Bharati Vidyapeeth
(Deemed to be University)
College of Engineering, Pune
Department of Mechanical Engineering

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- *To provide quality technical education with advanced equipment, qualified faculty members, and infrastructure to meet the needs of the profession & society.*
- *To provide an environment conducive to innovation, creativity, research, and entrepreneurial leadership.*
- *To practice and promote professional ethics, transparency, and accountability for the social community, economic & environmental conditions.*

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- *Experienced recruiting faculty.*
- *Organizing faculty development programs.*
- *Identifying socio-economically relevant areas & emerging technologies.*
- *Constant review & upgradation of curricula.*
- *Upgradation of laboratories, library & communication facilities.*
- *Collaboration with industry and research & development organizations.*
- *Sharing of knowledge, infrastructure, and resources.*
- *Training, extension, testing, and consultancy services.*
- *Promoting interdisciplinary research.*

The vision of the Mechanical Engineering Department is:

To develop high-quality Mechanical Engineers through dynamic education to meet social and global challenges.

Mission Statements of the Mechanical Engineering Department are:

- *To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.*
- *To inculcate aptitude for research, innovation, and entrepreneurial qualities in students.*
- *To acquaint students with ethical, social, and professional responsibilities to adapt to the demands of the working environment.*

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- *To fulfill the needs of industry and society with theoretical and practical knowledge.*
- *To engage in research, innovation, lifelong learning, and continued professional development.*
- *To fulfill professional ethics and social responsibilities.*

Knowledge and Attitude Profile (WK)

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

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

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

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

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

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

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

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

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

PROGRAM OUTCOMES

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

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

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

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

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

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

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

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

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

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

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

Statements of Program Specific Outcomes (PSOs)

PSO1: Use the knowledge of thermal, design, manufacturing engineering, and computational sciences to solve Mechanical Engineering problems.

PSO2: Use Mechanical Engineering principles for research, innovation, and develop entrepreneurial skills.

B. TECH. MECHANICAL: COURSE STRUCTURE: CBCS: 2021

B. Tech. Mechanical Sem.-V

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	UE	IA	TW	OR	PR	Total	L	P TW/OR/PR	T	Total
1	C301	Heat Transfer-Principles & Applications	4	2	-	60	40	25	-	--	125	4	1	-	5
2	C302	Turbo Machinery	4	2	-	60	40	25	25	-	150	4	1	-	5
3	C303	Hybrid & Electric Vehicles@	4	-	-	60	40	-	-	-	100	4	-	-	4
4	C304	Computer-Integrated Manufacturing	3	2	-	60	40	25	25	-	150	3	1	-	4
5	C305	Machine Design & Analysis -II*	3	2	1	60	40	25	-	-	125	3	1	1	5
6	C306	Vocational Course-III $	-	2	-	-	-	25	25	-	50	-	1	-	1
7	C307	Computer-Oriented Numerical Methods	-	2	-	-	-	25	-	25	50	-	1	-	1
	Total		**18**	**12**	**1**	**300**	**200**	**150**	**75**	**25**	**750**	**18**	**06**	**1**	**25**
8	C308	Environmental Studies+	2	-	-	50	-	-	-	-	50	-	-	-	-
9	C309	Social Activity-II**	-	-	-	-	-	-		-	-	-	-	-	2

*End Sem. Examination of 4 Hrs. @Industry Taught Course-III; $Logistics & Stores Management; +Mandatory Audit Course; ** Add-on Course

B. Tech. Mechanical Sem.-VI

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	UE	IA	TW	OR	PR	Total	L	P TW/OR/PR	T	Total
1	C310	Introduction to CFD & FEA	4	2	-	60	40	25	-	25	150	4	1	-	5
2	C311	Refrigeration & Air Conditioning	3	2	1	60	40	25	25	-	150	3	1	1	5
3	C312	Industrial Engineering & Management@	3	-	-	60	40	-	-	-	100	3	-	-	3
4	C313	Quantitative Techniques, Communication & Values	4	0	-	60	40	-	-	-	100	4	-	-	4
5	C314	Mechanical System Design*	4	2	-	60	40	25	25	-	150	4	1	-	5
6	C315	Vocational Course-IV$	-	2	-	-	-	25	-	25	50	-	1	-	1
7	C316	Introduction to Data Science	-	4	-	-	-	25	-	25	50	-	2	-	2
	Total		**18**	**12**	**1**	**300**	**200**	**125**	**50**	**75**	**750**	**18**	**6**	**1**	**25**
8	C317	MOOC-II**	-	-	-	-	-	-	-	-	-	-	-	-	2

*End Sem. Examination of 4 Hrs.; @Industry Taught Course-IV; $Refrigeration & Air Conditioning Systems Maintenance; ** Add-on Course

B. Tech. Mechanical
Sem.-V

HEAT TRANSFER- PRINCIPLES AND APPLICATIONS

(Course No. C301)

Designation of Course	**Heat Transfer-Principles and Applications**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End-of-Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**05**

Course Prerequisites: -	The students should know of 1. Fundamentals of Thermodynamics Principles and Applications. 2. Fundamentals of Fluid Mechanics.
Course Objectives:-	1. To provide the knowledge of basic principles and applications of heat transfer. 2. Analyze the performance of heat transfer equipment 3. Use principles in the different heat transfer applications
Course Outcomes: -	On completion of the course, students will be able to – 1. Explain the fundamental concepts of heat transfer and apply them to **solve** real-life engineering problems. 2. Formulate and evaluate one-dimensional steady-state heat conduction problems using appropriate analytical methods. 3. Develop and analyze mathematical models for extended surfaces and evaluate transient (unsteady) heat conduction problems. 4. Examine and compare heat transfer processes under forced and natural convection conditions. 5. Explain and apply the principles of thermal radiation to analyze practical heat transfer systems. 6. Evaluate the performance of various types of heat exchangers and **assess** the effects of phase-change heat transfer processes such as condensation and boiling.

Course Contents

Unit I	**Basic Concepts of Heat Transfer**	**(08 Hrs.)**
Overview of subject, Modes of heat transfer, Applications of heat transfer in different fields of engineering, Fourier's law of conduction, Newton's law of cooling, Stefan- Boltzmann's law of radiation, Isotropic and anisotropic materials, Three dimensional heat conduction equation in Cartesian coordinate for anisotropic material for steady state condition, and reduction to Fourier equation, Laplace equation and Poisson's equation, Three dimensional heat conduction equation in cylindrical and spherical coordinates (no derivation), Thermal diffusivity. Purpose of insulation, critical radius of Insulation, Economic thickness of Insulation, Thermal contact resistance, thermal conductivity, and its variation with temperature for metals, non-metallic solids, gases, and liquids, and one-dimensional problems of variable thermal conductivity.		
Unit II	**One-dimensional steady-state heat conduction**	**(08 Hrs.)**

One-dimensional steady state heat conduction through a plane wall, cylindrical wall, and sphere. Analogy between heat flow and electricity, heat conduction through a composite slab, cylinder, and sphere, Overall heat transfer coefficient, Concept of thermal resistance and conductance. Symmetrical boundary condition in a plane wall, conduction in a solid, hollow cylinder, and sphere, and practical problems of heat generation.		
Unit III	**Extended Surfaces and Unsteady Heat Conduction**	**(08 Hrs.)**
Extended surfaces: Heat transfer through extended surfaces, Classification of fins, Derivation of differential equation for fins with constant cross-sectional area with insulated tip boundary conditions, Effectiveness and efficiency of a fin, design of thermo well. **Unsteady Heat Conduction**: System with negligible internal resistance, Biot & Fourier numbers, Criteria for neglecting internal temperature gradient, Concept of time constant		
Unit IV	**Convection**	**(08 Hrs.)**
Introduction to hydrodynamic**,** thermal boundary layer, Laminar & turbulent flow over & closed conductors, convection heat transfer coefficients & order of magnitude, Dimensional analysis of free & forced convection, physical significance of the dimensionless, parameters, Nusselt's number, Reynolds' number, Prandtl's number, Grashof's number, Stanton number, Rayleigh number. **Forced Convection:** Empirical correlations for heat transfer in laminar and turbulent flow over a flat plate and in a circular pipe, Concept of hydraulic diameter, reference temperature. **Natural Convection:** Flow patterns, Empirical correlations for free convection, heat transfer over horizontal, vertical plates.		
Unit V	**Thermal Radiation**	**(08 Hrs.)**
Fundamental principles - Gray, White, Opaque, Transparent, and Black bodies, Spectral emissive power, Wien's, Rayleigh-Jeans' and Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws, View factor, Net radiation exchange in a two-body enclosure, Typical examples for these enclosures, Radiation Shield.		
Unit VI	**Heat Exchangers**	**(08 Hrs.)**
Classification, Applications of heat exchangers, Heat exchanger analysis, Logarithmic Mean Temperature Difference for parallel and counter flow heat exchangers, LMTD correction factors, fouling factor. The effectiveness: NTU method for parallel and counter flow heat exchangers, design considerations for heat exchangers. Film and drop-wise condensation, heat transfer coefficient for laminar film condensation on vertical and inclined plate (descriptive treatment), Correlations for condensation on and inside tubes, modes of pool boiling, critical heat flux, pool boiling.		

Term Work

Any ten experiments from the following:

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of a metal rod.
3. Determination of thermal conductivity of different materials in the composite wall.
4. Temperature distribution along the length of a fin and determination of fin effectiveness and fin efficiencies.
5. Determination of film heat transfer coefficient on a hollow vertical tube heated from inside.
6. Determination of film heat transfer coefficient for turbulent flow inside a pipe.
7. Determination of the emissivity of a non-black surface.
8. Determination of Stefan-Boltzmann constant.
9. Performance of a parallel flow and counter flow heat exchanger.
10. Calibration of the thermocouple.

11. Demonstration of a heat pipe.

Project-Based Learning

1. Demonstration of conduction heat transfer through a Plane Slab
2. Demonstration of conduction heat transfer through Composite Slab/ Sphere/ Cylinder.
3. Demonstration of different types of fins
4. Demonstration of Natural Convection mode heat transfer
5. Demonstration of forced Convection mode heat transfer
6. Demonstration of radiation mode heat transfer
7. Design of a heat exchanger for domestic application

Reference Books

1. Incropera F. P., Dewitt D. P., "Fundamentals of Heat and Mass Transfer", John Wiley.
2. Cengel Y. A. and Ghajar A. J., "Heat and Mass Transfer – Fundamentals and Applications", Tata McGraw-Hill Education Private Limited.
3. Holman J. P., "Fundamentals of Heat and Mass Transfer", McGraw–Hill publication.
4. Mills A. F., "Basic Heat and Mass Transfer", Pearson

Textbooks

1. Sukhatme S. P., "A Textbook on Heat Transfer", Universities Press.
2. Nag P. K., "Heat & Mass Transfer", McGraw-Hill Education Private Limited.
3. Thirumaleshwar M., "Fundamentals of Heat and Mass Transfer", Pearson Education India.
4. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age Science
5. S. C. Arora, S. Domkundwar," A Course in Heat and Mass Transfer" Dhanpat Rai & Co
6. Introduction to Heat Transfer - S. K. Som

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

TURBO MACHINERY
(Course No. C302)

Designation of Course	**Turbo Machinery**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites: -	The students should know of 1. Fundamentals of Thermodynamics: Principles and Applications. 2. Fundamentals of Fluid Mechanics.
Course Objectives:-	1. To provide knowledge of basic principles and applications of turbo machinery. 2. Analyze the performance of turbo machines. 3. Use thermodynamics and kinematics principles to turbo machines.
Course Outcomes: -	On completion of the course, students will be able to – 1. Explain the fundamental concepts of heat transfer and apply them to solve real-life engineering problems. 2. Formulate and evaluate one-dimensional steady-state heat conduction problems using appropriate analytical methods. 3. Develop and analyze mathematical models for extended surfaces and evaluate transient (unsteady) heat conduction problems. 4. Examine and compare heat transfer processes under forced and natural convection conditions. 5. Explain and apply the principles of thermal radiation to analyze practical heat transfer systems. 6. Evaluate the performance of various types of heat exchangers and **assess** the effects of phase-change heat transfer processes such as condensation and boiling.

Course Contents

Unit I	**Impact of Free Jets**	**(08 Hrs.)**
Impulse-momentum principle, fixed and moving flat plates, curved vanes, with jet striking at the center of the vane and jet striking tangentially onto the vane, Impact of jet on hinged plates, Impact of jets on a series of flat plates and vanes, water wheels, velocity triangles and their analysis, work done and efficiency calculations.		
Unit II	**Impulse Water Turbines**	**(08 Hrs.)**
Main components and constructional features of Pelton wheel, Concept of centrifugal head, general energy equation for turbine, Velocity diagrams and analysis, Important non-dimensional parameters such as speed ratio, jet ratio, flow ratio, Condition for maximum hydraulic efficiency, working Proportion of Pelton wheel, Design of Pelton turbine runner, Performance characteristics.		
Unit III	**Reaction Water Turbines**	**(08 Hrs.)**
Classifications, Construction and working of Francis, Propeller, Kaplan Turbines, construction features, velocity diagrams and analysis, working proportion of Francis, Propeller, Kaplan Turbines, Degree of reaction (DOR), draft tubes- types and analysis, cavitation causes and remedies, specific speed, performance characteristics and governing of reaction turbines, selection of turbines.		

Unit IV	Centrifugal Pumps	(08 Hrs.)
Centrifugal Pumps: Classification, components of centrifugal pump, various terms associated with centrifugal pump, various heads, velocity triangle and their analysis, effect of outlet blade angle, cavitation, NPSH, Thomas Cavitation factor, priming of pumps, installation, specific speed, Performance characteristics of centrifugal pump, Axial thrust, maintenance, trouble and remedies, series and parallel operation of pumps system, water hammer problem in pumping system, selection of pumps.		
Unit V	**Reciprocating Pumps**	**(08 Hrs.)**
Reciprocating Pumps: Classification, Main Components, Working of Single and double acting reciprocating pumps, discharge, work done, and Power required to drive the reciprocating pump, coefficient of discharge and slip of Reciprocating Pumps, Energy analysis, Performance characteristics.		
Unit VI	**Rotary Air Compressor**	**(08 Hrs.)**
Centrifugal Compressor: Classification, Construction, flow process on T-S Diagram, velocity diagram, Euler's work, slip factor, and its effect on work input, actual work input. Axial Flow Compressor: Construction, stage velocity triangles and their analysis, enthalpy-entropy diagram, Degree of reaction, flow through the blade rows, pressure rise across the stage, stage losses and efficiencies, performance characteristics		

Term Work

Any ten experiments from the following:

1. Study and application of impulse momentum principle.
2. Study and trial on a Pelton wheel and plotting of main/operating characteristics.
3. Study and trial on a Francis turbine and plotting of main/operating characteristics.
4. Study and trial on a Kaplan turbine and plotting of main/operating characteristics
5. Study and trial on a Centrifugal pump and plotting of operating / and variable speed characteristics.
6. Study and trial on the reciprocating Pump.
7. Study of axial flow compressors/ centrifugal air blower.
8. Assembly and disassembly of pumps.
9. Trial on centrifugal air compressor.
10. Design of a complete pumping system installation using standard tables, charts supplied by pump manufacturers.
11. Visit to Hydroelectric power stations and write a report based on the visit.
12. Visit to water pumping station and write a report based on the visit.

Reference Books

1. Maneesh Dubey, BVSSS Prasad, Archan Nema, “Turbomachinery”, Tata-McGraw Hill.
2. S.M. Yahya, “Turbines, Compressors & Fans”, Tata-McGraw Hill.
3. B. U. Pai, “Turbomachines”, Wiley India.
4. Dr. Onkar Singh, “Thermal Turbo machines”, Wiley India.

Textbooks

1. P. N. Modi and Dr. S. M. Seth, “Hydraulics and Fluid Mechanics”, Standard Book House, New Delhi.
2. R. K. Rajput, “Hydraulic Machines”, S. Chand Publishers, New Delhi.
3. R. K. Bansal, “Fluid Mechanics and Hydraulic Machines”, Laxmi Publications (P) LTD.
4. S.C. Gupta, “Fluid Mechanics & Hydraulic Machines”, Pearson Education.

Project-based learning

Demonstration model of

1. water wheel with flat blades
2. water wheel with curved blades
3. Pelton wheel
4. Francis's turbines
5. Propeller turbines
6. Kaplan Turbines
7. Rotary compressor
8. Preliminary design of Centrifugal pump- single stage/multistage.
9. Reciprocating pump.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

HYBRID AND ELECTRIC VEHICLES

(Course No. C303)

Designation of Course	**Hybrid and Electric Vehicles**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End-of-Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- --Hours/ Week	Term Work	-- Marks	--
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**04**

Course Prerequisites: -	The students should know of 1. Basics of Internal combustion engines, 2. Electrical and electronics engineering
Course Objectives:-	To study the basic concepts of 1. Hybrid Electric Vehicles, Vehicle Performance, and their drive trains. 2. Electric Vehicle Architecture design and different energy storage systems. 3. Electric Drives, Energy Management Strategies, and INDIAN and GLOBAL Scenario
Course Outcomes: -	On completion of the course, students will be able to – 1.Explain the fundamentals of hybrid and electric vehicles and evaluate their performance characteristics. 2.Analyze the concepts and configurations of hybrid electric drive trains for various vehicle applications. 3.Design and assess the architecture of electric vehicles considering component integration and system requirements. 4.Compare and evaluate different energy storage systems used in electric and hybrid vehicles. 5.Examine the construction and working principles of electric drives and analyze their performance under different operating conditions. 6.Evaluate various energy management strategies and **assess** the Indian and global electric mobility scenario**.**

Course Contents

Unit I	**Introduction to Hybrid, Electric Vehicles**	**(08 Hrs.)**
History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels, EV Terminology. Configurations of Electric Vehicles: Performance of Electric Vehicles, Traction Motor Characteristics, Tractive Effort and Transmission Requirement: Vehicle Performance.		
Unit II	**Drive Trains**	**(08 Hrs.)**
Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains, Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains.		
Unit III	**Electric Vehicle Architecture Design**	**(08 Hrs.)**

Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar-based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV, Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power-operated Electric vehicles		
Unit IV	**Types of Storage Systems**	**(08 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)		
Unit V	**Electric Drives**	**(08 Hrs.)**
Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, and 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.		
Unit VI	**Energy Management Strategies: Global Scenario**	**(08 Hrs.)**
Introduction, classification of energy management strategies, comparison of different energy management strategies, and implementation issues of energy management strategies. Introduction to various charging techniques and a schematic of charging stations. Technology Scenario, Market Scenario, Policies and Regulations, Payback, and commercial model, Payback, and commercial model, Polices in India		

Project-Based Learning

Following is the list of Topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart on the Components of an Electric Vehicle.
2. To prepare a demonstration model of electric Vehicle terminology.
3. To prepare a demonstration model of Series Hybrid Electric Drive Trains.
4. To prepare a demonstration model of Parallel Hybrid Electric Drive Trains.
5. To prepare a demonstration model of
6. To prepare a demonstration model of a Photovoltaic solar-based electric Vehicle design / Battery Electric vehicle (BEV)
7. Preparing a chart on Types of Storage Systems
8. Preparing a demonstration model of Storage Systems
9. To prepare a demonstration model of the Configuration and control of DC Motor drives/Induction Motor drives/ Permanent Magnet Motor drives.
10. To prepare a chart on energy management strategies used in hybrid and electric vehicles.
11. Preparing a chart on the comparison of different energy management strategies
12. To prepare a chart on the INDIAN and GLOBAL Scenario

Reference Books:

1. James Larminie, J. Lowry, “Electric Vehicle Technology Explained”, 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.
5. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design"
6. Chris MI, M. Abul, and David Wenzhong Gao "Hybrid Electrical Vehicle Principles and Application with Practical Perspectives"

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

COMPUTER INTEGRATED MANUFACTURING

(Course No. C304)

Designation of Course	**Computer-Integrated Manufacturing**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End-of-Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites: -	The student should have basic knowledge of 1. Manufacturing Processes.
Course Objectives: -	1. To acquire the knowledge of Machining Processes and CNC technology. 2. To acquire knowledge of Additive manufacturing processes and Computer integration for Manufacturing. 3. To acquire knowledge of Flexible Manufacturing Systems and Computer-Aided Process Planning.
Course Outcomes: -	On completion of the course, students will be able to: 1. Explain various manufacturing processes and apply suitable processes for product development. 2. Develop CNC part programs and execute them for the manufacturing of components. 3. Analyze different Additive Manufacturing (AM) techniques and fabricate components using suitable AM processes. 4. Illustrate the concept of Computer Integrated Manufacturing (CIM) and apply its elements in manufacturing systems. 5. Examine the components of Flexible Manufacturing Systems (FMS) and integrate them for efficient production. 6. Design a Computer-Aided Process Plan (CAPP) and implement it for manufacturing applications.

Course Contents

Unit I	**Machining Processes**	**(06 Hrs.)**
Mechanical Processes: Ultrasonic machining (USM), Abrasive Jet Machining (AJM), Water Jet machining (WJM), Abrasive water Jet Machining (AWJM) processes-Process principle and mechanism of material removal, Process Parameters, Applications, Operational characteristics; Limitations. **Electrochemical Processes:** Electrochemical Machining Process (ECM) principle; Mechanism of material removal; Process Parameters; Process Capabilities; Applications, Tool Design, Electrochemical Deburring (ECDE). **Thermal Processes:** Electro discharge Machine (EDM), Wire Electro Discharge Machining (WEDM), Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma Arc machining (PAM) processes–Process principle and mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy, Applications; Limitations.		
Unit II	**CNC Technology**	**(06 Hrs.)**

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning Centre, machining Centre, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Programming: Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming,		
Machining cycles, programming for the machining Centre and the turning Centre for well-known controllers such as Fanuc, Siemens. Introduction to CMM.		
Unit III	**Additive Manufacturing**	**(06 Hrs.)**
Introduction to Additive Manufacturing (AM): Need for Additive Manufacturing, Generic AM process, Distinction between AM and CNC, Classification of AM Processes, Steps in AM process, Advantages of AM, Major Applications. **Vat Photopolymerization AM Processes:** Stereolithography (SL), Materials, SL resin curing process, Micro-stereolithography, Process Benefits and Drawbacks, Applications of Photopolymerization Processes. **Extrusion-Based AM Processes:** Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.		
Unit IV	**Computer Integration for Manufacturing**	**(06 Hrs.)**
Manufacturing Systems: Concept Objectives, Types and Trends; Concepts of Mechanization, Automation and Integration. Concept of CAD/CAM and CIMS; Software Technology for CIM System: Business Database System: File processing, Data Processing and Database Design, File Organization and Relational Analysis; Decision Support System, Personal/Distributed Computing and Local Area Network.		
Unit V	**Flexible Manufacturing Systems**	**(06 Hrs.)**
Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS, and Automatic parts identification systems and data capture.		
Unit VI	**Computer-Aided Process Planning**	**(06 Hrs.)**
Process Planning and Production Planning, Manual Experience-based planning, Decision tables and decision trees, Process capability analysis, Variant and Generative process planning approach, Process planning systems like CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN, and PRO, CPPP. Introduction to total integrated process planning systems.		

Term Work

1. Study and demonstration of the EDM Machine.
2. Study and demonstration of the ECM Machine.
3. Manual part programming using G and M codes for turning, Step turning, Taper turning, and turning facing.
4. Manual part programming using G and M codes for Drilling.
5. Components manufacturing on a CNC machine.
6. CNC Milling program involving linear motion and circular interpolation.
7. A study on the group technology method utilized in FMS
8. Measurements of geometric parameters of parts using a Coordinate Measuring Machine (CMM).
9. Manufacturing of Component using Additive Manufacturing Technique
10. Generating G and M code using DelCAM and MasterCAM
11. Simulation of Tool using DelCAM and MasterCAM.

Textbooks:

1. P. C. Sharma, Production Engineering, S. Chand Publications
2. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw-Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technology, Vol- II, McGraw-Hill Education (India) Private Limited
3. Tai ran Hsu, "MEMS & Microsystem: Design & Manufacture", Tata McGraw Hill Publisher, 2002.
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
5. Julian W. Gardner & Vijay K. Varadan, "Microsensors, MEMS and smart Devices", John Wiley & Sons, 2001.
6. Roy A. Lindberg, Process & Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Black, and A. Kosher, Material and processes in manufacturing, PHI
8. HMT Handbook, Production Technology, TMH
9. Ian Gibson, David W Rosen, Brent Stucker. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
10. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.
11. S. R. Deb. "Robotics", Tata McGraw-Hill Publishing Co. Ltd., ISBN 0-07-460090-
12. M. P. Grover, M. Weiss, R. N. Nagel, N. G. Odrey, "Industrial Robotics Technology", ISBN 0-07-100442-
13. Computer Integrated Manufacturing and Engineering- U. Rembold, Addison-Wesley Publishers, 1993 edition.
14. Quick Responsive Manufacturing – Rajan Suri, Productivity Press, 1998.
15. Principles of computer-integrated manufacturing- S, Kant Vajpayee, PHI Learning Private Limited, New Delhi, 2012.

Project-Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Make a Working model of non-conventional machining processes
2. To show the use of controllers for CNC applications
3. Select an Industrial drawing, prepare a CNC program, and implement it on the CNC.
4. Make a Prototype Model for a Tool Changer for CNC.
5. Make a Prototype Model for Clamping and decamping of the job on the CNC
6. Make a model using additive Manufacturing
7. Prepare a process plan for the industrial component
8. Make models for an automated storage and retrieval system
9. Prepare system for automatic part identification and data capture
10. Prepare Process Plan for industrial components.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

MACHINE DESIGN AND ANALYSIS-II
(Course No. C305)

Designation of Course	**Machine Design and Analysis-II**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 03 Hours/ Week	End-of-Semester Examination	60 Marks	04
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**05**

Course Prerequisites: -	The students should know of 1. Computer-Aided Drafting and Visualization 2. Computer-Aided Machine Drawing 3. Strength of Machine Components 4. Machine Design and Analysis-I
Course Objectives: -	1. To study basic concepts of the design of machine elements. 2. Impart design skills for the students to use these skills for the problems in real-life industrial applications. 3. To enable students to attain the basic knowledge required to interpret, analyze, design, and select the machine elements required in transmission systems
Course Outcomes: -	On completion of the course, students will be able to: 1. Apply the principles of spur gear design to solve complex engineering problems. 2. Analyze the design parameters of helical gears for effective power transmission in engineering applications. 3. Evaluate the design aspects of bevel and worm gears to optimize mechanical performance. 4. Develop the ability to analyze and select suitable rolling contact bearings based on performance requirements and manufacturer's data. 5. Design and evaluate sliding contact bearings considering industrial operating conditions and lubrication requirements. 6. Design and select appropriate belt, rope, and chain drives for efficient power transmission in mechanical systems.

Course Contents

Unit I	**Design of Spur Gears**	**(06 Hrs.)**
Introduction to gears: Gear Selection, material selection, Basic modes of tooth failure, Gear Lubrication Methods, Introduction to Gear design standards like AGMA, IS. **Spur Gears:** Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation.		
Unit II	**Design of Helical Gears**	**(06 Hrs.)**
Transverse & normal module, virtual number of teeth, Force analysis, Beam & wear strength, Effective load on gear tooth, Estimation of dynamic load by velocity factor, Spott's equation, Buckingham's equation. (No numerical on force analysis of helical Gear)		
Unit III	**Design of Bevel Gears and Worm Gears**	**(06 Hrs.)**

Bevel Gears-Introduction, Terminology, Virtual number of teeth, and force analysis of Straight Bevel Gear. Design of Straight Bevel Gear based on Beam Strength, Wear Strength, and estimation of effective load based on Velocity factor (Barth factor) and Buckingham's equation. **Worm Gears**–Introduction, terminology and proportions of worm and worm gears, Force analysis of worm gear drives, Friction in Worm gears, efficiency of worm gears, Strength and wear ratings of worm gears (Bending stress factor, speed factor, surface stress factor, zone factor)		
Unit IV	**Rolling Contact Bearing**	**(06 Hrs.)**
Equivalent bearing load, Load life relationship, Selection of bearing life, Selection from manufacturer's catalogue, Design for cyclic load & speed, Bearing with probability of survival other than 90%, Lubrication & mounting, construction materials, Selection of oil seals & gaskets, Types of failure of bearings and their remedies. Taper roller bearing: Force analysis and selection criteria. (Theoretical Treatment only)		
Unit V	**Sliding Contact Bearing**	**(06 Hrs.)**
Basic modes for lubrication, Viscosity, Effect of temperature on viscosity, Viscosity index, Additives, Greases, and Selection of lubricants. Viscous flow through rectangular slot, Load carrying capacity & flow requirement of hydrostatic step bearing, Energy losses, Hydrodynamic lubrication, Reynolds equation, Summerfield number, Raimondi & Boyd's method, Parameters of bearing design, Length to diameter ratio, Unit bearing pressure, Radial clearance, Minimum oil film thickness, Constructional details of bearings, Bearing materials & their selection, Comparison of rolling& sliding contact bearing.		
Unit VI	**Belt, Rope, and Chain Drives**	**(06 Hrs.)**
Belt drive: Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition, Selection of Flat and V-belts from manufacturer's catalogue, belt tensioning methods, relative advantages and limitations of Flat and V-belts, **Wire Ropes** (Theoretical Treatment Only): Construction of wire ropes, lay of wire rope, stresses in wire rope, and selection of wire ropes. **Chain Drives** (Theoretical Treatment Only): Types of chains and their Geometry, selection criteria for chain drives, Polygon effect of chain, Modes of failure for chain, Lubrication of chains		

Term work

Term work shall consist of the following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Design Project on a single-stage Spur gear box design
2. Design of a single-stage helical Gearbox
3. Calculation of the module for the bevel gear
4. Calculation of the module for the worm gear
5. Selection of Bearing by using the manufacturer's catalogue
6. Calculation of belt drive parameters

Assignment

Numerical and/or theory questions on the following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Spur Gears
2. Helical Gears
3. Bevel and Worm Gears
4. Rolling Contact Bearing
5. Sliding Contact Bearing
6. Belt, Rope, and Chain Drive

Note: The Design Data Book should be used extensively.

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To develop an Industrial/real-life application demonstration model of different types of Gears.
2. To develop a demonstration model for any practical applications where spur gears are used.
3. To design the gearbox for a windmill application.
4. To design the in-line gearbox for an Automobile application
5. To design the gearbox for building an Elevator.
6. To design the gearbox for building a Hoist.
7. To design the gearbox for the Worm gearbox for the Sugar Industry.
8. To develop a demonstration model for any one practical application where helical gears are used.
9. To develop a demonstration model for any one practical application where bevel gears are used.
10. To develop a demonstration model for any practical applications where worms and worm gears are used.
11. To observe the mechanical system where transmission of power or motions takes place through gears. By selecting suitable materials, design the gears. To prepare a design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare a bill of materials using any CAD software.
12. To develop demonstration models of different types of bearings.
13. Case study on Selection of Bearing from Manufacturer's Catalogue.
14. Case study Mounting of machine elements on transmission shaft (like Bearings, gears, pulleys, sprockets, etc.).
15. To observe the mechanical system where different types of bearings are used.

Textbooks

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publication Co. Ltd.
2. R. S. Khurmi and J.K. Gupta "Machine Design", S Chand Publication.
3. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", McGraw-Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., "Design of Machine Elements", Prentice Hall International.

Reference Books

1. Black, P.H. and O. Eugene Adams, "Machine Design", McGraw-Hill Book Co. Inc.
2. Willium C. Orthwein, "Machine Components Design", West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G., "Theory and Problems of Machine Design", Schaum's Outline Series.
4. Sharma C. S. and Purohit Kamlesh, "Design of Machine Elements", PHI Learning Pvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., "Machine Design", S.K. Kataria and Sons
6. Gope P. C., "Machine Design: Fundamentals and Applications", PHI Learning Pvt. Ltd.
7. "Design Data- P. S. G." College of Technology, Coimbatore.
8. V. B. Bhandari, "Design Data Book", Tata McGraw-Hill Publication Co. Ltd.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

VOCATIONAL COURSE III: LOGISTICS & STORES MANAGEMENT
(Course No. C306)

Designation of Course	**Vocational Course III: Logistics & Stores Management**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - -- Hours/ Week	End-of-Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	02
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**02**

Course Prerequisites:-	The student should have 1. Inclination for taking up Logistics & Stores Management as a Professional Career option or as a self-employment occupation. 2. Computer literacy
Course Objectives:-	1. Aware of the Logistics & Stores Functions in any industry. 2. Improve their self-confidence, in the interview process and further in their training/working in any industry's stores and/or logistics departments. 3. Aware of various store layouts
Course Outcomes:-	On completion of the course, students will be able to: 1. Identify and classify different types of stores and warehouses applicable to various industries. 2. Interpret and apply Standard Operating Procedures (SOPs) for effective store management. 3. Design appropriate store layouts and supporting infrastructure to ensure efficient operations. 4. Analyze various types of stores and evaluate warehouse distribution strategies. 5. Formulate and solve inventory management problems using suitable techniques 6. Integrate modern technologies and operate hybrid computerized systems in trade and industry.

Course Contents

Unit I	**Introduction to logistics**	**(04 Hrs.)**
Introduction to Logistics & Stores Management. It's History, importance in Industry/Trade/Agriculture, etc. Types of Logistics Activities. Types of Stores/Warehouses, etc.		
Unit II	**Fundamentals of stores**	**(04 Hrs.)**
Various types of stores and their differentiation: E-Com Stores, Big Retail Stores, Factory Stores, Distribution Warehouses, Libraries, etc..		
Unit III	**Store Layout and Infrastructure**	**(04 Hrs.)**
Introduction to store layout and store infrastructure: Various Material Storage Systems, Material Handling Systems, various tools & gadgets used in stores, safety processes for stores, etc.		
Unit IV	**Store Management**	**(04 Hrs.)**
Introduction to Stores Management. Basics of Stores Management. Various Activities carried out in a store (general awareness). Various types of stores in an industry. Various SOPs in store management.		
Unit V	**Inventory Management**	**(04 Hrs.)**

Introduction to Inventory Management, its Importance (General Awareness). Methods of Inventory Management, FIFO/LIFO, and Documentation for Inventory Management, Inventory Verification Processes, what is Inventory Reconciliation & its methodology, etc. Inventory Replenishment & Methods adopted for the same.

Unit VI	**Advancements in Logistics Technology**	**(04 Hrs.)**
Transportation & Logistics. What is First Mile/Second Mile/ Last Mile Logistics/Delivery? Importance of Logistics & Transport in Modern Trade. Advancements & improvements due to the use of new technologies & Hybrid Computerized Systems in modern trade and industry. Brief intro to WMS-ERP, etc.		

Term Work

1. Physical Introduction to a Store, an actual visit to an industrial store or a College Library, which is a classic example of book storage, within college premises.
2. Stores Layout Study
3. Introduction to various Material Handling Equipment, Material Storage Systems, and tools + gadgets used in stores. For Example: Forklift, Stacker & Pallet Trucks, various types of Racking Systems, Various types of Pallets & Bins, Weighing machines, packaging tools, etc.
4. Introduction to stores processes/activities, like:
5. Receiving: Unloading, stacking, receiving documentation, offering to QC & finally sending to the main stores area.
6. Storage of materials in various designated locations.
7. Issues: Receive issue list, check availability of various items/parts, prepare pick list, actual pick-up, compile at issue place, Issue documentation.
8. Dispatch: Prepare dispatch documentation, actual dispatch through the vehicle, etc.
9. Industrial, multi-location store visits. (Total 2 industry visits)
10. Actual working in a Store / Library for Inventory Management Study.
11. Visit a Commercial store, like Big Bazar, to observe their layout, storage methods, etc.
12. Self-study Assignment: Visit any 2 big commercial stores & note down observations and compare the stores.
13. Know various common, printed documents/formats used in industrial stores
14. Introduction to various specialty stores, like: Cold Storage, Hazardous Chemicals, Paints & Fuel Storage, Fertilizers & Grains Stores, Silos for Grains, Open Yards for Steel Coils & Heavy Items, Bonded Goods Stores, etc.

Textbooks:

1. Supply Chain Management by Janat Shah.
2. Logistics Management by S. K. Bhattacharya S. Chand

Reference Book

1. Operations Management by Heizer and Render.
2. Supply Chain Management by Chopra and Meindl.
3. Operations Management by Evans and Collier

COMPUTER-ORIENTED NUMERICAL METHODS

(Course No. C307)

Designation of Course	**Computer-Oriented Numerical Methods**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites:-	The students should know of 1. Basic Mathematics 2. Programming Language
Course Objectives:-	1. The goal of the course is for students to develop techniques for problem-solving using a numerical method.
Course Outcomes:-	On completion of the course, students will be able to: 1. Apply numerical methods to determine the roots of single-variable equations. 2. Solve systems of simultaneous linear equations using suitable numerical techniques. 3. Analyze datasets and perform curve fitting to obtain empirical relationships. 4. Estimate unknown values using appropriate interpolation methods. 5. Compute numerical integration of functions using standard techniques. 6. Formulate and solve ordinary differential equations using numerical approaches.

Course Contents

Unit I	**Roots of equations**	**(04 Hrs.)**
Bracketing methods-Bisection and False Position method		
Unit II	**Linear Algebraic Equation:**	**(04 Hrs.)**
Naive Gauss elimination, pitfalls of Gauss Elimination, techniques of improving solutions		
Unit III	**Curve Fitting:**	**(04 Hrs.)**
Least-Squares Regression-Linear regression		
Unit IV	**Interpolation**	**(04 Hrs.)**
Newton's Forward and Backward Interpolation		
Unit V	**Numerical Integration**	**(04 Hrs.)**
Trapezoidal rule, Simson's 1/3 and 3/8 rule		
Unit VI	**Ordinary Differential Equations**	**(04 Hrs.)**
Ordinary Differential Equations: Euler's method		

Term work

1. Term work shall consist of any eight programs described in the syllabus and listed below.
2. Program on Bisection Method
3. Program on False Position Method
4. Program on the Gaussian Method
5. Program on Curve fitting by the least square method
6. Program on Newton’s Forward Method

7. Program on Newton’s Backward Method
8. Program on Trapezoidal RuleProgram on Simpson’s 1/3rd rule
9. Program on Simpson’s 3/8th rule
10. Program on Euler’s Method.

Textbooks/ Reference Books

1. Numerical Methods for Engineers, Steven Chapra and Raymond Canale, McGraw-Hill
2. Ordinary Differential Equations**:** Euler's method, improvement of Euler's method, Runge-Kutta method, system of equations, B. S. Garewal, Khanna Publisher
3. Numerical Recipes: The art of scientific computing, William H Press, Cambridge University Press
11.

B. Tech. Mechanical
Sem.-VI

INTRODUCTION TO CFD AND FEA
(Course No. C310)

Designation of Course	**Introduction to CFD and FEA**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites:-	The students should know of 1. Engineering Mathematics 2. Engineering Mechanics 3. Strength of Materials 4. Heat Transfer 5. Fluid Mechanics 6. Mechanical Vibration
Course Objectives:-	1. Analyze a physical problem 2. Develop finite element procedures for accurately investigating the problem and effectively performing and documenting findings. 3. Solve 1D, 2D, and dynamic problems using the Finite Element Analysis approach 4. Provide knowledge to solve complex fluid flow problems using computational fluid dynamics. 5. Familiar with modern trends in computational fluid dynamics
Course Outcomes:-	On successful completion of this course, students will be able to: 1. Formulate and derive governing equations by analyzing flow physics and evaluating their mathematical behavior. 2. Design and optimize computational grids by employing advanced meshing tools and techniques to enhance solution accuracy. 3. Implement appropriate turbulence and multiphase flow models, critically assess their assumptions, and analyze flow behavior using simulation results. 4. Develop and apply Rayleigh–Ritz, Galerkin, and weighted residual methods to solve complex engineering problems, and justify the selection and role of shape functions in finite element formulations. 5. Construct and validate element stiffness matrices and load vectors using the principle of minimum potential energy for one- and two-dimensional problems. 6. Derive and implement shape functions for bar, rectangular, and higher-order elements, and employ numerical techniques to perform integration and evaluate eigenvalues and eigenvectors for structural systems.

Course Contents

Unit I	**Governing Equations in CFD**	**(08 Hrs.)**

Philosophy of CFD, Governing equations of fluid dynamics and their physical meaning, Simple CFD techniques, Upwind and Downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Steady and transient solutions, Introduction to FVM and FDM.		
Unit II	**Meshing in CFD**	**(08 Hrs.)**
Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering, and quality checks for volume mesh. Adaptive, Moving, and Hybrid Grids, Need for adaptive and moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination.		
Unit III	**Introduction to Turbulence Modeling & Multi-Phase Flows**	**(08 Hrs.)**
Introduction and background of Turbulence Modeling, Algebraic models, One equation model, Two equation models, Near wall treatment, Reynolds stress models, Introduction to multi-phase flows		
Unit IV	**Introduction to FEA**	**(08 Hrs.)**
Introduction to FEM, Stress-strain relations, shape functions- linear and quadratic, Triangular, Quadrilateral, Higher order elements, Variational methods of approximation-Rayleigh Ritz Method, Methods of Weighted Residuals-Least Square Method, Subdomain Method, Collocation Method, Garlekin's method.		
Unit V	**One-Dimensional Problems**	**(08 Hrs.)**
Finite element modeling, Convergence of results, Potential energy approach, Global stiffness matrix, properties of stiffness matrix, load vector, Penalty approach, Elimination approach, Finite Element Analysis of a 2-D truss structure and a constant-strain triangle.		
Unit VI	**Isoparametric Elements**	**(08 Hrs.)**
Isoparametric formulation – Natural Co-ordinate system, Lagrangian interpolation polynomials, Isoperimetric element, Numerical Integration Newton Cotes formula, Gauss Quadrature formula in two and three dimensions, triangular elements, rectangular elements. Dynamic Analysis, Formulation of Dynamic problems, Consistent and Lumped Mass Matrices. Solution of Eigenvalue Problems. Transformation Method, Jacobi Method, Vector Iteration Method, Subspace Iteration Method.		

Term Work

The term work shall consist of

1. Four computer program assignments to be developed for FEA. (Using any programming language.)
2. Two assignments on structural and modal analysis using FEA Software
3. Two assignments on fluid flow analysis using CFD software.
4. Two assignments on solid thermal analysis using CFD software.
5. Two assignments on structural plus thermal analysis using CFD software.

Textbooks/ Reference Books

1. K. J. Bathe, “Finite Element Procedures”, PHI
2. R. D. Cook, D. S. Malus, M. E. Plesha, “Concepts and Applications of Finite Element Method Analysis”, John Wiley
3. J. N. Reddy, “An Introduction to Finite Element Method Analysis”, MGH
4. Desai & Abel, “Introduction to Finite Element Methods”
5. D. L. Logan, “A course in the Finite Element Method”, Third Edition, Thomson Learning
6. T. R. Chandrupatia, A. D. Belegundu, “Introduction to Finite Elements in

Engineering", Third Edition, PHI
7. John D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw-Hill, 1995
8. V. V. Ranade, "Computational Flow Modeling for Chemical Reactor Engineering", Process Engineering Science, Volume 5, 2001
9. Patrick Knupp and Stanly Steinberg, "Fundamentals of Grid Generation", CRC Press, 1994
10. D. C. Wilcox, "Turbulence Modelling for CFD", 1993
11. Pieter Wesseling, "An Introduction to Multigrid Methods", John Wiley & Sons, 1992
12. J. F. Thompson, Z. U., A. Warsi and C. W. Mastin, "Numerical Grid Generation: Foundations and Applications", North Holland, 1985
13. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", McGraw-Hill,1981
14. Thomas B. Gatski, M. Yousuff Hussaini, John L. Lumley, "Simulation and Modelling of Turbulent Flows", Eds., Oxford University Press, 1996
15. Laney, C. B., "Computational Gas Dynamics", Cambridge Uni. Press, 1998

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Structural analysis of any mechanical component.
2. Thermal analysis of any mechanical component.
3. Modal analysis of any mechanical component.
4. Heat transfer & fluid flow analysis using various models.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

REFRIGERATION AND AIR CONDITIONING
(Course No. C311)

Designation of Course	**Refrigeration and Air Conditioning**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- 01Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites:-	The students should know of 1. Fundamentals of Thermodynamics: Principles and Applications. 2. Fundamentals of Heat Transfer.
Course Objectives	1. To provide the knowledge of basic principles and applications of RAC **2.** Analyze the performance of Refrigeration and A/C systems.
Course Outcomes:-	On completion of the course, the students will be able to: 1. Explain the working principles and methods of various refrigeration systems. 2. Evaluate the performance of simple vapor compression refrigeration systems. 3. Compare and optimize different multi-pressure refrigeration systems. 4. Examine and apply various psychrometric processes in air conditioning systems. 5. Identify and appraise the functions of components used in refrigeration and air conditioning systems. 6. Design and assess air distribution systems for effective thermal comfort.

Course Contents

Unit I	**Methods of Refrigeration**	**(06 Hrs.)**
Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapor refrigeration system, steam jet refrigeration system, refrigeration by using liquid gases, Thermoelectric, and ultrasound refrigeration. **Air refrigeration system:** Definition, refrigeration load, unit of refrigeration, Introduction to heat pump, Reverse Carnot cycle, Bell Coleman cycle, Methods of air refrigeration systems, simple air-cooling system, boot strap system, reduced ambient system, regenerative system.		
Unit II	**Simple Vapor Compression Systems**	**(06 Hrs.)**
Limitations of air refrigeration systems, development of the vapor compressor cycle, effect of operating parameters on VCC, use of P-H charts, and actual vapor compression cycle. **Refrigerants:** Desirable properties of refrigerants, classification of refrigerants, secondary refrigerants, alternative refrigerants for CFCs, HCFC, ozone depletion potential (ODP), Global warming Potential (GWP).		
Unit III	**Multi-pressure Vapor compression system, Vapor absorption systems**	**(06 Hrs.)**

Multi-Pressure Systems: Introduction to multistage compression, two-stage compression with flash gas removal, with liquid intercooler, and Cascade systems. **Vapor absorption systems** Introduction, Simple Vapor absorption system, Practical Vapor absorption system, COP of an ideal vapor absorption system, Water ammonia system, Electrolux refrigerator, Lithium-Bromide absorption System, Comparison between VCC and VAC (no mathematical treatment).		
Unit IV	**Psychrometry and Human Comfort**	**(06 Hrs.)**
Introduction, Psychrometric terms, Use of Psychrometric charts, Psychrometric processes, adiabatic saturation temperature, evaporative cooling, bypass factor of coil, efficiency of coil, adiabatic mixing of two air streams, Air washers, Thermodynamics of human body with environment effective temperature, comfort chart, factors influencing human comfort.		
Unit V	**Air Conditioning Systems and Components**	**(06 Hrs.)**
Definition, factors, equipment used, classification, all air systems, all water systems, air water system, unitary and central air conditioning, in filtration and ventilation loads, concepts of SHF, RSHF, ERSHF, ADP. Compressors, condensers, evaporators, expansion devices such as capillary tubes, automatic expansion valves, thermostatic expansion valves, and controls such as thermostats, humidistats, and solenoids. Installation, charging, testing, and maintenance, study of modern trends in RAC		
Unit VI	**Air distribution system**	**(06 Hrs.)**
Introduction, classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct, friction losses, dynamic losses, air flow through a simple duct system, equivalent diameter, for the determination of duct size **Food Preservation:** Cold storage, control, and modified atmosphere (CAMA) storage, mobile refrigeration and air conditioning, refrigerant piping selection, pressure drop, valves, fittings, and insulating materials.		

Term Work

Any ten experiments from the following:

1. Test on the Computerized vapor compression test rig
2. Test on the Computerized air conditioning test rig
3. Test on the Computerized ice plant test rig.
4. Study of non-conventional refrigeration systems.
5. Determination of cooling load of air conditioning system (case study).
6. Determination of refrigeration load in cold storage (case study/visit).
7. Study of installation /operation/maintenance practices for the refrigeration system.
8. Visit any refrigeration or air conditioning plant.
9. Trial on the Computerized heat pump test rig
10. Test on the vapor absorption test rig.
11. Market survey of various components of refrigerating& air conditioning systems.
12. Determination of energy efficiency of refrigeration or air conditioning system.

Reference Books

1. Dossat Ray I, “Principal of Refrigeration”, Wiley Eastern Limited
2. Stocker W. F. and Jones J. W., “Refrigeration and Air Conditioning”, McGraw-Hill

Textbooks

1. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw-Hill
2. Arora S. C., Domkundwar S., “Refrigeration and Air Conditioning”, Dhanpat Rai and Company

3. Khurmi R. S. and Gupta J. K., “Refrigeration and Air Conditioning”, S Chand Publication

Project-Based Learning

1. Demonstration models of non-convection refrigeration systems
2. Demonstration models of a conventional system for domestic application
3. Demonstration models of vapor absorption systems
4. Finding applications of RAC
5. Demonstration models of air conditioning systems
6. Load calculations for any application
7. Design of duct and calculation of losses in ducts
8. Study of modern trends in RAC
9. Assembly and disassembly of RAC components.
10. Preliminary design of refrigeration system for real-life problems.
11. Preliminary design of an air conditioning system for real-life problems.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

12.

INDUSTRIAL ENGINEERING & MANAGEMENT
(Course No. C312)

Designation of Course	**Industrial Engineering & Management**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week	Term Work	-- Marks	--
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:-	The student should have basic knowledge of 1. Basic concept of Management 2. Basic information of Industrial Engineering 3. Man-machine interaction.
Course Objectives	1. The student should interpret the scope, objective, and application of industrial engineering tools and management practices in manufacturing.
Course Outcomes:-	On completion of the course, students will be able to: 1. Analyze the definitions, principles, and functions of management to determine their applicability in organizational settings. 2. Evaluate various organizational structures and forms of business organizations to recommend suitable structures for specific organizational contexts. 3. Examine the interrelationships and functions of the Production, Personnel, Marketing, and Finance departments to enhance organizational efficiency. 4. Apply method study tools to design and standardize efficient work methods for improved productivity. 5. Apply work measurement techniques to determine and standardize time for effective operations management. 6. Assess the significance of ergonomics, safety, and industrial laws to ensure compliance and promote a safe manufacturing environment.

Course Contents

Unit I	**Introduction to Industrial Management**	**(06 Hrs.)**
Management- Meaning and Definitions, Management, Administration, and Organization concepts, Management as an Art and Science and a profession, contribution of various thinkers to management thought, Types and Functions of Management. Different approaches to management – scientific, operational, human, and system approaches.		
Unit II	**Industrial Organization**	**(06 Hrs.)**
Different forms of business Organization –Individual proprietorship, Partnership, Joint stock company, Co-Operative enterprise, Public Sector, Undertakings, organizational structures in Industries, Line, Functional, Line and functional, Project, Matrix Organization, and Committees		
Unit III	**Departments of Industrial Management**	**(06 Hrs.)**
Production Management: Production/Operations Management, Materials / SCM & Logistics Management, Maintenance & Plant Engg. Planning, R&D, Quality Management. Personnel Management-Definitions: Recruitment, Selection, and training of the employees, Job valuation and Merit rating, wage administration, different methods of wage payments, incentives.		

Marketing Management-Definitions, Marketing and Selling concept, market segmentation, distribution channels, Market Research, Advertising and sales promotion, and Sales forecasting. Financial Management-Capital structure, Fixed capital, working capital, sources of finance, cost analysis, Break-even analysis, Depreciation, and financial statement		
Unit IV	**Method Study**	**(06 Hrs.)**
Steps in method study, tools and techniques used, process chart symbols, flow diagrams, two-handed chart, multiple activity chart, use of motion pictures, and their analysis. SIMO charts, chorno & cycle graph, developing, presentation, installation, and maintenance of improved methods. Layouts Planning, Workflow Planning, Work Balancing for multi-person assembly/production lines.		
Unit V	**Work Measurement**	**(06 Hrs.)**
Time Study: Aim and objectives, terminology and tools, use of stopwatch procedure in making a time study, elements, selection of operations time study forms, handling of foreign elements. Performance rating. Allowances: Personal, Fatigue, and other allowances. Analysis and calculation of Standard Time. Determination of the number of cycles study for indirect functions such as Maintenance, Marketing, etc., Most Technique. Works Sampling: Definition, Objectives, and Theory of Work Sampling. Other applications of work sampling, errors in the work sampling study. Synthetic and Standard data Methods: Concepts, introduction to PMTS, MTM-1, WF, Basic motion time, MTM-2, and other second–generation methods, timing of group operations.		
Unit VI	**Industrial Engineering Tools**	**(06 Hrs.)**
Ergonomics: Definitions, importance in industry, basic anatomy of the human body, anthropometrics, biomechanical factors, and environmental effects. Industrial Safety: Importance of safety, planning, training, safety precautions, safety equipment, and Government regulations on safety. Industrial Acts: Factory Act, AIR Act, Boiler Act, Workers Compensation Act. Kaizen, Kanban, 5S, Poke-Yoke, Cross-functional team, The 5 M's of Lean, TQM		

Textbooks

1. O. P. Khanna, Industrial Engineering & Management, Dhanapat Rai & Sons.
2. M. C. Shukla, Business Organization and Management, S. Chand & Co. Ltd, New Delhi.
3. Harold Koontz & Heinz Enrich, Essentials of Management, McGraw-Hill International.
4. M. N. Mishra, Organizational Behavior, Vikas Publishing, New Delhi.
5. Dale Yoder, Personnel Management.
6. Work Study, ILO.
7. S. S. Patil, Industrial Engineering & Management, Electro Tech Publication.
8. Mansoor Ali &Dalela, Industrial Engineering & Management System, Standard Publisher distributions.
9. R. M. Currie, Work Study, ELBS.
10. Management by James A. F. Stoner, R. Edward Freeman, PHI

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

QUANTITATIVE TECHNIQUES, COMMUNICATION, AND VALUES
(Course No. C313)

Designation of Course	Quantitative Techniques, Communication, and Values		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week	Term Work	-- Marks	01
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**04**

Course Prerequisites:-	The student should have basic knowledge of 1. Basic math and reasoning, and comprehensive ability 2. Basic knowledge of the communication process, soft skills 3. Basic knowledge and idea about leaders and leadership qualities, ethics, etiquette, and values
Course Objectives:-	The Quantitative Techniques, Communication, and Values aim to help students face the campus recruitment test and train them on using short techniques/ tricks to solve questions of Mathematics, reasoning, and English in a very short amount of time. The communication and values section focuses on the aspects of communication and soft skills, such as grooming personality for leading a team, presentation, and business communication, which would enable graduates to project themselves as professionals in the corporate sector and/or otherwise.
Course Outcomes:-	On successful completion of the course, the students will be able to: 1. Apply analytical and quantitative reasoning techniques to solve aptitude problems efficiently during recruitment and competitive examinations. 2. Employ logical reasoning strategies and utilize mnemonic techniques to analyze and solve reasoning questions within limited time frames. 3. Develop and demonstrate effective verbal communication skills using appropriate vocabulary, grammar, and sentence structures. 4. Interpret and evaluate the principles of soft skills and assess their implications for professional effectiveness in the workplace. 5. Compose and analyze various forms of business correspondence demonstrating clarity, coherence, and appropriate professional tone. 6. Examine and integrate concepts of business ethics, etiquette, and professional values in decision-making and workplace practices.

Course Contents

Unit I	**Quantitative Aptitude**	**(06 Hrs.)**
Number system, Percentage, profit and loss, Simple Interest and Compound Interest, Ratio, Proportion and Average, Mixture and Allegation, Time, Speed & Distance, Time & Work, Permutation & Combination, Probability, Pipes and Cisterns.		
Unit II	**Non-Verbal Reasoning**	**(06 Hrs.)**
Coding, Decoding, Number series, Blood relation Directions, cubes & dices, Data Interpretation, Data Sufficiency, Set Theory & Syllogisms, Matching, Selection & Arrangement, Clocks & Calendars, Visual Reasoning, Input, Output & Flow Chart.		
Unit III	**Verbal Reasoning**	**(06 Hrs.)**

Sentence Patterns, Sentence correction and spotting errors, Vocabulary, antonyms, and synonyms and analogy, Phrasal Verbs, idiomatic expressions, reading comprehension, closest, sentence rearrangement, and theme detection		
Unit IV	**Self-Awareness And Soft Skills Development**	**(06 Hrs.)**
Concept of SWOT, Importance of SWOT, Individual & Organizational SWOT Analysis, Soft skills, meaning, need and importance, difference between soft skills and hard skills, life skills and personal skills, Leadership skills,-Importance, Types, Attributes of good leader Motivational theories and leadership, Emotional intelligence in personal and professional lives its importance need and application, Team Building and conflict resolution Skills, Problem solving skills, Time Management and Stress Management Skills Pareto Principle(80/20) Rule in time management, Time management matrix, Creativity and result orientation, working under pressure, stress management.		
Unit V	**Communication and Honing Employment Skills**	**(06 Hrs.)**
Communication process, Non-verbal codes in communication, importance of LSRW in communication, Barriers to communication, Principles of effective Technical writing, Email writing and Netiquettes, Letter writing – formal letters, job application letter, cover letter, structure of technical report writing, Building Resume and CV, Tips to build an effective Resume Group discussion, Skills required for Group Discussion Interview skills, Ways of handling telephonic interviews, Importance of body language, grooming &etiquettes for getting right impression in PI&GD, Extempore, Introduction to PowerPoint presentation, Structure & flow of presentation.		
Unit VI	**Business Ethics, Etiquettes, and Values**	**(06 Hrs.)**
The Importance of Ethics and Values in the Business World, Respect for Individuality and Diversity at the Workplace, Values of a Good Manager, Key Features of Corporate Etiquette, Corporate Grooming & Dressing, Etiquettes in Social & Office Setting-Interpret the importance of professional behavior at the workplace, Corporate Social Responsibility (CSR), its importance and need.		

Project-Based Learning

1. Prepare mock Tests on Unit I and solve them in the given time (use of PSD lab manual)
2. Prepare mock Tests on Unit I and solve them in the given time (use of PSD lab manual)
3. Prepare an online model test based on Unit-II and solve it within a specific time (use of PSD lab manual)
4. Prepare an online model test based on Unit-II and solve it within a specific time (use of PSD lab manual)
5. Form a model for spoken and written communication skills that avoid grammar mistakes and common errors
6. Develop various activity models for enriching and developing vocabulary
7. Preparing strategies by using SWOT and TWOS analysis
8. Analyzing differences between Soft Skills, Hard Skills, and Personal Skills
9. Develop Bruce Tuckman's Team Building Models with classmates/Teammates
10. To study different personalities of Leaders from various sectors and find out their attributes and success stories
11. Preparing a model for Time Management Skills and Stress Management and conducting activities for effective implementation of it.
12. Form a model to develop LSRW and communication Skills
13. Conduct a mock interview and practice GD activities to build competencies for the actual selection process

14. Preparing a model for evaluating the Values and Ethics of Good Managers
15. Preparing a model of dress codes and attire for different professional situations, Corporate Etiquettes, and their implications
16. Develop some good activities to interpret the importance and need of Corporate Social Responsibility (CSR)

Reference Books

1. Quantitative Aptitude by R. S. Agarwal, published by S. Chand
2. The Book of Numbers by Shakuntala Devi
3. A Modern Approach to Logical Reasoning by R. S. Agarwal, published by S. Chand
4. A New Approach to Reasoning Verbal & Non-Verbal by Indu Sijwali
   Business Communication by Meenakshi Raman, Prakash Singh, published by Oxford University Press, second edition
5. Communication Skills by Sanjay Kumar, Pushp Lata, published by Oxford University Press, second edition
6. Technical Communication by Meenakshi Raman, Sangeeta Sharma, published by Oxford University Press
7. Developing Communication Skills by Krishna Mohan, Meera Banerji published by Macmillan India Pvt Ltd
8. Soft Skills by Meenkashi Raman, published by Cengage Publishers
9. Soft Skills by Dr. K Alex, published by Oxford University Press
10. Soft Skills for Managers by Dr. T. Kalyana Chakravarthi and Dr. T. Latha Chakravarthi, published by Biztantra

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

MECHANICAL SYSTEM DESIGN
(Course No. C314)

Designation of Course	**Mechanical System Design**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- -- Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites:-	The students should know of 1. Statics and dynamics 2. Computer-Aided Machine Drawing 3. Machine design & Analysis I & II 4. Theory of the machine
Course Objectives:-	To provide the knowledge of 1. To study basic concepts of vibration analysis 2. To acquaint oneself with the principles of vibration-measuring instruments 3. To develop competency for system visualization and design. 4. To enable students to design pressure vessels and to use the IS code. 5. Introducing students to optimum design and using optimization methods to design mechanical components.
Course Outcomes:-	On successful completion of the course, the students will be able to: 1. Analyze the characteristics of free undamped single-degree-of-freedom (SDOF) systems and evaluate key vibration parameters. 2. Examine forced vibration in single-degree-of-freedom systems and determine the transmissibility and critical speed of rotating shafts. 3. Develop mathematical models of multi-degree-of-freedom (MDOF) vibration systems and analyze them to determine natural frequencies and mode shapes. 4. Analyze the stress distribution in various components of pressure vessels and design different types of pressure vessels based on strength and safety criteria. 5. Design the layout of machine tool gearboxes and compute the speed ratios at each stage using ray diagrams. 6. Formulate optimum design strategies based on standard specifications and apply optimization techniques to various machine components.

Course Contents

Unit I	**Free Undamped Single Degree of Freedom Vibration System**	**(08 Hrs.)**
Vibration classification, Steps involved in vibration analysis, Longitudinal, transverse, Torsional Vibration System, Methods for formulation of differential equations by Newton, Energy, and Rayleigh's Method.		
Unit II	**Forced Single Degree of Freedom Vibratory System**	**(08 Hrs.)**
Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper). Vibration Isolation and Transmissibility Force Transmissibility, Motion Transmissibility Typical isolators& Mounts Rotor Dynamics: Critical speed of single rotor, undamped and damped.		

Unit III	Free Undamped and Damped Vibration System	(08 Hrs.)
Viscous damped system – under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping; Combined viscous and Coulomb's damping. Two rotors, three rotors, and a geared system; Dunkerley's and Rayleigh's method for a transverse vibratory system. Vibration Measurement: Vibration measuring devices: Accelerometers, Vibration exciters, FFT analyzer. Introduction to signal analysis: Time domain & Frequency domain analysis of signals. Noise measurement		
Unit IV	**Pressure Vessels**	**(08 Hrs.)**
Introduction, Classification of Pressure Vessels, Stresses in a Thin Cylindrical Shell due to an Internal Pressure, Circumferential or Hoop Stress, Longitudinal Stress, Thin Spherical Shells Subjected to an Internal Pressure, Thick Cylindrical Shell Subjected to an Internal Pressure, Compound Cylindrical Shells, Stresses in Compound Cylindrical Shells, Cylinder Heads and Cover Plates, Auto-frettage.		
Unit V	**Design of Machine Tool Gearbox**	**(08 Hrs.)**
Introduction to machine tool gear boxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, deviation diagram, difference between The number of teeth of successive gears in a gearbox.		
Unit VI	**Optimum Design**	**(08 Hrs.)**
Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations, and limit equations. Frequency Distribution-Histogram and frequency polygon, normal distribution-units of central tendency and dispersion – standard deviation- population combinations, statistical analysis of tolerances, mechanical reliability and factors of safety.		

Term Work

Part A (Any 4)

1. To determine the natural frequency of the damp vibration of a single degree of freedom system and to find its damping coefficient.
2. To obtain frequency response curves of a single degree of freedom system of vibration for different amounts of damping
3. Free vibration of a simply supported beam
4. Free Vibration of a Two-DOF System
5. Forced vibration of SDOF system
6. To determine the natural frequency of vibration of the beam using a vibration analyzer.
7. Noise measurement and analysis using a vibration Analyzer

Part B

1. One design project: The design project shall consist of two imperial-size sheets (Preferably drawn with 3D/2D CAD software)-one involving an assembly drawing with a part list and overall dimensions, and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols, and geometric tolerances must be specified to make it a working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted. Projects shall be in the form of the design of mechanical systems, like a multispeed gearbox.

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Case study on: Free Undamped Single Degree of Freedom Vibration System
2. Case study on: Forced Single Degree of Freedom Vibratory System
3. Case study on: Free Undamped and Damped Vibration System
4. Case study on: Measurement of natural frequency of vibration of a beam using an FFT vibration analyzer
5. Case study on: Noise measurement using FFT vibration Analyzer.

Textbooks/ Reference Books

1. Mechanical Vibrations - G. K. Grover Nem Chand & Bros James Gere, Mechanics of
2. Mechanical Vibrations 4th edition- S. S. Rao - Pearson Education
3. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
4. Bhandari V.B.-Design of Machine Elements, Tata McGraw-Hill Pub. Co. Ltd
5. S. K. Basu and D. K. Pal, Design of Machine Tools, Oxford and IBH Pub Co
6. Design Data-P. S. G. College of Technology, Coimbatore
7. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons
8. I.S. 2825: Code for unfired pressure vessels

Unit Tests

Unit Test-I	Unit I, II, III
Unit Test-II	Unit-IV, V, VI

VOCATIONAL COURSE-IV
(REFRIGERATION AND AIR CONDITIONING SYSTEM MAINTENANCE)
(Course No. C315)

Designation of Course	**Vocational Course-IV (Refrigeration and Air Conditioning System Maintenance)**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites:-	The students should know of 1. Fundamentals of Thermodynamics: Principles and Applications. 2. Fundamentals of Heat Transfer and RAC
Course Objectives	1. To provide knowledge of materials used, piping systems, maintenance, and installation of RAC systems 2. Analyze the fault in the Refrigeration and A/C systems
Course Outcomes:-	On completion of the course, students will be able to: 1. Identify and classify various materials used in RAC systems. 2. Illustrate and interpret RAC piping systems. 3. Demonstrate the use of specialist tools and accessories in RAC systems. 4. Analyze and troubleshoot mechanical and electrical faults in RAC systems. 5. Apply and evaluate RAC installation techniques. 6. Perform and analyze cooling and heating load calculations for RAC systems.

Course Contents

Unit I	**Refrigeration & Air-conditioning Material**	**(04 Hrs.)**
Introduction, desired properties of ideal insulating material, factors affecting the thermal conductivity, types of insulating material, reflective insulating blinds, lap rock – a thermal acoustic and fire insulation, natural insulator, new transparent heat insulator, heat transfer through insulation used for A.C., thickness of insulation, few insulated systems, low temperature insulations, importance of relative humidity for the selection of the insulations, air distribution for reducing heat loss.		
Unit II	**RAC Piping Systems**	**(04 Hrs.)**
Codes, Standards and Specifications: Piping codes, ASME codes and standards, ASTM Specifications, ASME Boiler, Pressure vessel codes, ASME B31-Code for pressure piping, mechanical strength, testing of piping system and valves, fabrications, Piping Components: Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material, specifications, pipe ends, pipe fittings, pipe support		
Unit III	**RAC Maintenance Specialist Tools and Accessories**	**(04 Hrs.)**
Flexible charging line, bending springs, pipe tube cutter, fin combs, soldering and brazing equipment, Vacuum pump, charging cylinders, electric test lamps, jumper lead, welding goggles, Pipe installation work, pumping down the system, purging the system, starting the plant, using system analyzer, transferring and handling liquid refrigerant		

Unit IV	Mechanical and Electrical Fault Finding	(04 Hrs.)
Compressor motor fails to start, compressor motor tries to start but does not run, compressor motor starts but does not reach running speed, thermostat failure type, pressure cut-out failure, wiring, and collection faults, Fault analysis by temperature and pressure, methods of confirming the fault, finding The fault occurs when the compressor is not running, an abnormal noise problem, or domestic system faults.		
Unit V	**RAC Installation Techniques**	**(04 Hrs.)**
Introduction: Installation operation, adding oil, testing for leak detection, Evacuation and dehydration, removing air, charging of the system, through suction valve, through discharge, Installation of Room Air-Conditioner: Selection of proper location, providing proper slope and provision for draining water, Installation of split air conditioner, providing arrangement for pipes and pipe insulation		
Unit VI	**Automobile Air Conditioning**	**(04 Hrs.)**
Design Automobile AC system: Load Calculations & Analysis- Design considerations for achieving desired inside/room conditions with respect to prevailing outside/environment conditions. Factors affecting/contributing towards the load on refrigeration & air conditioning systems, Cooling& heating load calculations, Load calculations for automobiles, Effect of air conditioning load on engine, AC Service & Control: Air Conditioning Service- Air conditioner maintenance & service - removing & replacing Components. Compressor service, Testing, Diagnosis & troubleshooting of air conditioning system, Refrigerant gas charging procedure &. Servicing of heater system, Air Conditioning Control - Common controls such as thermostats, humidistat, control dampers, and pressure cut-outs, relays.		

Term Work

Any ten experiments from the following:

1. Introduction of various insulation materials, properties, and fire hazards
2. Technique of glass wool filling method in conventional refrigerant
3. Leak detection in the refrigeration system by different methods
4. Determination of cooling load for a specified situation
5. Study of piping codes, ASME codes and standards, ASTM Specifications
6. Checking the performance of the air ducting system
7. To study the hermetically sealed compressor, condensing units, performance, and volumetric efficiency
8. To design the AC System for the automobile according to the use.
9. To diagnose the fault in the Central Air Conditioning System.
10. Diagnosing the fault in the Automobile AC System
11. Refrigeration systems and air conditioning system simulation analysis using MATLAB, Java, ASPA, Suma soft, and LabVIEW.

Reference Books

1. Dossat Ray I, “Principal of Refrigeration”, Wiley Eastern Limited
2. Stocker W. F. and Jones J. W., “Refrigeration and Air Conditioning”, McGraw-Hill
3. Air conditioning: procedures and installation by V. Paul Lang, CBS publishers & distributors, Delhi
4. Handbook of Air Conditioning and Refrigeration by Shan K Wang, McGraw-Hill International Edition, Singapore
5. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger

Textbooks

1. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw-Hill
2. Arora S. C., Domkundwar S., “Refrigeration and Air Conditioning”, Dhanpat Rai and Company
3. Khurmi R. S. and Gupta J. K., “Refrigeration and Air Conditioning”, S Chand Publication

INTRODUCTION TO DATA SCIENCE
(Course No. C 316)

Designation of Course	**Introduction to Data Science**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 04 Hours/ Week	Term Work	25 Marks	02
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**02**

Course Prerequisites:-	The students should know of 1. Linear Algebra, Probability, Statistics, Logical Reasoning
Course Objectives	To explore the fundamental concepts of data analytics. 1. To interpret the various search methods and visualization techniques. 2. To use various machine learning techniques for data analysis.
Course Outcomes:-	On completion of the course, students will be able to: 1. Explain the fundamentals of data analytics using statistical and probabilistic concepts. 2. Demonstrate the basics of data mining through applications of statistical and probabilistic methods. 3. Apply inferential statistical techniques to analyze datasets and draw meaningful conclusions. 4. Explore and implement data analytics techniques using appropriate software tools. 5. Utilize data science concepts and methodologies to solve real-world problems effectively. 6. Perform advanced analytical techniques to conduct comprehensive analyses and interpret the results accurately.

Course Content

Unit I	**Introduction to Data Science**	**(08 Hrs.)**
Predictive Analytics involves the use of mathematical methods and tools such as statistical analysis and predictive models.		
Unit II	**Data mining**	**(08 Hrs.)**
Data mining is used to identify anomalies in the process, which help in preventive maintenance. Estimate the demand for products, raw materials, etc., based on historical data and the current scenario. Forecast possible outcomes based on data obtained from the process.		
Unit III	**Prescriptive Analytics**	**(08 Hrs.)**
Prescriptive Analytics is used to identify ways in which an industrial process can be improved, like action needed to avoid failure, plan the maintenance schedule, review your supplier, etc.		
Unit IV	**Descriptive Analytics**	**(08 Hrs.)**
Descriptive Analytics describes the problem by diagnosing the symptoms, using analytics methods to discover the trends and patterns based on historical data, charts, and graphs.		
Unit V	**Data visualization**	**(08 Hrs.)**
Data visualization tools, problems in the manufacturing process, and descriptive analytics in the form of charts and graphs.		
Unit VI	**Diagnostic Analytics**	**(08 Hrs.)**
Root cause analysis, data discovery, correlation, and down and drill down.		

Term work

Any 8 experiments on the following topics (not limited to this)

1. Data analysis of experiments in thermal engineering.
2. Data analysis of experiments in design engineering.
3. Data analysis of experiments in manufacturing processes.

Note: Students need to use computational algorithms using suitable software /programming language.

Textbook

1. Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press.
2. Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC Press.
3. Roy, S. S., Samui, P., Deo, R., & Ntalampiras, S. (Eds.). (2018). Big data in engineering applications (Vol. 44). Berlin/Heidelberg, Germany: Springer.
4. Middleton, J. A. (2021). Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers. Chapman and Hall/CRC.

References Books:

1. Zsolt Nagy, "Artificial Intelligence and Machine Learning Fundamentals", Packt Publishing, 2018, ISBN: 978-1-78980-165-1
2. Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: Springer, 2009.
3. Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.
4. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

Rules and Regulations

- **Rules regarding the conduction of Internal Assessment (IE):**
  Internal Assessment (IA) will comprise 40 marks. Out of this, 20 marks will be for Unit Tests, and 20 marks will be for Project-Based Learning. Two Unit Tests, each of 20 marks, will be conducted: The average of marks obtained in these two-unit tests will be considered as UT marks. Roll numbers allotted to the students shall be the examination numbers for the conduct of unit tests.

- **Rules Regarding ATKT, Standard of Passing and Award of Class of Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune**

  A.T. K. T.

  1. A candidate who is granted a term for B.Tech. Semester I, III, V, VII will be allowed to keep the term for his/her B.Tech. Semester-II, IV, VI, VIII examinations respectively, even if he/she appears and fails or does not appear at the B.Tech. Semester I, III, V, VII examinations respectively.
  2. A candidate shall be allowed to keep the term for the B.Tech. Semester-III course if he/she has a backlog of any number of Heads of passing at B.Tech. Semester I & II taken together.
  3. A student shall be allowed to keep the term for the B.Tech. Semester-V of the respective course if he/she has no backlog of B. Tech. Semester I & II, and he/she has a backlog of any number of Heads of passing at B. Tech. Semester-III & IV taken together.
  4. A student shall be allowed to keep the term for the B. Tech. Semester-VII of the respective course if he/she has no backlog of B. Tech. Semester I, II, III, IV, and he/she has a backlog of any number of Heads of passing at B. Tech. Semester V & VI taken together.

Standard of Passing:

1. Internal Assessment (IE):

- ✓ There will not be a separate passing head of 16 marks out of 40 marks for Internal Assessment (IA; the overall passing of 40% marks for the combined 100 marks will be imposed. However, the End Semester University Examination of 60 marks should have a separate passing of 40% marks.
- ✓ To grant the term, it is mandatory to appear for all the Unit tests conducted each semester.

2. Overall Passing:

- ✓ The candidate must obtain a minimum Grade Point of 5.0 (40% marks) in the End.
- ✓ Semester University Examinations, and in the combined End Semester + Internal Assessment
- ✓ A student who fails in the End Semester Examinations of a course must reappear only in the End Semester Examinations as a backlog candidate and clear that hurdle to pass.
- ✓ **Award of the Class for the Degree, considering CGPA:**
- ✓ A student who has completed the minimum credits specified for the programme shall be declared to have passed the programme. The result will be in terms of letter grade only and is based on the CGPA of all courses studied and passed. The Criteria for the Award of Honors at the end of the Programme are as follows. (Same as CBCS 2014 Course Curriculum).

Range of CGPA	**Final Grade**	**Performance Descriptor**	**Equivalent range of Marks (%)**
$9.50 \leq CGPA \leq 10.00$	O	Outstanding	$80 \leq Marks \leq 100$
$9.00 \leq CGPA \leq 9.49$	A+	Excellent	$70 \leq Marks < 80$
$8.00 \leq CGPA \leq 8.99$	A	Very Good	$60 \leq Marks < 70$
$7.00 \leq CGPA \leq 7.99$	B+	Good	$55 \leq Marks < 60$
$6.00 \leq CGPA \leq 6.99$	B	Average	$50 \leq Marks < 55$
$5.00 \leq CGPA \leq 5.99$	C	Satisfactory	$40 \leq Marks < 50$
CGPA below 5.00	F	Fail	Marks Below 40

Rules for Credits of MOOC courses, Social Activities, and Publication of Research Paper:

1. If a candidate completes a **MOOC/NPTEL course** in a particular semester **relevant to the courses in that semester**, he/ she will be allotted **TWO** credits after producing the certificate of completion of the respective course.

   Students shall register to MOOCs which are offered by any of the following agencies:

   a. SWAYAM: www.swayam.gov.in

   b. NPTEL: www.onlinecourse.nptel.ac.in

   c. Course Era: www.coursera.org

   d. edX online learning: www.edx.org

   e. MIT Open Course ware: www.ocw.mit.edu

   f. Udemy: www.udemy.com

   g. Spoken tutorial: www.spoken-tutorial.org

2. If a candidate completes his/her duties in NSS/Social Activities, he/she will be allotted **TWO** credits after producing the certificate of completion of the respective course/ activity from the relevant authorities.
3. If a candidate publishes a research paper in UGC approved CARE journals, he/she will be allotted **TWO** credits after producing the certificate of publication of the respective paper.
4. These credits will be given only after the authentic document is verified by the Head of the Department, and a separate marksheet is submitted by the Head of the Department along with the subject examiner.