COEP Technological University Pune

(A Unitary Public University of Govt. of Maharashtra)

School of Engineering and Technology

Curriculum Structure & Detailed Syllabus

Final. B. Tech.

<Mechanical Engineering>

(Effective from: A.Y. 2026-27)

Program Educational Objectives (PEOs)

After the completion of the program,

I. Student will be employable in the diversified sectors of the industry, government organizations, public sector and research organizations.

II. Student will pursue higher education in engineering or other fields of their interests, at institutes of repute and high ranking.

III. Student will demonstrate effective communication, lifelong learning ability, integrity, teamwork, leadership qualities, concern to environment and commitment to safety, health, legal and cultural issues in the fields they choose to pursue.

Program Outcomes (POs):

Engineering Graduate will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science, and engineering sciences.

PO3: Design/Development Solution: Design solution for complex engineering problems and design system component or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social and environmental conditions.

PO4: Conduct Investigation of Complex Problem: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusion.

PO5: Method, Tool Usage: Create, select and apply appropriately technique, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding the limitation.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to access societal health, safety, legal and cultural and consequent responsibility relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices.

PO9: Individual and Team Work: Function effectively as an individual, and as the member or leader in diverse team and multidisciplinary setting.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, and being able to comprehend and write effective reports and design documentation and effective presentation and give and receive clear instructions.

PO11: Project management and Finance: Demonstrate knowledge & understanding of the engineering and management principles and apply these to one’s work, as the member and the leader in a team to manage projects and in multidisciplinary environment.

PO12: Lifelong Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in broadest context of technological change.

Final Year B. Tech.
<Mechanical Engineering>

List of Abbreviations

Abbreviation	Title	No of Courses	Credits	% of Credits
BS	Basic Science Course	--	--	--
ESC	Engineering Science Course	--	--	--
PCC	Programme Core Course (PCC)	03	8	23.5
PEC	Programme Elective Course (PEC)	04	12	35.29
OE/SE	Open/School Elective (OE/SE) other than particular program	01	02	5.88
MDM	Multidisciplinary Minor (MDM)	01	03	8.82
VSEC	Vocational and Skill Enhancement Course (VSEC)	--	--	--
HSMC	Humanities Social Science and Management	--	--	--
IKS	Indian Knowledge System (IKS)	--	--	--
VEC	Value Education Course (VEC)	--	--	--
RM	Research Methodology (RM)	--	--	--
--	Internship	02	04	11.76
--	Project	01	5	14.7
CEA	Community Engagement Activity (CEA)/Field Project	--	--	--
CCA	Co-curricular & Extracurricular Activities (CCA)	--	--	--
	Total	**12**	**34**	**100**

Final Year B. Tech.
<Mechanical Engineering>

Semester -IV

Sr. No	Cours e Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC	*<tbd>*	Energy Conversion	2	0	0	1	2	30	20	50	---	---
2	PCC	*<tbd>*	Refrigeration and Air Conditioning	2	0	2	1	3	30	20	50	50	50
3	PCC	*<tbd>*	Vibration and Acoustics	2	0	2	1	3	30	20	50	50	50
4	PEC	*<tbd>*	Program Elective Course -III (Specify List) *	3	0	0	0	3	30	20	50	---	---
5	ELC	*<tbd>*	Internship 2#	0	0	0	0	1	30	20	50	---	---
6	OE	*<tbd>*	Research Methodology and IPR	2	0	0	1	2	30	20	50	---	---
7	MDM	*<tbd>*	Multidisciplinar y Minor IV	3	0	0	1	3	30	20	50	---	---
8	ELC		Project-III	0	0	10	2	5	--	--	--	50	50
			Total	**14**	**01**	**02**	**07**	**22**					

Summer Internship (Industry /R&D / Academic Institute) after VI semester during summer vacation and evaluation will be done at the start of VII semester. Duration minimum One and a maximum Two months.

*Program Elective Course III – Discipline-wise List			
Design Engineering	**Thermal Engineering/Fluid Science**	**Manufacturing Science and Engineering**	**Other Disciplines**
Advanced CAD/CAM	Advanced Computational Fluid Dynamics	Industrial Engineering	Hybrid and Electric Vehicles
Mechanics of Composite Materials	Design of Thermal Systems	Reverse Engineering	Aerospace Engineering
Condition Monitoring	Mathematical Modelling & Analysis Thermal System	Production and Operations Management	Design of Defense Equipment
Automatic control systems		AI and ML for Mech. Engineers	Automotive control systems

Semester -VIII

Sr. No	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PEC	*<tbd>*	Program Elective Course -IV (Specify List) **	3	0	0	0	3	30	20	50	---	---
2	PEC	*<tbd>*	Program Specific Elective- V (Specify List) **	3	0	0	3	3	30	20	50	---	---
3	PEC	*<tbd>*	Program Specific Elective- VI (Specify List) **	3	0	0	3	3	30	20	50	---	---
4	ELC	*<tbd>*	Internship #3	0	0	0	0	3	---	---	--	50	50
			Total	**9**	**00**	**00**	**06**	**12**					

*** MOOCS / Online Courses*

Semester - VII

ENERGY CONVERSION						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	2-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	2		**Laboratory**	CIE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Explain the fundamental principles of energy resources, energy conversion processes and global energy scenario.
2. Analyze the working principles and performance of thermodynamic power cycles used in energy conversion systems.
3. Evaluate the performance characteristics of internal combustion engines, gas turbines and steam power plants.
4. Apply energy conversion principles to renewable energy systems such as solar, wind, geothermal and biomass energy.
5. Assess environmental impacts and sustainability considerations of different energy conversion systems

Introduction to Energy & Energy Resources:	**[6 Hrs]**
Global and Indian energy scenario, classification of energy resources, energy demand and supply, energy crisis, energy security. Primary and secondary energy resources, conventional vs non-conventional energy sources.	
Thermodynamic Power Cycles:	**[10 Hrs]**
Review of thermodynamic laws, Carnot cycle, Otto, Diesel, Dual cycles; Brayton and Rankine cycles – analysis and comparison, combined cycles, cogeneration systems and trigeneration concepts	
Mechanical Energy Conversion Systems:	**[6 Hrs]**
Internal combustion engines – working principles and performance parameters; Steam power plant layout and components; Gas turbine systems and jet propulsion.	
Renewable Energy Conversion Systems:	**[10 Hrs]**
Solar thermal and solar PV systems, wind energy conversion systems, biomass gasification, biogas plants, hydroelectric power systems, geothermal and tidal power..	
Energy Storage & Environmental Impact:	**[6 Hrs]**
Energy storage technologies – mechanical, chemical, thermal and electrical storage; hydrogen energy and fuel cells; environmental aspects, emissions, carbon footprint and sustainability.	
Recent Advancements in Energy Systems:	
Smart grid, waste heat recovery, ORC systems, nuclear fusion status, carbon capture and utilization.	

Textbooks:

[1]	B.H. Khan, *Non-Conventional Energy Resources*, McGraw Hill.
[2]	P.K. Nag, *Power Plant Engineering*, Tata McGraw Hill.
[3]	S.P. Sukhatme, *Solar Energy: Principles of Thermal Collection & Storage*, Tata McGraw Hill.

Reference Books:

[1]	Gilbert M. Masters, *Renewable and Efficient Electric Power Systems*, John Wiley.
[2]	M.M. El-Wakil, *Power Plant Technology*, McGraw Hill.
[3]	Godfrey Boyle, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press.
[4]	Yogesh Jaluria, *Energy and Thermal Systems*, CRC Press.

REFRIGERATION AND AIR CONDITIONING						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	2-0-2-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Understand the working of Vapour Compression refrigeration system.
2. Design the Vapour Compression refrigeration system for various applications.
3. Apply the knowledge of HVAC for multi-pressure systems.
4. Able to understand and apply the Psychrometry for air conditioning applications.
5. Able to design the duct for various air conditioning systems.

Refrigeration Systems: **[12 Hrs]**

Vapour Compression refrigeration system: A Refrigerating Machine, Types of refrigeration system, Vapour Compression refrigeration system and thermodynamic cycle, Effect of Evaporator Pressure, Effect of Condenser Pressure, Effect of refrigerant Superheating and Sub cooling, Actual Vapour Compression Cycle (Numerical treatment). Vapour Absorption Refrigeration Systems: Introduction, working principle, aqua-ammonia, Lithium-bromide and Electrolux Systems. Multipressure systems: Multi-evaporator Systems, Multistage Systems, Flash Gas Removal, Flash Intercooling, Choice of Intermediate Pressure, Complete Multistage Compression System, Multi-evaporator Systems, Cascade Systems, Solid Carbon Dioxide-Dry Ice, Manufacture of Solid Carbon Dioxide, System Practices for Multistage Systems (Numerical treatment)

Refrigerants: **[3 Hrs]**

A Survey of Refrigerants, Designation of Refrigerants, Selection of a Refrigerant, Thermodynamic, Chemical, Physical, and safety Requirements, Secondary Refrigerants, Ozone depletion, Global warming, green house effect, Environment friendly refrigerant R134a, R410a, R600a, R290, R32. (Theoretical only)

Refrigerant Compressors: **[5 Hrs]**

Types of Compressors, Thermodynamic Processes during Compression, Principal Dimensions of a Reciprocating Compressor, Performance Characteristics of a Reciprocating Compressor, Capacity Control of Reciprocating Compressors, Rotary Compressors, Screw Compressors, Centrifugal Compressors, Digital scroll compressors

Condensers, Evaporators and Expansion Devices: **[6 Hrs]**

Construction and working, Types of condensers, evaporators and expansion devices, Capillary Tube and Its Sizing, pumps, heat exchangers etc. Work done and heat transfer during steady flow processes.

Psychometrics of Air – Conditioning Processes: **[8 Hrs]**

Properties of moist Air, Working Substance in Air Conditioning, Psychometric Properties, Psychometric Chart, Mixing Process, Basic Processes in Conditioning of Air Psychometric Processes in Air – conditioning Equipment comfort conditions, (Numerical Treatment).

Load Calculation and Applied Psychrometrics: **[6 Hrs]**

Preliminary Considerations, Internal Heat Gains, System Heat Gains, Break-up of ventilation Load and Effective Sensible Heat Factor, Cooling-load Estimate, Heating – load Estimate, Psychometric Calculations for Cooling, Design of air conditioning equipment, Numerical examples, Introduction to duct design by equal friction method.

Textbooks:

[1]	Arora R.C., Refrigeration and Air Conditioning, PHI,
[2]	Dossat Ray J., Principal of Refrigeration, Pearson, India
[3]	Arora C P, Refrigeration and Air Conditioning, Tata McGraw Hill
[4]	Manohar Prasad, Refrigeration and Air-conditioning, Wiley Eastern Limited, 1983
[5]	India S.N. Sapali “Refrigeration and Air-conditioning”, PHI (Second Edition) 2016

Reference Books:

[1]	Threlkeld J.L., Thermal Environmental Engineering, Prentice Hall Inc. New Delhi
[2]	ASHRAE Handbook (HVAC Equipments)
[3]	Stocker W.F. and Jones J.W., Refrigeration and Air-conditioning, McGraw Hill International editions 1982.
[4]	Roger Legg, Air conditioning systems: Design, Commissioning and maintenance
[5]	Shan Wang, Handbook of Refrigeration and Air Conditioning, McGrawHill Publications
[6]	Wilbert Stocker, Industrial Refrigeration, McGrawHill Publications
[7]	Keith Harold, Absorption chillers and Heat Pumps, McGrawHill publications
[8]	ASHRAE, Air Conditioning System Design Manual, IInd edition, ASHRAE
List of Experiments	
[1]	Demonstration of a domestic refrigerator along with different auxiliary systems associated with a refrigerator.
[2]	Trial on Vapour Compression Refrigeration System to determine cooling capacity and coefficient of performance.
[3]	Trial on Vapour Compression Refrigeration System with R290 as a refrigerant
[4]	Trial on Air conditioning test rig to determine cooling capacity and COP of VCR system.
[5]	Trial on Air conditioning test rig to study the psychrometric processes.
[6]	Trial on an Evaporative Air Cooler
[7]	Trial on Ice Plant, to determine Coefficient of Performance for ice plant test rig
[8]	Performance analysis of expansion devices at different operating conditions
[9]	Study of Vapour Absorption refrigeration Systems.
[10]	Design of cold storage with process layout
[11]	Building heat load simulation using suitable software (Trace 700, Energy plus etc.)

VIBRATION AND ACOUSTICS

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	2-0-2-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Model a given vibratory system as SDOF or MDOF system, with or without damping, and with base or force excitation as periodic or aperiodic.
2. Evaluate continuous natural systems frequencies using and mode shapes of MDOF and modal analysis and computational methods such as Rayleigh-Ritz method and Holzer method.
3. Explain various terminologies used in acoustics and acoustic wave transmission and estimate sound pressure level.
4. Summarize the mechanism of hearing by human and principles of Psychoacoustics and noise control.

Systems with one degree of freedom:	**[5 Hrs]**
Review of one degree of freedom, Energy method, Undamped, damped free and forced vibrations	
General forced response:	**[6 Hrs]**
Impulse response function, response to an arbitrary input, response to an arbitrary periodic input, response to random input, shock spectrum, stability	
Systems with more than one degree of freedom system:	**[6 Hrs]**
Undamped free vibration: principal modes, semidefinite systems, steady state undamped forced vibrations, damped free vibrations, steady state forced vibrations with damping, influence coefficients, Generalised coordinates and coordinate coupling, principle coordinates, The langrage equation.	
Multi degree of freedom system matrix method:	**[7 Hrs]**
Undamped free vibration: principal modes, Normal coordinates, orthogonality of the principal modes of vibrations, systems with equal frequencies, Natural frequencies and principal modes by matrix iteration. Damped free vibrations, forced vibrations, Eigenvalues and natural frequencies, Modal analysis, modal analysis of the forced response. Design for vibration suppression, Vibration isolation, vibration absorbers	
Plane Acoustic waves:	**[6 Hrs]**
Plane acoustic waves, derivation of plane wave equation relationship between acoustic pressure, particle displacement and velocity, velocity of plane acoustic waves, specific acoustic impedance, Sound power, sound intensity, sound pressure and sound intensity levels. Transmission Phenomena, transmission from one fluid medium to another, normal incidence reflection at the surface, of a solid,standing wave patterns.	
Psychoacoustics:	**[8 Hrs]**
Speech, Hearing and Noise, anatomy of the ear, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre.	

Textbooks:

[1]	Francis S. Tse, Ivan E. Morse, Rolland “Mechanical Vibrations” 1963.
[2]	Robert K. Vierck, “Vibration Analysis”1967.
[3]	Inmann Daniel J. ,“Engineering Vibration”, 4th Edition, Pearson,2014.
[4]	Thomson W.T., “Theory of vibrations with applications”, CBS Publishers, Delhi, 2008.
[5]	Rao S.S., “Mechanical Vibrations”, Wiley Publishing Co., 2003.
[6]	G. K. Grover, “Mechanical Vibrations” 1998.
[7]	Kinsler Lawrence E. and Frey Austin R. “Fundamentals of Acoustics”, Wiley Eastern Ltd., 2000

Reference Books:

[1]	Timoshenko S, “Vibration problems in Engineering”, Wiley, 1990.

[2]	Meirovitch Leonard, “Fundamentals of vibrations”, McGraw Hill International Edition, 2003.
[3]	Rettinger Michael, “Acoustic Design and Noise Control”, Vol. I & II. , Chemical Publishing Co., New York, 1977.
[4]	Shriniwasan P., “Mechanical Vibration Analysis”, Tata McGraw Hill,1982.

Program Elective Courses

ADVANCED CAD/CAM

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Develop an ability to create automated solid model using CAD Customization.
2. Understand CAD/CAM data exchange formats.
3. Understand applications of CAD for computer aided Advanced Manufacturing Methods
4. Understand concept of Product Life Cycle Management (PLM)

Introduction to Python Programming:	**[6 Hrs]**
Data Types, Variables, Basic Input-Output Operations, Basic Operators. Boolean Values, Conditional Execution, Loops, Lists and List Processing.Writing functions in Python	
CAD Customization:	**[6 Hrs]**
Need of Cad customization. OLE interfaces in CAD/CAM software; Use of General programming interfaces like VB, VBS, VC++, Open GL programming and System dependent programming interfaces like Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro/Engineer). Creating automated Solid modeling using Customization through API	
Data Exchange Formats:	**[6 Hrs]**
Introduction to CAD/CAM data exchange formats. Direct and Indirect translators. Neutral file formats: Data Exchange format (DXF), Standard Triangular Languages (STL), Initial Graphics Exchange Specification (IGES), 3MF etc	
Surface and Hyper patch Modeling:	**[6 Hrs]**
Surface modeling methods, twist vector, algebraic and control point based hyper patch modeling techniques	
Additive Manufacturing Processes:	**[7 Hrs]**
Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies of following: Solid-based Rapid Prototyping Systems: Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM). Liquid based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA). Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS).	
Introduction to Product Life Cycle Management:	**[4 Hrs]**
Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Threads of PLM-computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM, comparison of PLM to Engineering resource planning (ERP).	

Textbooks:

[1]	Solid Modelling, MarttiMantilya, Computer Science Press,2014
[2]	Rapid prototyping: Principles and Applications, Chua C.K., Leong K.F. and LIM C.S, World Scientific publications , Third Edition, 2010
[3]	Geometric modeling, Michael Morteanson,John Wiley publication
[4]	Python Programming: An Introduction to Computer Science (3rd Edition), John M. Zelle

Reference Books:

[1]	Manuals of Professional CAD software such as Creo Parametric, NX, CATIA
[2]	Additive Manufacturing Technologies, 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2013, Gibson, Ian, Rosen, David, Stucker, Brent

ADVANCED COMPUTATIONAL FLUID DYNAMICS						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand governing equations of fluid flow, including Navier–Stokes equations, and their numerical formulation.
2. Apply discretization techniques such as FDM, FVM, FEM and evaluate their accuracy, stability and convergence.
3. Implement numerical schemes for convection–diffusion equations and pressure–velocity coupling.
4. Solve turbulence modelling problems using RANS, LES and hybrid approaches.
5. Use advanced CFD techniques for engineering case studies and assess validation & verification requirements

Introduction to CFD & Governing Equations: **[7 Hrs]**

Overview of CFD applications in mechanical and aerospace engineering, differential conservation equations, integral forms, tensor notation, classification of PDEs (elliptic–parabolic–hyperbolic), well-posedness of CFD problems.

Discretization & Numerical Approximations: **[8 Hrs]**

Finite Difference, Finite Volume and Finite Element methods; spatial discretization concepts: truncation errors, consistency, stability and convergence; grid generation, structured vs unstructured grids, mesh quality.

Numerical Schemes for Convection–Diffusion Problems: **[8 Hrs]**

Central, upwind, QUICK, hybrid and higher-order schemes; stability analysis, CFL condition, artificial diffusion, treatment of source terms, multi-dimensional formulations.

Pressure–Velocity Coupling & Solution Algorithms: **[7 Hrs]**

SIMPLE, SIMPLER, PISO, fractional step methods, Poisson equation solvers, iterative solution methods (Jacobi, Gauss–Seidel, SOR), convergence acceleration & multigrid methods.

Turbulence Modelling: **[8 Hrs]**

Reynolds decomposition and closure problem, RANS models (k–ε, k–ω, SST), LES and filtering concepts, wall modelling, hybrid LES/RANS approaches, DNS fundamentals, CFD model selection for engineering problems.

Advanced Topics & Applications: **[7 Hrs]**

Compressible CFD framework, shock capturing methods (TVD, ENO/WENO), multiphase & reacting flows overview, HPC and parallel computing introduction, verification & validation (V&V), case studies using commercial & open-source solvers.

Textbooks:

[1]	Versteeg & Malalasekera, *An Introduction to Computational Fluid Dynamics — The Finite Volume Method*, Pearson.
[2]	John D. Anderson, *Computational Fluid Dynamics: The Basics with Applications*, McGraw-Hill.
[3]	H.K. Versteeg, *Computational Methods for Fluid Flow*, Springer.

Reference Books:

[1]	Ferziger & Peric, *Computational Methods for Fluid Dynamics*, Springer.
[2]	Pope S.B., *Turbulent Flows*, Cambridge University Press.
[3]	Moukalled, Mangani & Darwish, *The Finite Volume Method in CFD*, Springer.

INDUSTRIAL ENGINEERING						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Apply the Industrial Engineering concept in the industrial environment.
2. Manage and implement different concepts involved in methods study and understanding of work content in different situations.
3. Undertake project work based on the course content.
4. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
5. Identify various cost accounting and financial management practices widely applied in industries.
6. Develop capability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.

Introduction to Industrial Engineering and Productivity: **[6 Hrs]**

Definition and Role of Industrial Engineering, Contribution of Taylor and Gilbreth, Organisation : Concept of organisation, characteristics of organisation, elements of organisation, organisational structure, organisation charts; Types of organisation- formal line, military organisation, functional organization, line & staff organisation; Introduction to management principles, authority and responsibility, span of control, delegation of authority. Productivity : Definition of productivity, Productivity of materials, land, building, machine and power. Measurement of productivity: factors affecting the productivity, Productivity Models and Index (Numerical), productivity improvement programmers..

Method Study: **[6 Hrs]**

Work Study : Definition, objective and scope of work-study. Human factors in work-study. Method Study : Definition, objective and scope of method study, activity recording and exam aids, Charts to record moments in shop - operation process charts, flow process charts, travel chart, two handed chart and multiple activity charts. Charts to record movement at work place - principles of motion economy, classification of moments, SIMO chart, and micro motion study. Definition and installation of the improved method, brief concept about synthetic motion study and related Numericals.

Work Measurements: **[6 Hrs]**

Work Measurements: Definition, objectives and uses; Work measurement techniques. Work sampling - need, confidence levels, sample size determinations, random observation, conducting study with the simple problems. Time study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination; Introduction to PMTS and MTM. (Numerical), Introduction to MOST

Production Planning and Control: **[6 Hrs]**

Introduction: Types of production systems, Need and functions of PPC, Aggregate production planning, Capacity Planning, ERP: Modules, Master Production Schedule; MRP and MRP-II; Forecasting techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality; (Numerical)., SOR), convergence acceleration & multigrid methods.

Facility Design: **[6 Hrs]**

Facility Location Factors and Evaluation of Alternate Locations; Types of Plant Layout; Computer Aided Layout Design Techniques; Assembly Line Balancing (Numerical); Material Handling: Principles, Types of Material Handling Devices;) Industrial Safety: Safety Organisation, Safety Programme, General Safety Rules. Stores Management

Engineering Economy: **[6 Hrs]**

Engineering Economy and Costing: Elementary Cost Accounting and Methods of Depreciation; Breakeven Analysis (Numerical).Inventory Control: Functions, costs, classifications- Concept of EOQ, purchase model without shortages (Numerical); ABC ,VED and other Analysis

Textbooks:	
[1]	M Mahajan, “Industrial Engineering and Production Management”, DhanpatRai and Co,2015.
[2]	O. P. Khanna, “Industrial engineering and management”, DhanpatRai publication, 2010
[3]	Martend Telsang, “Industrial
[4]	Banga and Sharma, “Industrial Organisation & Engineering Economics”, Khanna publication, 2003.
Reference Books:	
[1]	Introduction to Work Study by ILO, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008.
[2]	H. B. Maynard, K Jell, “Maynard‘s Industrial Engineering Hand Book”, McGraw Hill Education.
[3]	Askin, “Design and Analysis of Lean Production System”, Wiley, India
[4]	Zandin K.B., “Most Work Measurement Systems”, CRC Press, 2002
[5]	Martin Murry, “SAP ERP: Functionality and Technical Configuration”, SAP Press; 3rd New edition (2010).
[6]	Barnes, “Motion and time Study design and Measurement of Work”, Wiley India

HYBRID AND ELECTRIC VEHICLES						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Apply basic principles of hybrid and electric vehicles to design vehicles.
2. Select appropriate cycle source of energy for the hybrid electric vehicle based on driving.
3. Analyze the power and energy needs of the various hybrid electric vehicles.
4. Measure and estimate the energy consumption of the Hybrid Vehicles.
5. Evaluate energy efficiency of the vehicle for its drive trains.

Introduction to Electric Vehicle: **[6 Hrs]**

History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

Induction to Hybrid Electric Vehicle: **[6 Hrs]**

Social and environmental importance of hybrid and electric vehicles, impact of modern drivetrains on energy supplies. Hybrid Electric drivetrains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive Trains: **[8 Hrs]**

Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Types of Storage Systems: **[7 Hrs]**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the ratings.

Modelling of Hybrid Electric Vehicle Range: **[7 Hrs]**

Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2-wheeler, 3-wheeler and 4 wheeled vehicles.

Energy Management Strategies: **[7 Hrs]**

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations.

Textbooks:

[1]	James Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
[2]	M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
[3]	S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.
[4]	Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.

MECHANICS OF COMPOSITES OF MATERIALS

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Differentiate the basic concepts and difference between composite materials with conventional materials.
2. Determine role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
3. Knowledge for finding failure envelopes and stress-strain plots of laminates.
4. Utilize subject knowledge using computer programs to solve problems at structural level.

Introduction:	**[3 Hrs]**

Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus

Basic Concepts and Characteristics:	**[4 Hrs]**

Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Macromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials

Elastic Behavior of Unidirectional Lamina:	**[5 Hrs]**

Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.

Strength of Unidirectional Lamina:	**[5 Hrs]**

Micromechanics of failure; failure mechanisms, Macromechanical strength parameters, Macromechanical failure theories, Applicability of various failure theories

Elastic Behavior of Laminate:	**[8 Hrs]**

Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates Hygrothermal Effects:Hygrothermal effects on mechanical behavior, Hygrothermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage

Stress and Failure Analysis of Laminates:	**[5 Hrs]**

Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials

Reference Books:

[1]	Isaac M. Daniels, OriIshai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
[2]	Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
[3]	Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science", CRC Press, Boca Raton, 2003.
[4]	MadhujitMukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004.
[5]	Mazumdar S. K., "Composaite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 2002.
[6]	Robert M. Jones, "Mechanics of Composite Materials", Taylor and Francis, Inc., 1999.

DESIGN OF THERMAL SYSTEMS						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the basic principles of thermal design.
2. Apply modeling and analytical knowledge of applied thermodynamics and heat transfer to systems such as heat exchangers, evaporators, condensers, boilers, binary mixtures and turbomachinery.
3. Construct simulations of thermal systems for performance evaluation.
4. Understand fundamentals of optimum system design and apply optimization approaches.

Introduction and Fundamentals of Thermal System Design: **[8 Hrs]**

Fundamental concepts of engineering design, design methodology, economic analysis, present worth analysis, rate of return, payback period, cost estimation, cost analysis, equation fitting, solution of linear and nonlinear equation sets.

Design of Thermal Systems and Components: **[10 Hrs]**

Fundamentals of design and selection of heat exchangers, evaporators, condensers, boilers, cooling towers, binary mixture equipment and turbomachinery. System performance criteria and design standards.

Mathematical Modelling of Thermal Systems: **[8 Hrs]**

Model formulation, assumptions, development of governing equations, control-volume and distributed modelling, steady and transient modelling, numerical solution considerations.

Simulation of Thermal Systems: **[9 Hrs]**

Simulation methodology, system simulation vs component simulation, modular modeling, sequential modular and equation-oriented simulation, solving system-level models, applications to real-life thermal systems.

Optimization of Thermal Systems: **[10 Hrs]**

Fundamentals of optimum design, objective functions, constraints, search methods, Lagrange multipliers, linear and nonlinear optimization, numerical optimization strategies, optimization of selected thermal equipment, and system case studies.

Textbooks:

[1]	William F. Stoecker, *Design of Thermal Systems*, McGraw-Hill.
[2]	Jaluria Yogesh, *Design and Optimization of Thermal Systems*, CRC Press.
[3]	R. K. Shah & D. P. Sekulic, *Fundamentals of Heat Exchanger Design*, John Wiley & Sons

Reference Books:

[1]	J.P. Holman, *Heat Transfer*, McGraw-Hill.
[2]	Bejan A., *Advanced Engineering Thermodynamics*, Wiley.
[3]	Incropera & DeWitt, *Fundamentals of Heat and Mass Transfer*, Wiley.

REVERSE ENGINEERING

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Explain the fundamentals, scope, and applications of reverse engineering and product development.
2. Understand and apply techniques for the measurement and digitization of physical components.
3. Analyze design parameters, materials, manufacturing processes, and functional intent of existing products.
4. Develop 3D CAD models from physical parts using reverse engineering workflows.
5. Suggest improvements and redesign strategies for engineering products and assemblies.

Introduction to Reverse Engineering: **[6 Hrs]**

Definition, history, applications, ethics, reverse engineering workflow, comparison of forward vs reverse engineering. Product teardown and benchmarking.

Component Measurement & Inspection Methods: **[9 Hrs]**

Manual measurement tools, coordinate measurement machines (CMM), optical scanners, CT scanning, structured light scanning, surface digitization, accuracy and data processing.

3D CAD Reconstruction: **[9 Hrs]**

Point cloud processing, polygon mesh creation, surface reconstruction, parametric and free-form modeling, feature recognition, CAD modeling from scan data

Materials & Manufacturing Process Identification: **[7 Hrs]**

Material characterization methods, mechanical and thermal properties estimation, nondestructive testing, identifying manufacturing processes from geometry and surface features..

Product Function Analysis: **[7 Hrs]**

Functional decomposition, design intent recovery, tolerance analysis, assembly relationships, failure analysis, DFMA (Design for Manufacturing & Assembly) considerations.

Re-Design & Future Technologies: **[7 Hrs]**

Design improvement strategies, optimization basics, rapid prototyping, 3D printing, digital twins, generative design, use of AI and automation in reverse engineering.

Textbooks:

[1] Wego Wang, *Reverse Engineering: Technology of Reinvention*, CRC Press.

[2] Gideon Halevi, *Process and Operation Planning*, Springer.

[3] Ibrahim Zeid, *Mastering CAD/CAM*, McGraw Hill.

Reference Books:

[1] Vinesh Raja & Kiran J. Fernandes, *Reverse Engineering: An Industrial Perspective*, Springer.

[2] Kaushik Kumar, *Engineering Metrology and Measurements*, Wiley.

[3] M. Grujicic, *Rapid Prototyping and Engineering Applications*, Springer.

AEROSPACE ENGINEERING

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Explain the fundamentals of aerospace engineering, atmospheric properties, and vehicle performance.
2. Analyze basic aerodynamic forces, airfoil behavior, and aircraft performance parameters.
3. Identify the structure and functioning of aircraft components and flight control systems.
4. Explain the working principles of propulsion systems such as piston engines, gas turbines, and rocket propulsion.
5. Understand stability and control characteristics of aircraft and spacecraft.

Introduction to Aerospace Engineering & Flight Environment: **[6 Hrs]**

Evolution of aviation, classification of aircraft, spacecraft categories, atmosphere and its properties, International Standard Atmosphere (ISA), speed regimes (subsonic, transonic, supersonic, hypersonic).

Aerodynamics: **[9 Hrs]**

Basic aerodynamics principles, Bernoulli's equation, airfoil nomenclature, aerodynamic forces and moments, lift and drag forces, drag polar, boundary layer concepts, flow separation, high lift devices.

Aircraft Performance: **[8 Hrs]**

Level flight, climbing and gliding performance, range and endurance for jet and propeller aircraft, turning performance, take-off and landing performance.

Aircraft Structures & Materials: **[7 Hrs]**

Airframe components, wing, fuselage, tail design; loads and stresses; composite materials, fatigue and fracture, structural failure modes, aerospace material selection.

Propulsion Systems: **[8 Hrs]**

Internal combustion engines, turboprop and turbojet basics, turbofan thrust production, ramjet and scramjet principles, fundamentals of rocket propulsion.

Stability and Control / Space Systems Overview: **[7 Hrs]**

Static and dynamic stability, control surfaces, longitudinal and lateral stability. Introduction to spacecraft systems, orbit fundamentals, space missions.

Textbooks:

[1] Anderson J.D., *Introduction to Flight*, McGraw-Hill.
[2] Kermode A.C., *Mechanics of Flight*, Pearson Education.
[3] T.H.G. Megson, *Aircraft Structures for Engineering Students*, Butterworth-Heinemann

Reference Books:

[1] John D. Anderson, *Fundamentals of Aerodynamics*, McGraw-Hill.
[2] Sutton & Biblarz, *Rocket Propulsion Elements*, Wiley.
[3] Nelson R. C., *Flight Stability and Automatic Control*, McGraw-Hill.
[4] B. V. Mohan, *Aerospace Engineering Fundamentals*, Universities Press.

CONDITION MONITORING						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the concept of condition-based maintenance of plant, machinery, equipment and structures, etc., in online and offline mode
2. Understand the types of signals and sensors used to acquire vital health parameters of machineries to monitor changes that precede equipment failures.
3. Analyze the fault in the machinery like gear boxes, bearings and shafts by using a variety of monitoring techniques.
4. Interpret the data of rotating machinery and detect the onset of impending faults through vibration signature, acoustic emissions, thermography, oil-debris analysis, motor current signature analysis and /or several other NDT methods (Eddy Current Testing, Ultrasonic Testing, Radiography, etc.).
5. Understand the techniques and analyze electronic component heat generation, leak detection as an aid to condition monitoring.
6. Understand the techniques for the condition monitoring of the buildings, structures etc

Introduction to Condition Monitoring and Principles of Maintenance: **[5 Hrs]**

Machinery Condition Monitoring, Fault Diagnosis and Prognosis, Overview of Different Techniques of Condition Monitoring, Principles of Maintenance, Reactive, Preventive, Predictive Maintenance, Bath Tub Curve, Brief concept of Failure Modes Effects and Criticality Analysis (FMECA), RAMS standards (Reliability, Availability, Maintainability and Safety)

Digital Signal Processing and Instrumentation: **[6 Hrs]**

Introduction, Classification of Digital Signal Processing, Fundamentals of Fast Fourier Transform, Computer-Aided Data Acquisition, Signal Conditioning, Engine Vibration, Static and Dynamic Measurements, Frequency Response, Dynamic Range, Basic Measuring Equipment, Signal Amplifiers, RMS/Peak Meters, Oscilloscope, Signal Filter, etc., Laser-Based Measurements, Current Measurements, Chemical Composition Measurement, Data Recorders, etc.

Machinery Vibrations and Vibration Based CBM: **[10 Hrs]**

Introduction to Vibration, Forced Vibration Response, Characteristics of Vibrating Systems, Vibration of Continuous Systems, Experimental Modal Analysis, Mode Shapes and Operational Deflection Shapes, Rotodynamics, Unbalance Response and Critical Speed, Journal Bearings, Condition Monitoring in Large Rotor Systems Misalignment Detection, Eccentricity Detection, Cracked Shaft, Bowed and Bent Shaft, Rub, Looseness, Bearing Defects, Gear Faults, etc, and case studies thereof.

Noise Monitoring and Electrical Machinery Faults: **[7 Hrs]**

Introduction to Acoustical terminologies, Sound Pressure Level, A-Weighting, Sound Power Level, Sound Intensity Level, Octave Frequency Bands, Sound Fields, Near-Field Condition, FarField Condition, Anechoic/Reverberation Chamber, Noise Measurements, Acoustic Emission. Faults and fault detection in Electric Motors, Fault Detection in Electro-Mechanical Systems by MCSA, Relation between Vibration and Motor Current, Fault Detection in a Submersible Pumps, etc.

Thermography and Wear Debris Analysis **[7 Hrs]**

Introduction to Thermography, Thermal Imaging Devices: Optical Pyrometer, Infrared Cameras, Industrial Applications of Thermography in Condition Monitoring Electrical and Electronic Component Heat Generation, Leakage Detection, Introduction to Wear Debris Analysis, Mechanisms of Wear, Detection of Wear Particles, Common Wear Materials, Oil Sampling Technique, Oil Analysis, Limits of Oil Analysis, Other Methods: Eddy Current Testing, Ultrasonic Testing, Radiography, etc.

Cutting Tool Condition Monitoring: **[6 Hrs]**

Introduction, Tool Wear, Sensor Fusion in TCM, Sensors for Tool Condition Monitoring, Direct Tool Wear Measurements: Dimensional Deviation, Tool-Work Electric Resistance, Optical Sensors,

Force/ Torque Sensor, Vibration Sensor, Surface Roughness, Acoustic Emission Sensor, Use of IoT, ML, AI and Data analytics in condition monitoring and fault diagnosis, etc.	
Textbooks:	
[1]	Mohanty R A, Machinery, Condition Monitoring Principles and Practices, CRC Press, Taylor and Francis Group, (2015).
[2]	P Girdhar, Machinery vibration analysis and predictive maintenance, Elsevier Newnes Publications. (2004)
[3]	Collacott R.A., Mechanical fault diagnosis and condition monitoring, London: Chapman and Hall (1977).
[4]	Rao, B. K. N., Handbook of condition monitoring, Elsevier advanced technology, Oxford. (1996)
[5]	A Davis – Handbook of condition monitoring, London: Chapman and Hall. (1998)
Reference Books:	
[1]	R G Eisenmann et-al – Machinery malfunction diagnosis and correction, HewlettPackard professional books. (1997)
[2]	Robert Bond Randall, Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications (Google eBook) John Wiley & Sons. (2011)
[3]	Ron Barron, Engineering condition monitoring: practice, methods and applications, Longman, (1996)
[4]	E. D. Yardley, Condition Monitoring: Engineering the Practice, Wiley. (2002)

MATHEMATICAL MODELLING AND ANALYSIS OF THERMAL SYSTEM

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Develop mathematical models for thermal systems using physical laws, assumptions, and simplifying constraints.
2. Formulate and solve systems of ordinary and partial differential equations relevant to thermal engineering.
3. Analyze steady and unsteady heat transfer problems using analytical and numerical methods.
4. Apply lumped and distributed parameter modelling approaches to real engineering components.
5. Evaluate performance characteristics of thermal systems through simulation and sensitivity analysis.

Introduction to Mathematical Modeling of Thermal Systems:	**[6 Hrs]**
Need for modelling, classification of models, configuration of thermal systems, thermodynamic and heat transfer basics, formulation of governing equations.	
Model Development Using Conservation Laws:	**[8 Hrs]**
Control volume analysis, conservation of mass, momentum and energy, differential equations for thermal processes, assumptions and boundary conditions.	
Lumped & Distributed Parameter Systems:	**[8 Hrs]**
Biot and Fourier numbers, transient conduction models, system response using lumped modeling, conduction PDE formation for 1D–2D systems.	
Analytical & Approximate Solutions:	**[8 Hrs]**
Separation of variables, superposition method, integral method, usage of Heisler charts, introduction to similarity solutions, error estimation.	
Numerical Modelling Methods:	**[8 Hrs]**
Finite difference formulation for transient and steady conduction, stability and convergence, 1D explicit/implicit schemes, basic CFD concepts for convection modelling.	
System Simulation & Performance Evaluation:	**[8 Hrs]**
Thermal system modeling in engineering applications such as heat exchangers, HVAC systems, solar collectors and energy storage. Sensitivity analysis, optimization considerations.	

Textbooks:

[1]	Özisik, *Heat Conduction*, John Wiley & Sons.
[2]	Frank P. Incropera, *Fundamentals of Heat and Mass Transfer*, Wiley.
[3]	S. V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Hemisphere.

Reference Books:

[1]	Cengel & Ghajar, *Heat and Mass Transfer*, McGraw Hill.
[2]	Jaluria Yogesh, *Design and Optimization of Thermal Systems*, CRC Press.
[3]	Suhas V. Patankar & Spalding, *Mathematical & Computational Methods in Heat Transfer*, Hemisphere.
[4]	Holman J. P., *Heat Transfer*, McGraw-Hill.

PRODUCTION AND OPERATIONS MANAGEMENT						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the fundamentals, role, and strategic importance of production and operations management in engineering industries.
2. Analyze forecasting, capacity planning, facility layout, and production system types.
3. Evaluate inventory control models, material requirement planning (MRP), and supply chain operations.
4. Apply scheduling and work-study methods for productivity improvement.
5. Assess quality improvement tools, lean manufacturing concepts, and continuous improvement strategies.

Introduction to Production & Operations Management: [6 Hrs]

Definition, objectives, scope, functions and responsibilities of POM, manufacturing vs service operations, productivity and factors affecting productivity, decision making in operations.

Product Design & Process Planning: [7 Hrs]

Product life-cycle, value engineering and value analysis, selection of processes, process planning steps, process selection criteria, computer-aided process planning (CAPP), design for manufacturability.

Production System & Facility Planning: [8 Hrs]

Types of production systems (continuous, intermittent, project), plant location, factors affecting location, facility layout types (product, process, cellular and fixed layout), line balancing basics.

Forecasting, Capacity Planning & Scheduling: [8 Hrs]

Qualitative and quantitative forecasting methods, demand management, capacity measurement and strategies, aggregate planning, master production scheduling (MPS), Gantt charts, sequencing rules (FCFS, SPT, EDD etc.).

Inventory & Materials Management: [8 Hrs]

Types of inventory, EOQ model, reorder point, ABC/VED/FSN classification, material requirement planning (MRP), manufacturing resource planning (MRP-II), Just-In-Time (JIT), supply chain management basics.

Work Study, Quality Management & Lean Systems: [8 Hrs]

Method study, motion economy, work measurement, time study and PMTS systems, statistical quality control, TQM, Six Sigma, lean concepts, Kaizen, 5S, Poka-yoke, value stream mapping

Textbooks:

[1] Kanishka Bedi, *Production and Operations Management*, Oxford University Press.
[2] Norman Gaither & Greg Frazier, *Operations Management*, Cengage Learning.
[3] S.N. Chary, *Production and Operations Management*, McGraw Hill.

Reference Books:

[1] Jay Heizer & Barry Render, *Operations Management*, Pearson.
[2] Lee J. Krajewski, *Operations Management: Processes and Supply Chains*, Pearson.
[3] Elwood S. Buffa, *Modern Production/Operations Management*, Wiley.
[4] B.S. Goel, *Work Study and Industrial Engineering*, Pearson.

DESIGN OF DEFENSE EQUIPMENT						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the basic principles, operational requirements, and constraints in the design of defense equipment.
2. Analyze strength, reliability, survivability, and environmental factors influencing defense system design.
3. Explain the functioning and design considerations of small arms, armored vehicles, naval, and aerospace defense systems.
4. Evaluate materials, manufacturing methods and safety standards required for military-grade equipment.
5. Apply systems engineering and design methodology to develop conceptual designs for defense applications.

Introduction to Defense Equipment Design:	**[6 Hrs]**

Need and scope, defense system classifications (land, naval, air defense systems), operational and tactical requirements, design methodology.

Design Factors & Standards:	**[9 Hrs]**

Strength requirements, ballistic impact, blast resistance, fatigue and reliability, ergonomics, maintainability, environmental specifications (temperature, shock, vibration, corrosion). Introduction to MIL-STD and ISO standards.

Military Materials & Manufacturing:	**[8 Hrs]**

High-strength steels, armor composites, ceramics, smart materials, alloys used in missiles and aircraft; additive manufacturing in defense, joining technologies, and coatings..

Design of Small Arms & Ground Vehicles:	**[8 Hrs]**

Working principles of firearms, recoil mechanisms, barrel design, targeting systems. Armored vehicles, suspension systems, power transmission, weapon mounting, and survivability.

Defense Aerospace & Naval Systems:	**[8 Hrs]**

Missile and UAV structural requirements, stealth technology basics, electronic warfare components, naval vessel hull design fundamentals, and underwater weapon systems introduction.

Systems Engineering & Future Technologies:	**[6 Hrs]**

Conceptual design process, requirement flow down, risk assessment, testing & validation, digital twin & simulation environments, AI & robotics in defense systems.

Textbooks:

[1]	Sadraey M., *Aircraft Design: A Systems Engineering Approach*, Wiley.
[2]	Przemieniecki J. S., *Theory of Matrix Structural Analysis*, McGraw-Hill.
[3]	R.H. Kuhn, *Modern Weapons and Warfare*, Springer.

Reference Books:

[1]	George M. Chinn, *The Machine Gun* (Vol. I–V), U.S. Navy Publications.
[2]	Military Standards Compendium — MIL-STD-810H, MIL-STD-1472G (Ergonomics), MIL-STD-331.
[3]	Richard M. Ogorkiewicz, *Technology of Tanks*, Jane's Information Group.
[4]	Amitabh Bhattacharya, *Metallic and Ceramic Armor Materials*, CRC Press.

AUTOMATIC CONTROL SYSTEM

Course Code	<*tbd*>		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the basic contolconcepts, control actions and control systems.
2. Find the transfer function for linear, time-invariant mechanical systems and produce analogous electrical, thermal and fluid-flow circuits/systems.
3. Analyse quantitatively the transient response of first and second order systems.
4. Apply frequency response techniques for stability analysis.
5. Study of system in time & frequency domain and understand concept of stability.

Introduction to Automatic Control System : **[6 Hrs]**

Need of control system, Manual Vs. Automatic Control System, Advantages of Automatic Control System, Open Loop and Closed Loop Control System and their comparison, Concept of Feedback, Generalized Control System and concept of Transfer Function. Representation of Control System Components: Study of various types of control system components and their mathematical representation used in systems like Mechanical system, Electrical System, Thermal System, Fluid System, Grounded chair representation, Analogies,Block representation of System Elements, Block Diagram Algebra, Block Diagram Reduction

Transient Response Analysis: **[6 Hrs]**

Transient and Steady State Response Analysis: Introduction, Various types of standard input signals, First order response to Step, Ramp and Impulse Input, Response of second order system to step input, 8 System specifications, Concept of time constant and its importance in speed response, Effect of Damping ratio on response of Second Order System.

Control Action and Controllers: **[6 Hrs]**

Basic types of control action like ON/OFF, Proportional, Integral, Derivative type and their combinations (P,I,PI,PD and PID), Pneumatic and Hydraulic Controllers, Comparison of Pneumatic and Hydraulic Control System. Electrical Systems: Detail study of AC and DC Servo motors, Stepper motors, Servomechanism, Position Control System

Frequency Response Analysis and Root Locus Technique: **[6 Hrs]**

Stability analysis, System Stability and Routh's Stability Criteria, Relative Stability Concepts, Polar plots, Phase and Gain Margin, Stability analysis using Bode plots, Simplified Bode plot Root Locus Plots: Definition of Root loci, General Rules for constructing Root Locus, Analysis using Root Locus Plots, Use of MATLAB software in control system.

MATLAB, SIMULINK and LABVIEW: **[6 Hrs]**

Application of MATLAB in Automatic Control, Dynamic system simulation and PID control using MATLAB and SIMULINK, Introduction to LABVIEW

Digital Control: **[6 Hrs]**

Introduction to digital/computer-based measurement and control systems, Role of computers in process control, Basic components of computer based measurement and control system, sample and hold, ADC /DAC, Architecture of computer based control, Human Machine Interface (HMI), Interfacing computer system with process, Hardware and software of computer based process control system.

Textbooks:

[1]	Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India,5thEdition, 2010.
[2]	Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, 6th Edition, 2010.
[3]	Rudrapratap,"Getting srated with MATLAB",Oxford university press,12 th Edition,2009

Reference Books:

[1]	Francis H. Raven, "Automatic Control Engineering", TMH, 5th edition, 1994.

AI AND ML FOR MECHANICAL ENGINEERS

Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Demonstrate fundamentals of AI&ML, apply feature extraction and selection techniques
2. Apply machine learning algorithms for classification and regression problems
3. Devise and develop a machine learning model using various steps
4. Explain concepts of reinforced and deep learning
5. Simulate machine learning model in mechanical engineering problems

Introduction:	**[7 Hrs]**

History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Machine Learning Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning

Development of ML Model:	**[8 Hrs]**

Problem identification: Classification, Clustering, Regression, Ranking. Steps in ML modelling: Data Collection, Data pre-processing, Model Selection, Feature Extraction, Feature Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions

Feature Extraction and Selection:	**[7 Hrs]**

Feature extraction: Statistical features, Principal Component Analysis. Feature selection: Ranking, Decision tree - Entropy reduction & information gain, Exhaustive, best first, Greedy forward & backward

Classification & Regression Classification:	**[8 Hrs]**

Decision tree, Random forest, Naive Bayes, Support vector machine. Regression: Logistic Regression, Support Vector Regression. Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbour (KNN)

Deep & Reinforced Learning:	**[7 Hrs]**

Introduction to Deep learning: Artificial neural networks, Deep neural networks, Convolutional neural network, Recurrent neural network, Long short term memory LSTM, Auto encoder (AE), Dip belief network, Generative adversarial network, Extreme learning machine, Deep residual network. Introduction to reinforced learning: Motivation, background, characteristics, Algorithms for control learning: Criterion of optimality, Brute force, Value function, direct policy search, Model-based algorithms, Associative reinforcement learning, Deep reinforcement learning, Inverse reinforcement learning, Safe Reinforcement Learning, Partially Supervised Reinforcement Learning (PSRL)

Advanced & Recent Techniques:	**[8 Hrs]**

Pitfalls of traditional ML models, Data expansion and augmentation, Adversarial Machine learning (AML), Domain generalization and adaptation, Transfer Learning (TL), Explainable AI (XAI), Digital Twin (DT), Multi-models, Multi-agent adaptation, Self-paced learning

Textbooks:

[1]	Tom M. Mitchell, "Machine Learning", McGraw-Hill, 1997
[2]	ShaiShalev-Shwartz and Shai Ben-David, "Understanding Machine Learning", Cambridge University Press, 2017.
[3]	Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012
[4]	P. Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data. First Edition", Cambridge University Press, 2012.

AUTOMOTIVE CONTROL SYSTEMS						
Course Code	*<tbd>*		**Examination Scheme**			
Teaching Scheme	3-0-0-0		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	ISE: --	ESE: --	--

Course Outcomes: Students will be able to:

1. Understand the process of controller development in automotive applications.
2. Understand the basics of powertrain controls (engine and motor control).
3. Gain an overall understanding of vehicle control systems (dynamics).
4. Simulate and design the behavior of automotive control systems using contemporary software tools and communicate the outcomes of such studies

Vehicle Electronics and Microcontrollers: **[6 Hrs]**

Vehicle Electronics: Semiconductor diodes, FETs, Rectifiers, Small signal amplifiers, OPAMPs and Automotive applications and case studies. Introduction to modern computer logic, Programming inputs and outputs, Interrupts and system design, Typical controllers used in vehicles

Sensors, Actuators, and Signal Conditioning: **[6 Hrs]**

Types of sensors & Actuators, Sensors & Actuators calibration and Signal attenuation, shielding etc.,

Engine Control & Calibration: **[6 Hrs]**

Control Systems Overview, Control Strategies – Gasoline & Diesel, Open and closed loop control strategies, Components for electronic engine management system, Digital Engine Control System, Open loop and close loop control system, Calibration Process & Equipment, Calibration Techniques such as: Cranking, Warm Up, Idle & Idle Stability, Open Loop & Closed Loop, Steady State, Transients, EGR Control, Phased Injection, Calibration for Drivability, Performance & Emissions, Adaptive Control Strategies, Fail-Safe Scenarios. Engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control.

Vehicle Communication and Networking: **[6 Hrs]**

Various networks used, topology etc., Basic architecture of CAN systems, Security protocols and vulnerabilities

EMC/EMI and Diagnostics: **[6 Hrs]**

Electromagnetic Compatibility (EMC) / Interference (EMI): Basics of EMC / EMI, Component segregation, cable routing etc., Grounding, shielding, common impedance coupling, Classification of EMC environments, EMC test methods. **Diagnostics:** Overview of diagnostic, OBD1, OBD2 Protocols, Fault isolation, Types of diagnostic, tools used, Scope of Diagnostic, case study.

Advanced Vehicle Control and Intelligent Systems: **[6 Hrs]**

Automotive Control Systems: Transmission and powertrain control system, Brake control systems - ABS, EBD, Traction control systems. **Intelligent Vehicle Systems & ADAS:** In-vehicle electronic sensors, Future of automotive electronics & control, Active Cruise Control & Adaptive Systems, Electronic dash board instruments.

Textbooks:

[1]	U Kiencke, L Nielsen, “Automotive Control Systems for Engine, Driveline, and Vehicle”, Springer.
[2]	Ronald K. Jurgen, “Automotive Electronics Handbook”, McGraw-Hill, Inc.
[3]	Tao, F., Cheng, Y., & Zhang, M. - Digital Twin Driven Smart Manufacturing (Elsevier)
[4]	Alasdair Gilchrist - Industry 4.0: The Industrial Internet of Things

Reference Books:

[1]	Allan W.M. Bonnick, “Automotive Computer Controlled systems, Diagnostic tools and techniques”
[2]	Bechfold, Understanding Automotive electronics, SAE, 1998.
[3]	William, B. Ribbens, Understanding Automotive electronics, ButterWorth Heinemann 1998.