicles dynamic response	Understanding (K2)
CO2	apply vehicle design performance criteria and how to use the criteria to evaluate vehicle	Applying (K3)
CO3	use dynamic analyses in the design of vehicles.	Applying (K3)
CO4	understand the principle behind the lateral dynamics.	Understanding (K2)
CO5	understand the longitudinal dynamics and control in an automobile.	Understanding (K2)

TEXT BOOKS

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014
2. J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Interscience, 2008.

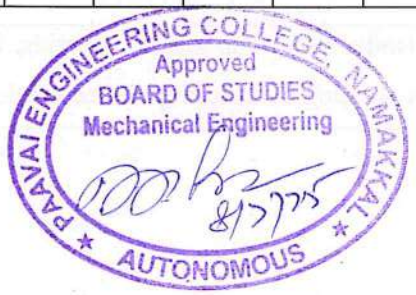
REFERENCES

1. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010
2. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014.
3. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013.
4. R. Nakhaie Jazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer, 2013

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	1	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	1	-	-	-	-	-	-	-	1	2	2



ME23652	ELECTRIC VEHICLE TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals and classifications of electric vehicles.
2	learn about various types of electric propulsion systems and their operation.
3	analyze energy storage systems and battery technologies used in EVs.
4	study charging infrastructure and power electronics in EVs.
5	explore design considerations, challenges, and emerging trends in electric vehicle technology.

UNIT I	INTRODUCTION TO ELECTRIC VEHICLES	9

History and evolution of electric vehicles – Comparison with IC engine vehicles – Types of electric vehicles: BEV, HEV, PHEV, FCEV – Vehicle performance parameters – Electric vehicle configurations and components – Challenges and opportunities in EV adoption.

UNIT II	ELECTRIC PROPULSION SYSTEMS	9

Architecture of EV and HEV – Traction motor characteristics – Types of motors used: DC motor, Induction motor, BLDC, PMSM, SRM – Motor control strategies – Transmission systems in electric vehicles – Regenerative braking.

UNIT III	ENERGY STORAGE SYSTEMS	9

Battery fundamentals – Types of batteries: Lead-acid, NiMH, Li-ion – Battery characteristics: energy and power density, efficiency, cycle life – Battery management system (BMS) – Thermal management – Supercapacitors – Fuel cells: types, working, and integration in EVs.

UNIT IV	POWER ELECTRONICS AND CHARGING SYSTEMS	9

DC-DC converters, inverters, and control – Charging methods: slow, fast, wireless – Charging standards and protocols – On-board and off-board chargers – Smart charging infrastructure – Grid integration and V2G concepts.

UNIT V	DESIGN, CONTROL, AND FUTURE TRENDS	9

Vehicle design aspects for EVs – EV modeling and simulation basics – Safety and standards – Thermal management of EV components – Autonomous and connected electric vehicles – Trends in EV technologies – Government policies and initiatives.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	describe the fundamentals, architecture, and types of electric vehicles	Understanding (K2)
CO2	explain electric propulsion systems and motor control strategies.	Understanding (K2)
CO3	analyze the selection, operation, and management of energy storage systems.	Applying (K3)
CO4	discuss power electronics and charging infrastructure in EVs.	Understanding (K2)
CO5	evaluate vehicle design considerations and emerging trends in electric mobility.	Analysing (K4)

TEXT BOOKS

1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd Edition, CRC Press, 2011.
2. James Larminie and John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, 2012.

REFERENCES

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2004.
2. John G. Hayes, G. A. Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, Wiley, 2018.
3. Chan, C.C. and Chau, K.T., Modern Electric Vehicle Technology, Oxford University Press, 2001.
4. Rui Xiong, Battery Management Algorithm for Electric Vehicles, Springer, 2020.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
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COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	1	2	2	-	-	-	-	2	3	2
CO2	3	2	2	1	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	3	1	-	-	-	-	-	2	3	3
CO4	3	2	2	2	3	1	-	-	-	-	-	2	3	3
CO5	3	3	3	2	2	2	2	1	1	1	1	3	3	3

ME23653	SMART MOBILITY AND VEHICLE SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2	learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3	learn Basic Control System Theory applied to Autonomous Automobiles
4	produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
5	allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT I	INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES	9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.

UNIT II	SENSOR TECHNOLOGY FOR SMART MOBILITY	9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems.

UNIT III	CONNECTED AUTONOMOUS VEHICLE	9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

UNIT IV	VEHICLE WIRELESS TECHNOLOGY & NETWORKING	9

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

UNIT V	CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY	9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles	Analysing (K4)
CO2	select the concept of remote sensing and the types of sensor technology needed to implement remote sensing	Understanding (K2)
CO3	familiar with the concept of fully autonomous vehicles	Applying (K3)
CO4	apply the basic concepts of wireless communications and wireless data network	Applying (K3)
CO5	analyze the concept of the connected vehicle and its role in automated vehicles	Analysing (K4)

TEXT BOOKS

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. "Smart Energy and Intelligent Transportation Systems" Albert Y.S. Lam, Boguslaw Lazarz, Grzegorz Perun, MPDI, 2022.

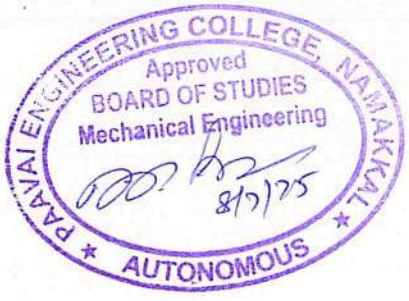
REFERENCES

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group, 5th Edition, 2018.
2. "Smart Mobility and Intelligent Transportation Systems for Commercial and Hazardous Vehicles", Naga Swetha Pasupuleti, T. Poongodi, Balamurugan Balusamy, CRC Press, 2023
3. "Smart Mobility", Arif Sarwat, Asadullah Khalid, Ahmed Hasnain Jalal, Intech Open, 2023.
4. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	1	-	-	-	-	-	1	2	1
CO2	3	2	1	1	-	1	-	-	-	-	-	1	2	1
CO3	3	2	1	1	-	1	-	-	-	-	-	1	2	1
CO4	3	2	1	1	-	1	-	-	-	-	-	1	2	1
CO5	3	2	1	1	-	1	-	-	-	-	-	1	2	1



ME23654	THERMOCHEMICAL ENERGY SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	evaluvate the potential and role of biomass in sustainable energy development
2	identify typical biomass feedstocks for biogas production
3	learn the significance of the equivalence ratio in combustion systems
4	analyse the governing parameters and yield characteristics of each process
5	explore the engine modifications required for using bio-alcohols as fuels.

UNIT I	SOLID FUELS AND RESOURCE ASSESSMENT	9

Types of solid fuels – Advantages and limitations – Typical fuel characteristics – Proximate and ultimate analysis – Comparison with coal – Indian energy scenario – Carbon neutrality concepts – Resource assessment studies – Conversion mechanisms – Densification technologies.

UNIT II	ANAEROBIC CONVERSION SYSTEMS	9

Anaerobic digestion process – Influencing parameters – Common feedstocks – Digesters: types and design – Utilization systems: burners, lighting, and power generation – Conversion of industrial effluents into energy, Storage and distribution systems for anaerobic gas.

UNIT III	COMBUSTION FUNDAMENTALS	9

Types of combustion: perfect, complete, and incomplete – Stoichiometric air requirement – Equivalence ratio – Fixed bed and fluidized bed combustion systems, Design considerations for small- and large-scale combustion systems.

UNIT IV	THERMOCHEMICAL CONVERSION METHODS	9

Gasification chemistry – Types and comparative analysis – Applications – Performance evaluation and economic aspects. Pyrolysis: classification, process parameters, and yield. Carbonization: benefits of carbonized fuels – Techniques used.

UNIT V	LIQUID FUELS FROM ALTERNATIVE SOURCES	9

Use of straight oils as fuels – Production of synthetic diesel from oils and waste – Process and reaction chemistry – Emission and performance comparison with conventional diesel. Alcohol-based fuels (ethanol and methanol): production from various sources – Engine adaptation requirements.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	estimate the surplus biomass availability of any given area.	Analysing (K4)
CO2	design a biogas plant for a variety of biofuels.	Understanding (K2)
CO3	determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.	Applying (K3)

CO4	analyse the influence of process governing parameters in thermochemical conversion of biomass.	Analysing (K4)
CO5	synthesize liquid biofuels for power generation from biomass.	Understanding (K2)

TEXT BOOKS

1. Biomass for Bioenergy and Biomaterials, by Nidhi Adlakha, Rakesh Bhatnagar , Syed Shams Yazdani, CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550
2. Bioenergy and Biochemical Processing Technologies, by Augustine O. Ayeni, Samuel Eshorame Sanni , Solomon U. Oranusi, Springer (30 June 2022).

REFERENCES

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
4. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	2	-	3	-	1	-	2	2	3	-
CO2	2	2	3	2	-	2	2	-	-	-	2	2	3	-
CO3	2	2	3	2	-	-	1	-	-	-	2	2	3	2
CO4	2	2	3	2	-	-	1	-	-	-	2	2	3	1
CO5	2	2	3	2	-	-	1	-	-	-	2	2	3	1

ME23655	SHEET METAL AND COMPOSITE MATERIAL DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals and properties of sheet metal and composite materials.
2	explore various forming processes and their applications.
3	learn design considerations specific to sheet metal components.
4	understand composite material selection and manufacturing techniques.
5	develop design strategies using CAD/CAE for lightweight and high-strength structures.

UNIT I	SHEET METAL MATERIALS AND PROPERTIES	9

Types of sheet metals – Mechanical and physical properties – Formability tests – Springback and anisotropy – Material failure and defect analysis – Industry standards and specifications – Environmental and cost aspects of sheet metal usage.

UNIT II	SHEET METAL FORMING PROCESSES	9

Shearing, blanking, bending, deep drawing – Stretch forming – Roll forming – Hydroforming – Design of dies and punches – Process parameters and formability limits – Safety and quality control in forming operations.

UNIT III	SHEET METAL PART DESIGN AND CAD TECHNIQUES	9

Design for manufacturability – Bend allowance and relief – Tolerances – Hole and feature positioning – Fastening and joining methods – CAD modeling for sheet metal (using software like SolidWorks/Creo) – Flattening and nesting strategies.

UNIT IV	INTRODUCTION TO COMPOSITE MATERIALS	9

Classification of composites – Matrix and reinforcement types – Properties and selection criteria – Micromechanics and macromechanics – Applications in aerospace, automotive, and consumer products – Environmental resistance and fatigue behaviour.

UNIT V	COMPOSITE MANUFACTURING AND DESIGN PRINCIPLES	9

Hand lay-up, spray-up, compression molding, RTM, filament winding, pultrusion, and prepreg techniques – Tooling and processing requirements – Design guidelines for laminates – Failure theories – Hybrid composites – CAD/CAE tools for composite design.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	evaluate mechanical properties and failure behavior of sheet metal materials.	Analyzing (K4)
CO2	select suitable forming processes for manufacturing sheet metal parts.	Understanding (K2)
CO3	design sheet metal components using CAD tools considering manufacturability.	Applying (K3)
CO4	analyze the mechanical performance of different composite materials.	Analyzing (K4)
CO5	develop designs using suitable composite manufacturing processes.	Analysing (K4)

TEXT BOOKS

1. Paul D. Mathur, Sheet Metal Design and Fabrication, Cengage Learning, 2020.
2. Mallick, P.K., Fiber-Reinforced Composites: Materials, Manufacturing, and Design, CRC Press, 4th Edition, 2022.

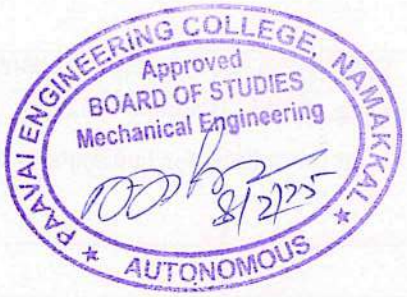
REFERENCES

1. Gibson, R.F., Principles of Composite Material Mechanics, CRC Press, 4th Edition, 2016.
2. Rao, P.N., Manufacturing Technology Vol. 2, McGraw-Hill Education, 5th Edition, 2018.
3. Kalpakjian, S., Manufacturing Engineering and Technology, Pearson Education, 8th Edition, 2021.
4. Campbell, F.C., Introduction to Composite Materials, ASM International, 2010.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	2	-	2	-	1	-	2	2	3	-
CO2	2	2	3	2	2	1	1	-	-	-	2	2	3	-
CO3	2	2	3	2	3	-	1	-	-	-	2	2	3	2
CO4	2	2	3	2	2	-	2	-	-	-	2	2	3	2
CO5	2	2	3	2	3	-	2	-	-	-	2	2	3	2



ME23656	AUTOMOTIVE ENGINES AND SUBSYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study the construction and function of engine components in SI and CI engines.
2	understand the combustion process and influencing factors in SI engines.
3	examine combustion characteristics and air-fuel interaction in CI engines.
4	learn the principles and types of engine lubrication and cooling systems.
5	explore the impact and methods of supercharging and turbocharging.

UNIT I	ENGINE CONSTRUCTION AND ITS COMPONENT	9

Four stroke SI and CI engines – Working principle- Constructional details of engine components, function, materials, Intake system components - Discharge coefficient, Pressure drop Air filter, intake manifold, Connecting Pipe, Exhaust system components – Exhaust manifold and exhaust pipe, Spark arresters - Exhaust mufflers, Types, operation.

UNIT II	COMBUSTION IN SI ENGINES	9

Combustion process in IC engines, Stages of combustion, Flame propagation Flame velocity and area of flame front - Rate of pressure rise - Cycle to cycle variation, Abnormal combustion - Theories of detonation -Effect of engine operating and design variables on combustion, Combustion chambers – types, factors controlling combustion chamber design. Gasoline injection Systems

UNIT III	COMBUSTION IN CI ENGINES	9

Importance of air motion – Swirl, squish and turbulence – Swirl ratio. Fuel air mixing – Stages of combustion – Delay period – Factors affecting delay period, Knock in CI engines – methods of controlling diesel knock. CI engine combustion chambers – Combustion chamber design objectives – open and divided. Induction swirl, turbulent combustion chambers. – Air cell chamber – M Combustion chamber, Diesel injection system.

UNIT IV	LUBRICATION AND COOLING SYSTEM	9

Need for cooling system – Types of cooling system – Liquid cooled system: Thermosyphon system, Forced circulation system, pressure cooling system – properties of coolant, additives for coolants Need for lubrication system – Mist lubrication system, wet sump any dry sump lubrication – Properties of lubricants, consumption of oil.

UNIT V	SUPERCHARGING AND TURBOCHARGING	9

Objectives – Effects on engine performance – engine modification required – Thermodynamics of supercharging and Turbocharging – Turbo lag- Windage losses- Turbo charging methods – Engine exhaust manifold arrangements.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	outline the various components of the engine and its functions.	Understanding (K2)
CO2	examine the combustion process in SI and CI Engine for understanding the performance and emission characteristics.	Analysing (K4)
CO3	summarize various fuel supply and injection system used in IC engines	Understanding (K2)
CO4	identify various lubricants used in IC engines and assess their properties relevant to engine performance. .	Analysing (K4)
CO5	explain the concepts of supercharging and turbocharging.	Applying (K3)

TEXT BOOKS

1. Ganesan V "Internal combustion engines", 4th edition, Tata McGraw Hill Education, 2017.
2. Rajput R. K, "A textbook of Internal Combustion Engines, 2nd edition Laxmi Publications (P) Ltd, 2017.

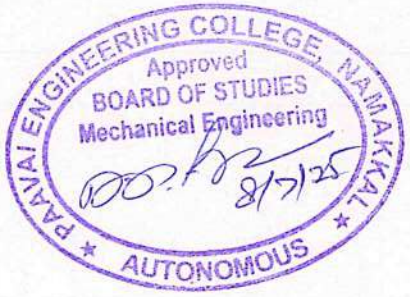
REFERENCES

5. B.P.Pundir, "IC Engines Combustion and Emissions", , Narosa Publishers, 2010
6. Edward F, Obert, "Internal Combustion Engines and Air Pollution", Intext Education Publishers, 2023.
7. Mathur and Sharma, "A course on Internal combustion Engines", Dhanpat Rai & Sons, 2015
8. A.K. Babu and V. Antony Aroul Raj, "Automotive Engines", Khanna Publishing House, 2018

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO4	3	2	2	-	-	-	-	-	-	-	-	1	2	2
CO5	3	2	3	2	2	-	-	-	-	-	-	1	2	2



ME23657	INTELLIGENT VEHICLE SYSTEM	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the need, benefits, and modern trends in Intelligent Vehicle Systems and explore various ADAS technologies used to enhance driving safety and comfort.
2	introduce connected vehicle technologies, including V2V and V2I communications, and understand the role of telematics and onboard systems in modern vehicles.
3	provide foundational knowledge of autonomous driving technologies, including perception algorithms, localization methods, and system architecture.
4	develop an understanding of perception systems, prediction models, and routing techniques.
5	understand the decision-making and control mechanisms that guide autonomous vehicle motion.

UNIT I	INTRODUCTION TO INTELLIGENT VEHICLE SYSTEM	9

Benefits of Intelligent Vehicles; Enabling Technologies-Environment State - Driver State-; Road Scene Understanding-Road/Lane Tracking-Road Sign Detection-Traffic-Light Detection-Visibility Assessment-Vehicle Detection; Advanced Driver Assistance-Collision Avoidance and Mitigation-Adaptive Cruise Control; Driver Monitoring-Driver Fatigue, Inattention, and Impairment -Driver and Passenger Protection; Automated Vehicles-Traffic Congestion-Environmental Factors.

UNIT II	WIRELESS VEHICULAR COMMUNICATIONS	9

Background and History of Vehicular Networking; Vehicular Networking Approaches; Vehicular Ad-hoc Networking- Vehicle-to-infrastructure Communication- Vehicle-to-vehicle Communication- Combined Vehicle-to-vehicle and Vehicle-to-infrastructure Communication- Hybrid Vehicular Network- LTE and Liquid Applications; MAC Solutions for Safety Applications in Vehicular Communications.

UNIT III	INTRODUCTION TO AUTONOMOUS DRIVING	9

Autonomous driving technology overview; Autonomous driving algorithm – Sensing- Perception- Object Recognition And Tracking—Action; Autonomous Driving Client System- Robot Operating System (Ros)-Hardware Platform; Autonomous Driving Cloud Platform- Simulation- HD Map Production- Deep Learning Model Training; Autonomous Vehicle Localization- GNSS Error Analysis- Satellite-Based Augmentation Systems- Real-Time Kinematic and Differential GPS.

UNIT IV	PERCEPTION, PREDICTION AND ROUTING IN AUTONOMOUS DRIVING	9

Perception in Autonomous Driving – Datasets- Detection- Stereo, Optical Flow, and Scene Flow- Tracking; Prediction And Routing- Architecture: Planning and Control in a Broader Sense- Traffic Prediction - Behavior Prediction as Classification- Lane Level Routing- Constructing A Weighted Directed Graph For Routing- Typical Routing Algorithms.

UNIT V	DECISION PLANNING AND CONTROL IN AUTONOMOUS DRIVING	9

Behavioral Decision- Markov Decision Process Approach - Scenario-Based Divide and Conquer Approach; Motion Planning – Vehicle Model, Road Model, and SL-Coordination System - Motion Planning with Path Planning and

Speed Planning; Feedback Control- PID Control; Learning-Based Planning and Control in Autonomous Driving – AI in Autonomous driving.	
	TOTAL PERIODS:45
COURSE OUTCOMES	**BT MAPPED** (Highest level)
At the end of the course, the students will be able to	
CO1 explain the need and advantages of intelligent vehicle systems.	Understanding (K2)
CO2 understand the fundamentals of V2V and V2I communication systems.	Understanding (K2)
CO3 apply localization techniques using GNSS, LIDAR, HD maps	Applying (K3)
CO4 illustrate traffic prediction and lane-level routing mechanisms.	Understanding (K2)
CO5 analyze the interaction between vehicle dynamics, road models, and motion planning algorithms in autonomous driving systems.	Analysing (K4)

TEXT BOOKS

1. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.
2. Shaoshan Liu; Liyun Li; Jie Tang; Shuang Wu; Jean-Luc Gaudiot, —Creating AutonomousVehicle Systems, Morgan &Claypool, 2017.

REFERENCES

1. Alberto Broggi , Michel Parent , Alexander Zelinsky , Charles E. Thorpe Intelligent Vehicles : Springer Handbook of Robotics, 2008.
2. Michael E. McGrath, —Autonomous Vehicles: Opportunities, Strategies, and Disruption, Amazon, 2018
3. Andreas Herrmann, Walter Brenner, Rupert Stadler, —Autonomous Driving: How the Driverless Revolution will Change the World Emerald Publishing, 2018
4. R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	-	1	3	2
CO2	2	3	2	1	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	1	-	2	3	3
CO4	3	2	3	3	3	-	-	-	-	1	-	3	3	3
CO5	3	3	3	3	3	-	-	-	1	1	1	3	3	3

ME23851	BASICS OF MANUFACTURING TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals of metal cutting and the mechanics involved in machining processes.
2	gain knowledge of lathe machines and their operations including machining time calculations.
3	learn the working principles of shaping, slotting, and planning machines and their practical applications.
4	understand various milling operations and grinding techniques used in finishing processes.
5	familiarize with drilling and boring machines, including tools and accessories used.

UNIT I	METAL CUTTING	9

Single and multi-point machine tools. Orthogonal cutting, various force components, chip formation, tool wear and tool life, surface finish and integrity, machinability, cutting tool materials, cutting fluids, coatings.

UNIT II	LATHE AND ITS OPERATIONS	9

Principle of working, specifications, types of lathes, operations performed, work holders and tool holders. Taper turning, thread turning attachments for lathes. Machining time calculations. Turret and capstan lathes - Principle of working, collect chucks, other work holders - tool holding devices.

UNIT III	SHAPING AND SLOTTING MACHINES	9

Shaping, Slotting and planning machines -Principles of working principal parts, specification, classification and operations performed, machining time calculations.

UNIT IV	MILLING OPERATIONS AND GRINDING MACHINES	9

Principle of working, specifications. Classifications of milling machines, machining operations. Types and geometry of milling cutters, methods of indexing and accessories to milling machines. Machining time calculations. Grinding process, types of grinding machines, grinding process parameters, honing, lapping, other finishing processes.

UNIT V	DRILLING AND BORING	9

Drilling: Principle of working, specifications, types and operations performed. Tool holding devices. Nomenclature of twist drill. Boring: Principle of working, specifications, types, and operations performed - tool holding devices - nomenclature of boring tools.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	explain the fundamentals of metal cutting processes, tool life, chip formation, and tool materials.	Understanding (K2)
CO2	apply knowledge of lathe operations and perform machining time calculations.	Applying (K3)
CO3	analyze the working principles of shaping, slotting, and planning machines and select suitable applications.	Analysing (K4)

CO4	understand the working of milling and grinding machines and related accessories.	Understanding (K2)
CO5	demonstrate knowledge on drilling and boring operations, tools, and tool holders.	Understanding (K2)

TEXT BOOKS

1. R. K. Jain, "Production Technology", Khanna Publishers, 18th Edition, 2021.
2. Hajra Choudhury S.K., Hajra Choudhury A.K., Nirjhar Roy S.K., "Elements of Workshop Technology Vol. I & II", Media Promoters & Publishers, 2018.

REFERENCES

1. P.C. Sharma, "A Textbook of Production Engineering", S. Chand Publishing, 2021.
2. Kalpakjian S., Schmid S.R., "Manufacturing Engineering and Technology", Pearson Education, 7th Edition, 2014.
3. HMT, "Production Technology", Tata McGraw Hill, 2001.
4. Mikell P. Groover, "Fundamentals of Modern Manufacturing", Wiley, 6th Edition, 2020.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	1	-	-	2	2
CO2	3	3	2	2	-	-	-	-	-	1	-	-	2	3
CO3	3	2	3	2	-	-	-	-	-	1	-	-	3	3
CO4	3	2	2	2	-	-	-	-	-	1	-	-	2	3
CO5	2	2	2	1	-	-	-	-	-	1	-	-	2	2

ME23852	FUNDAMENTALS OF ADDITIVE MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	explore the technology used in additive manufacturing.
2	understand the importance of additive manufacturing in advance manufacturing process.
3	acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4	explore the techniques and skills in additive manufacturing process
5	apply the enhancing methods in additive manufacturing products .

UNIT I	INTRODUCTION AND BASIC PRINCIPLES	9

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

UNIT II	PRE-PROCESSING IN ADDITIVE MANUFACTURING	9

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

UNIT III	POWDER AND WIRE BASED ADDITIVE MANUFACTURING PROCESSES	9

Stereo lithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS)

UNIT IV	ENERGY BASED ADDITIVE MANUFACTURING PROCESSES	9

Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM) and Metal inert gas additive manufacturing (MIGAM).

UNIT V	POST-PROCESSING IN ADDITIVE MANUFACTURING	9

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

	TOTAL PERIODS:45
COURSE OUTCOMES	**BT MAPPED** (Highest level)
At the end of the course, the students will be able to	
CO1 apply the technology used in additive manufacturing	Applying (K3)
CO2 explain importance of additive manufacturing in advance manufacturing process	Analysing (K4)
CO3 introduce techniques and skills to select relevant additive manufacturing process	Applying (K3)
CO4 apply the techniques and skills in additive manufacturing process	Applying (K)

CO5	utilize the enhancing methods in additive manufacturing products	Applying (K3)

TEXT BOOKS

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 3rd Edition, World Scientific Publishers, 2010

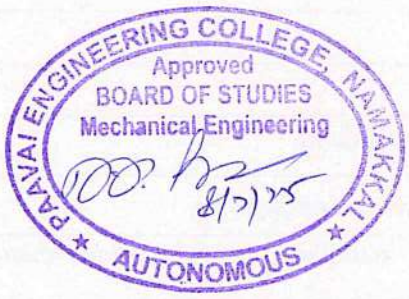
REFERENCES

1. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: 4 th Edition of Rapid Prototyping, World Scientific Publishers, 2014.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.Kenneth G. Budinski& Michael K. Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Pearson, 2009.
3. Bandyopadhyay, A.& Bose.S. Additive Manufacturing, second edition, CRC Press, 2019
4. Milan Brandt. "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	-	-	-	2	2	2
CO2	3	-	3	-	3	-	-	-	-	-	-	-	2	2
CO3	3	-	-	2	3	-	-	-	-	-	-	-	2	2
CO4	3	2	-	2	3	-	-	-	-	-	-	-	2	2
CO5	3	-	2	-	3	-	-	-	-	-	-	2	2	2



ME23853	NON-TRADITIONAL MANUFACTURING PROCESSES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	classify non-traditional manufacturing processes and describe their advantages over conventional methods.
2	illustrate various non-traditional forming and joining techniques.
3	describe additive manufacturing technologies and their applications.
4	explain nano and micro manufacturing techniques.
5	introduce hybrid and intelligent manufacturing processes and compare them with traditional manufacturing systems.

UNIT I	INTRODUCTION TO NON-TRADITIONAL MANUFACTURING	9

Introduction – Need for non-traditional manufacturing processes – Classification of non-traditional manufacturing processes – Applications, advantages and limitations – Overview of non-traditional machining, forming, joining, additive manufacturing and nano processes.

UNIT II	NON-TRADITIONAL FORMING AND JOINING PROCESSES	9

Introduction – Need for non-traditional forming and joining – Classification of non-traditional forming and joining processes – Applications, advantages and limitations – Principles, equipment, effect of process parameters, applications, advantages and limitations of Explosive forming, Electromagnetic forming, Electrohydraulic forming, Friction stir welding, Ultrasonic welding, Laser beam welding, and Electron beam welding.

UNIT III	ADDITIVE MANUFACTURING PROCESSES	9

Introduction – Need for additive manufacturing – Classification of additive manufacturing processes – Applications, advantages and limitations – Overview of Stereolithography (SLA), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), and Binder Jetting – Principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT IV	NANO AND MICRO MANUFACTURING PROCESSES	9

Introduction – Need for nano and micro manufacturing – Classification of nano and micro manufacturing processes – Applications, advantages and limitations – Principles, equipment, effect of process parameters, applications, advantages and limitations of Nano-imprint lithography, Electron beam lithography, Micro-milling, Micro-drilling, Atomic layer deposition, and Scanning probe-based techniques.

UNIT V	HYBRID AND INTELLIGENT MANUFACTURING SYSTEMS	9

Introduction – Need for hybrid and intelligent manufacturing – Classification and overview of hybrid manufacturing processes – Applications, advantages and limitations – Principles, equipment, effect of process parameters, applications, advantages and limitations of processes such as Laser-assisted machining, Ultrasonic-assisted machining, and EDM with USM – Introduction to intelligent manufacturing: smart factories, cyber-physical systems, real-time monitoring, and Industry 4.0.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	formulate classifications of non-traditional manufacturing processes and interpret their relevance.	Create (K6)
CO2	illustrate and evaluate non-traditional forming and joining processes.	Applying (K3)
CO3	analyze additive manufacturing techniques and their industrial applicability.	Analyzing (K4)
CO4	describe the principles of nano and micro-manufacturing processes.	Understanding (K2)
CO5	compare hybrid and intelligent manufacturing systems with traditional methods.	Analysing (K4)

TEXT BOOKS

1. G.F. Benedict, Nontraditional Manufacturing Processes, CRC Press, 2018.
2. M. Koc, T. Altan, Micro-manufacturing: Design and Manufacturing of Micro-Products, Wiley, 2007.

REFERENCES

1. Kalpakjian & Schmid, Manufacturing Processes for Engineering Materials, Pearson, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, Wiley, 2020.
3. Kapil Gupta, Advanced Manufacturing Technologies, CRC Press, 2018.
4. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies, Springer, 2015.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	1	-	-	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	-	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	-	2	3
CO4	2	2	2	2	3	-	-	1	1	1	-	1	-	2
CO5	3	3	3	3	3	-	-	1	1	1	-	1	3	3

ME23854	SMART MANUFACTURING AND INDUSTRY 4.0	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce the concept of Industry 4.0 and its global significance, including lean manufacturing and smart factories
2	familiarize students with automation technologies such as PLCs, sensors, HMI, and cyber-physical systems
3	provide knowledge on industrial communication protocols and augmented reality in smart systems
4	explore the fundamentals and components of IoT platforms and machine-to-cloud communication
5	introduce foundational concepts in machine learning relevant to smart manufacturing and Industry 4.0

UNIT I	INDUSTRY 4.0	9

Concept, Historical development, Globalization and its influence on manufacturing system, emerging issues, The Fourth Revolution, LEAN manufacturing, Smart and connected business perspectives, Smart factories, case studies on real world industry 4.0 implementations.

UNIT II	AUTOMATION	9

Programmable Logic Controller (PLC) and its Programming software, Communication of different devices with PLC, Sensor, Smart Sensor, HMI design, Cyber Physical System – key components, ISA-95 architecture, CPS-5C architecture, Concept of Digit Twin.

UNIT III	COMMUNICATION	9

Protocols – MQTT, OPC UA, EtherNet/IP, Profinet, EtherCAT, etc; MQTT – History, MQTT broker, Message types, Quality of Service (QoS), Application; OPC UA – History, Specification, Client, Server, Programming with – Free and open-source software, Propriety software; Augmented Reality.

UNIT IV	IOT PLATFORM	9

Data Modelling, IoT platforms – Thing, basic functionalities, Abstract definition of Thing, Networks, etc; IoT Gateway, Machine interfaces – Cloud-based Mosquitto brokers, Programming with – Free and open-source software, Propriety software.

UNIT V	MACHINE LEARNING FOUNDATION	9

Learning algorithms – Supervised, Unsupervised, Self learning, Feature learning, etc. Models – Artificial Neural Networks, Decision trees, Regression analysis, Genetic algorithms, etc.; Programming with – Free and open-source software, Propriety software.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	explain the fundamental principles of Industry 4.0, globalization, lean manufacturing, and the concept of smart factories	Understanding (K2)

CO2	apply automation concepts by utilizing PLCs, sensors, and cyber-physical system architecture in industrial applications	Applying (K3)
CO3	analyze and differentiate between various industrial communication protocols and their applications in smart manufacturing	Analysing (K4)
CO4	understanding of IoT platforms, IoT gateways, and cloud communication through appropriate tools and software	Understanding (K2)
CO5	apply fundamental machine learning algorithms using suitable tools for analysis and decision-making in smart manufacturing environments	Applying (K3)

TEXT BOOKS

1. Christoph Jan Bartodziej, "The Concept Industry 4.0 – An Empirical Analysis of Technologies and Application in Production Logistics", Spinger Gabler, 2015
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publications.

REFERENCES

1. Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5.
2. Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" Willy Publications
3. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Willy Publications.
4. Jen-Ruey Jiang, "An improved cyber-physical systems architecture for Industry 4.0 smart factories", Advances in Mechanical Engineering, 2018.

CO - PO MAPPING

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	1	2	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO3	2	2	2	2	3	-	-	-	-	-	-	2	2	2
CO4	2	2	2	2	3	-	-	-	-	-	2	3	2	2
CO5	2	3	3	3	3	-	-	-	-	-	2	3	2	2

ME23855	PRODUCT DESIGN AND INNOVATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand fundamental principles of product design and innovation, including need identification and ideation
2	gain knowledge of design thinking and its applications in real-world product development.
3	learn creative and systematic approaches to user-centered design.
4	understand digital prototyping tools and rapid prototyping techniques
5	develop entrepreneurship skills through innovation frameworks and case studies.

UNIT I	INTRODUCTION TO PRODUCT DESIGN	9

Definition and Scope of Product Design – Importance of Design in Innovation – Life Cycle Thinking – User Needs Identification – Product Requirements – Design Briefs – Types of Products – Case Studies of Innovative Products from Various Industries.

UNIT II	DESIGN THINKING METHODOLOGY	9

Design Thinking Process: Empathize, Define, and Ideate, Prototype, Test – Human-Centered Design – Creative Problem Solving – Brainstorming Techniques Storyboarding – Persona Creation – Value Proposition Canvas.

UNIT III	DESIGN CONCEPTUALIZATION AND EVALUATION	9

Concept Generation Techniques – Morphological Charts – SCAMPER – TRIZ – Concept Evaluation and Selection – Pugh Matrix – Decision Matrices – Product Aesthetics and Ergonomics – Design for X (Manufacturing, Assembly, Environment, Cost, etc.).

UNIT IV	DIGITAL DESIGN AND PROTOTYPING TOOLS	9

CAD Basics (Fusion 360/TinkerCAD for Non-Mech Students) – Simulation Concepts – 3D Printing Principles – Introduction to Arduino and IoT-based Prototypes – Virtual and Augmented Reality in Product Demos – Free and Open Source Prototyping Tools.

UNIT V	INNOVATION MANAGEMENT AND ENTREPRENEURSHIP	9

Types of Innovation – Innovation Funnel – Lean Startup Methodology – Business Model Canvas – Intellectual Property (IPR) Basics – Technology Transfer – Case Studies of Student Innovations and Startups.

TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED** (Highest level)
At the end of the course, the students will be able to		
CO1	explain fundamental concepts in product design, user needs, and lifecycle thinking	Understanding (K2)
CO2	apply design thinking process to solve real-world problems and generate innovative ideas	Applying (K3)
CO3	analyze and evaluate multiple design concepts using structured decision-making tools	Analysing (K4)

CO4	demonstrate basic digital prototyping using CAD, AR/VR, or IoT tools for product representation	Understanding (K2)
CO5	apply innovation frameworks and entrepreneurial thinking to transform ideas into viable product concepts	Applying (K3)

TEXT BOOKS

1. Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.
2. Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and future trends. CRC Press.

REFERENCES

1. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGRAW-HILL book company.
2. Roozenburg, N. F., & Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). John Wiley & Sons Inc.
3. Tim Brown, Change by Design: How Design Thinking Creates New Alternatives for Business and Society, Harvard Business Press.
4. Jeanne Liedtka, Design Thinking for the Greater Good, Columbia Business School Publishing.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
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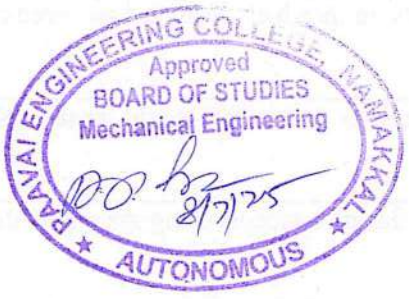
CO1	3	2	1	-	-	1	2	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO3	2	2	2	2	3	-	-	-	-	-	-	2	2	2
CO4	2	2	2	2	3	-	-	-	-	-	2	3	2	2
CO5	2	3	3	3	3	-	-	-	-	-	2	3	2	2



ME23856	LEAN AND SUSTAINABLE MANUFACTURING SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals and importance of lean thinking in modern industries.
2	learn various tools and techniques to eliminate waste and improve process efficiency.
3	gain insight into sustainable manufacturing practices and environmental impacts.
4	analyze and apply appropriate sustainability metrics and tools like LCA and green VSM.
5	explore the role of Industry 4.0 and AI in enabling lean and green transformation

UNIT I	INTRODUCTION TO LEAN MANUFACTURING	9

Definition – Evolution of Lean Manufacturing – Toyota Production System (TPS) – Principles of Lean – Types of Waste (Muda, Mura, Muri) – Value vs Non-value Activities – Benefits of Lean Thinking – Overview of Lean Tools: 5S, Standard Work, Visual Management, Kaizen, SMED – Introduction to Value Stream Mapping (VSM).

UNIT II	LEAN TOOLS AND APPLICATIONS	9

Detailed Study of Lean Tools – Just-in-Time (JIT), Kanban, Cellular Manufacturing, Poka-Yoke – Heijunka (Level Scheduling), Total Productive Maintenance (TPM), Andon – Lean Implementation Framework – Lean Culture and Organizational Readiness – Case Studies in Manufacturing and Service Sectors.

UNIT III	BASICS OF SUSTAINABLE MANUFACTURING	9

Definition and Objectives of Sustainability – Triple Bottom Line – Sustainable Manufacturing Indicators – Material, Energy and Water Efficiency – Carbon Footprint – Waste Minimization – Cleaner Production – Concepts of Circular Economy – Environmental Standards (ISO 14001).

UNIT IV	TOOLS FOR SUSTAINABILITY ANALYSIS	9

Life Cycle Assessment (LCA): Goal and Scope, Inventory, Impact Assessment – Sustainable Value Stream Mapping (SVSM) – Green Supply Chain Management – Metrics for Evaluating Environmental Performance – Industrial Symbiosis – Environmental and Economic Trade-offs – Sustainability Scorecards.

UNIT V	INDUSTRY 4.0 FOR LEAN AND GREEN TRANSFORMATION	9

Industry 4.0 and Smart Manufacturing – Role of IoT, Cyber Physical Systems and Digital Twins – Data-driven Lean – AI for Waste Reduction and Sustainability – Automation and Sustainability Integration – Machine Vision, Smart Sensors – Case Studies on AI-Based Lean/Sustainable Systems.

	TOTAL PERIODS:45
COURSE OUTCOMES	**BT MAPPED** (Highest level)
At the end of the course, the students will be able to	
CO1 understand lean principles, identify types of waste and distinguish lean from traditional approaches	Understanding (K2)
CO2 apply lean tools and techniques to eliminate inefficiencies in processes	Applying (K3)

CO3	analyze manufacturing systems for sustainability with appropriate tools and metrics	Analysing (K4)
CO4	evaluate environmental performance using LCA, SVSM and other sustainability metrics	Understanding (K2)
CO5	explore the role of AI and Industry 4.0 tools in enhancing lean and sustainable practices	Understanding (K2)

TEXT BOOKS

1. Feld, W. M., Lean Manufacturing: Tools, Techniques, and How to Use Them, CRC Press, 2000.
2. Gopalakrishnan, N., Sustainable Manufacturing: Challenges and Implementation, Wiley India, 2018.

REFERENCES

1. Dornfeld, D., Green Manufacturing: Fundamentals and Applications, Springer, 2013.
2. Beamon, B., Sustainability and Supply Chain Management, OR Journal, 1999.
3. McKinsey & Co., Industry 4.0 and the Future of Manufacturing, 2015.
4. Womack, J.P. & Jones, D.T., Lean Thinking, Free Press, 2003.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	2	2	-	2	-	2	-	1
CO2	2	1	2	-	1	-	2	2	-	1	-	2	-	1
CO3	2	2	2	2	-	2	3	2	-	1	-	3	2	2
CO4	2	2	2	2	2	2	3	2	-	2	-	3	3	3
CO5	2	2	1	2	3	2	3	2	-	2	-	2	2	3