

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, infrastructure to meet needs of profession & society.*
- *To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.*
- *To practice and promote professional ethics, transparency and accountability for social community, economic & environmental conditions.*

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

- *Recruiting experienced faculty.*
- *Organizing faculty development programs.*
- *Identifying socio-economically relevant areas & emerging technologies.*
- *Constant review & up gradation of curricula.*
- *Up gradation of laboratories, library & communication facilities.*
- *Collaboration with industry and research & development organizations.*
- *Sharing of knowledge, infra-structure and resources.*
- *Training, extension, testing and consultancy services.*
- *Promoting interdisciplinary research.*

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 working environment.*

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

Graduates will be able,

- *To fulfill need 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.*

PROGRAM OUTCOMES

Engineering Graduates will be able to:

- 1. Engineering knowledge:*** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. Problem analysis:*** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. Design/development of solutions:*** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- 4. Conduct investigations of complex problems:*** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5. Modern tool usage:*** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6. The engineer and society:*** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7. Environment and sustainability:*** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8. Ethics:*** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. Individual and team work:*** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. Communication:*** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. Project management and finance:*** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. Life-long learning:*** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Statements of Programme Specific Outcomes (PSOs)

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

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

PSO3: Apply concepts of mechanical engineering to assess' societal, environmental, health and safety issues with professional ethics.

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	TW & OR	TW & PR	Total	L	P	T	Total
													TW/OR/PR		
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	TW & OR	TW & PR	Total	L	P	T	Total
													TW/OR/PR		
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 PRINCIPALS AND APPLICATIONS
(Course No. C301)

Designation of Course	Heat Transfer Principals and Applications		
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	-- Marks	
	Total	125 Marks	05

Course Prerequisites: -	The students should have knowledge 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. Apply principles to heat transfer for different applications
Course Outcomes: -	The students should be able to– 1. Understand basic concepts of heat transfer and apply them to solve engineering problems 2. Analyze problems based on one dimensional steady state heat conduction 3. Analyze problems based on extended surfaces and also on unsteady heat conduction 4. Analyze problems based on the concepts of heat transfer by forced and natural convection 5. Understand concepts of heat transfer by thermal radiation and apply them to solve engineering problems 6. Analyze performance of heat exchangers and understand concepts of condensation & boiling.

Course Contents

Unit I	Basic concepts of Heat Transfer	(08 Hrs.)
<p>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.</p> <p>Purpose of insulation, critical radius of Insulation, Economic thickness of Insulation, Thermal contact resistance, thermal conductivity and it's variation with temperature for metals, non-metallic solids, gases and liquids, one dimensional problems of variable thermal conductivity.</p>		
Unit II	One dimensional steady state heat conduction	(08 Hrs.)
<p>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.</p> <p>Symmetrical boundary condition in plane wall, conduction in solid, hollow cylinder and sphere, practical problems of heat generation.</p>		

Unit III	Extended surfaces and Unsteady Heat Conduction	(08 Hrs.)
<p>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.</p> <p>Unsteady Heat Conduction: System with negligible internal resistance, Biot & Fourier numbers, Criteria for neglecting internal temperature gradient, Concept of time constant</p>		
Unit IV	Convection	(08 Hrs.)
<p>Introduction to hydrodynamic, thermal boundary layer, Laminar & turbulent flow over & closed conducts, convection heat transfer coefficients & order of magnitude, Dimensional analysis of free & forced convection, physical significance of the dimensionless parameters, Nusselt's number, Reynold's number, Prandtl's number, Grashoff's number, Stanton number, Rayleigh number.</p> <p>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.</p> <p>Natural Convection: Flow patterns, Empirical correlations for free convection, heat transfer over horizontal, vertical plate.</p>		
Unit V	Thermal Radiation	(08 Hrs.)
<p>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.</p>		
Unit VI	Heat Exchangers	(08 Hrs.)
<p>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.</p> <p>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.</p>		

Term Work

Any ten experiments from the following:

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of metal rod.
3. Determination of thermal conductivity of different materials in composite wall.
4. Temperature distribution along a 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 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 thermocouple.
11. Demonstration of a heat pipe.

Project Based Learning

1. Demonstration of conduction heat transfer through 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 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

Text Books

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 have knowledge 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 turbo machinery. 2. Analyze the performance of turbo machines. 3. Apply thermodynamics and kinematics principles to turbo machines.
Course Outcomes: -	The students should be able to– 1. Analyze the impact of jet and velocity triangles. 2. Analysis of Impulse water turbine. 3. Analysis of Reaction water turbine. 4. Analysis of rotary and axial flow compressor. 5. Analysis of centrifugal pump and velocity triangles. 6. Study and analysis of reciprocating pump.

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 vane and jet striking tangentially on to the vane, Impact of jet on hinged plates, Impact of jets on series of flat plates and vanes, water wheels, velocity tri-angles 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 and Euler's work, slip factor and its effect on work input, actual work input. Axial Flow Compressor: Construction, stage velocity triangles and its 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 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 writing a report based on the visit.
12. Visit to water pumping station and writing a report based on 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.

Text Books

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 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 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 have knowledge of 1. Basic 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: -	Students should be able to 1. Understand basics of hybrid and electric vehicle and analysis their performance. 2. Understand Concept of Hybrid Electric Drive Trains 3. Understand Electric Vehicle Architecture Design 4. Understand different Types of Storage Systems 5. Understand construction and working of electric drives and analyze their performance. 6. Understand Energy Management Strategies and INDIAN /GLOBAL 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, 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, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations. Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model, Payback and commercial model, Policies 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 Components of Electric Vehicle.
2. To prepare demonstration model of electric Vehicle terminology.
3. To prepare demonstration model of Series Hybrid Electric Drive Trains.
4. To prepare demonstration model of Parallel Hybrid Electric Drive Trains.
5. To prepare demonstration model of
6. To prepare demonstration model of Photovoltaic solar based electric Vehicle design / Battery Electric vehicle (BEV)
7. To prepare a chart on Types of Storage Systems
8. To prepare demonstration model of Storage Systems
9. To prepare demonstration model of 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. To prepare a chart on comparison of different energy management strategies
12. To prepare a chart on 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 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 the knowledge of Additive manufacturing processes and Computer integration for Manufacturing. 3. To acquire the knowledge of Flexible Manufacturing Systems and Computer Aided Process Planning.
Course Outcomes: -	The students should be able to– 1. Understand the manufacturing processes and apply them. 2. Understand the various CNC Programming and apply same for manufacturing of components. 3. Understand the various Additive Manufacturing processes and apply them to create the jobs. 4. Understand the Computer integration for Manufacturing apply them in manufacturing. 5. Understand the use of Flexible Manufacturing Systems for manufacturing. 6. Understand the use of Computer aided process planning and apply it for manufacturing purpose.

Course Contents

Unit I	Machining Processes	(06 Hrs.)
<p>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.</p> <p>Electro Chemical Processes: Electrochemical Machining Process (ECM) principle; Mechanism of material removal; Process Parameters; Process Capabilities; Applications, Tool Design, Electro Chemical Deburring (ECDE).</p> <p>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.</p>		
Unit II	CNC Technology	(06 Hrs.)
<p>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,</p>		

machining cycles, programming for machining Centre and turning Centre for well-known controllers such as Fanuc, Siemens. Introduction to CMM.		
Unit III	Additive Manufacturing	(06 Hrs.)
<p>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.</p> <p>Vat Photopolymerization AM Processes: Stereolithography (SL), Materials, SL resin curing process, Micro-stereolithography, Process Benefits and Drawbacks, Applications of Photopolymerization Processes.</p> <p>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.</p>		
Unit IV	Computer Integration for Manufacturing	(06 Hrs.)
<p>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.</p>		
Unit V	Flexible Manufacturing Systems	(06 Hrs.)
<p>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.</p>		
Unit VI	Computer Aided Process Planning	(06 Hrs.)
<p>Process Planning and Production Planning, manual experience-based planning, Decision table 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.</p>		

Term Work

1. Study and demonstration of EDM Machine.
2. Study and demonstration of ECM Machine.
3. Manual part programming using G and M codes for Turning, Step turning, Taper turning, turning, Facing.
4. Manual part programming using G and M codes for Drilling.
5. Component to be manufactured on CNC machine.
6. CNC Milling program involving linear motion and circular interpolation.
7. A study on group technology method utilized in FMS
8. Measurements of geometric parameters of parts using 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 Technologyp, 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”, 2ndEdition, Springer, 2015.
10. PatriK. Venuvinod and Weiyin Ma, “Rapid Prototyping: Laser-based and Other Technologies”, Springer, 2004.
11. S. R. Deb. “Robotics”, Tata McGrawHill 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 Working model of non-conventional machining processes
2. To show the use of controller for CNC applications
3. Select a Industrial drawing, and prepare CNC program and implement it on CNC.
4. Make a Prototype Model for Tool changer for CNC.
5. Make a Prototype Model for Clamping and decamping of job on CNC
6. Make a model using additive Manufacturing
7. Prepare processes plan for industrial component
8. Make model for 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 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 have knowledge 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 design of machine elements. 2. Impart design skills to the students to apply these skills for the problems in real life industrial applications. 3. To Enable students to attain the basic knowledge required to understand, analyze, design and select machine elements required in transmission systems
Course Outcomes: -	The student should be able to – 1. Apply the concepts of spur gear design for solving engineering problems. 2. Apply the concepts of helical gear design for solving engineering problems. 3. Apply the concepts of bevel gear, worm and design for solving engineering problems. 4. Develop capability to analyze rolling contact bearing and its selection from manufacturer's catalogue. 5. Achieve an expertise in design of sliding contact bearing in industrial applications. 6. Inculcate an ability to design belt drives and to select belt, rope and chain drives.

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.)

<p>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.</p> <p>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)</p>		
Unit IV	Rolling Contact Bearing	(06 Hrs.)
<p>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 its remedies.</p> <p>Taper roller bearing: Force analysis and selection criteria. (Theoretical Treatment only)</p>		
Unit V	Sliding Contact Bearing	(06 Hrs.)
<p>Basic modes for lubrication, Viscosity, Effect of temperature on viscosity, Viscosity index, Additives, Greases, Selection of lubricants. Viscous flow through rectangular slot, Load carrying capacity & flow requirement of hydrostatic step bearing, Energy losses, Hydrodynamic lubrication, Reynolds equation, Sommerfield 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.</p>		
Unit VI	Belt, Rope and Chain Drives	(06 Hrs.)
<p>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,</p> <p>Wire Ropes (Theoretical Treatment Only): Construction of wire ropes, lay of wire rope, stresses in wire rope, selection of wire ropes.</p> <p>Chain Drives (Theoretical Treatment Only): Types of chains and its Geometry, selection criteria for chain drive, Polygon effect of chain, Modes of failure for chain, Lubrication of chains</p>		

Term work

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

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

Assignment

Numerical and/or theory questions on 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: 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 Industrial/Real life application demonstration model of different types of Gears.
2. To develop a demonstration models for any practical applications where spur gears are used.
3. To design the gearbox for wind mill application.
4. To design the in-line gearbox for Automobile application
5. To design the gearbox for building Elevator.
6. To design the gearbox for building Hoist.
7. To design the gearbox for Worm gear box for Sugar Industry.
8. To develop a demonstration models for any one practical applications where helical gears are used.
9. To develop a demonstration models for any one practical applications where bevel gears are used.
10. To develop a demonstration models for any one practical applications where worm and worm gears are used.
11. To observe the mechanical system where transmission of power or motions takes place through gears like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the gears. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare 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 Catalog.
14. Case study Mounting of machine elements on transmission shaft (like Bearings, gears, Pulley, Sprocket, etc).
15. To observe the mechanical system where different types of bearings are used. By selecting suitable materials, design a sliding contact bearing. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials using any CAD software.

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 PurohitKamlesh, "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 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 interview process and further in their training/working in any industry's stores and/or logistics departments. 3. Aware of various stores layouts
Course Outcomes:-	The students should be able to– 1. Acquire knowledge of different types of Stores / Warehouses, related to various industries. 2. Understand SOP's and implement them for store management 3. Design store layout and infrastructure 4. Understand various types of stores and distribution of warehouses 5. Solve inventory management problems in store 6. Apply new technologies & Hybrid Computerized Systems in modern 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 stores layout and stores 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 stores 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.)
<p>Transportation & Logistics. What is First Mile/Second Mile/ Last Mile Logistics/Delivery. Importance of Logistics & Transport in Modern Trade. Advancements & improvements due to use of new technologies & Hybrid Computerized Systems in modern trade and industry. Brief intro to WMS-ERP, etc.</p>		

Term Work

1. Physical Introduction to a Store, actual visit to an industrial store or College Library, which is a classic example of book storage, within college premises.
2. Stores Layout Study
3. Introduction to various Material Handling Equipment's, Material Storage Systems and tool + gadgets used in stores. For Example: Fork Lift, 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, offer to QC & finally send to 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 thro vehicle, etc.
9. Industrial, multi-location stores visits. (Total 2 industry visits)
10. Actual working in a Store / Library for Inventory Management Study.
11. Visit to a Commercial Stores, 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.

Text Books:

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 have knowledge of 1. Basic Mathematics 2. Programming Language
Course Objectives:-	1. The goal of the course is that students should develop techniques for problem solving using a numerical method.
Course Outcomes:-	The students should be able to– 1. Find roots of equation of single variable equations 2. Find solutions of simultaneous linear equations 3. Find the data that fits the given equations by curve fitting 4. Find the data that fits the given equation by interpolation 5. Integrate a given equations 6. Find the solution of ODE

Course Contents

Unit I	Roots of equations	(04 Hrs.)
Bracketing methods-Bisection and False position method		
Unit II	Linear Algebraic Equation:	(04 Hrs.)
Navie Gauss elimination, pitfalls of Gauss Elimination, techniques of improving solutions		
Unit III	Curve Fitting:	(04 Hrs.)
Least-Square Regression-Linear regression		
Unit IV	Interpolation	(04 Hrs.)
Newtons 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 syllabus and listed below.
2. Program on Bisection Method
3. Program on False Position Method
4. Program on Gaussian Method
5. Program on Curve fitting by least square method
6. Program on Newton's Forward Method
7. Program on Newton's Backward Method
8. Program on Trapezoidal Rule

9. Program on Simpson's $1/3$ rule
10. Program on Simpson's $3/8$ rule
11. 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

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 have knowledge of <ol style="list-style-type: none"> 1. Engineering Mathematics 2. Engineering Mechanics 3. Strength of Materials 4. Heat Transfer 5. Fluid Mechanics 6. Mechanical Vibration
Course Objectives:-	<ol style="list-style-type: none"> 1. Analyze a physical problem 2. Develop finite element procedures for accurately investigating the problem, and effectively perform and document findings. 3. Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach 4. Impart knowledge to solve complex fluid flow problems using computational fluid dynamics. 5. Familiar with modern trends in computational fluid dynamics
Course Outcomes:-	The students should be able to– <ol style="list-style-type: none"> 1. Apply Rayleigh-Ritz, Galerkin and weighted residual method to solve engineering problems and understand the role and significance of shape functions in finite element formulations. 2. Derive governing equations by understanding flow physics and mathematical behavior. 3. Understand the formulation of element stiffness matrix, load vector by potential energy approach for 1D and 2D problems 4. Create grid and improve mesh quality using advanced tools and techniques 5. Derive the shape functions for bar, rectangle and higher order elements as well as able to apply numerical methods to solve numerical integration and evaluate the Eigenvalues and Eigenvectors for stepped bar and beam. 6. Develop turbulence models and understand its approaches.

Course Contents

Unit I	Pre-processing	(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	Processing	(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	Post-processing	(08 Hrs.)
Introduction and background of Turbulence Modeling, Algebraic models, One equation models, 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 2-D truss structure and 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, Guass Quadrature formula in two and three dimensions, triangular elements, rectangular elements. Dynamic Analysis, Formulation of Dynamic problems, Consistent and Lumped Mass Matrices. Solution of Eigen Value Problems. Transformation Method, Jacobi Method, Vector Iteration Method, Subspace Iteration Method.		

Term Work

Term work shall consists of

1. Four computer program assignments to be developed for FEA. (Using any programming language.)
2. Two assignments on structural and on modal Analysis 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.

Text Books/ 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 Moeling 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 have knowledge 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:-	The students should be able to– 1. Understand the methods of refrigeration systems. 2. Analyze the simple vapour compression system 3. Analyze the different multi-pressure systems 4. Analyze various psychrometric processes used in air conditioning systems. 5. Understand the components of refrigeration and air conditioning systems 6. Analyze the air distribution systems.

Course Contents

Unit I	Methods of Refrigeration	(06 Hrs.)
Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapour 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 Vapour Compression Systems	(06 Hrs.)
Limitations of air refrigeration system, development of vapour compressor cycle, effect of operating parameters on VCC, use of P-H charts, actual vapour compression cycle. Refrigerants Desirable properties of refrigerants, classification of refrigerants, secondary refrigerants, alternative refrigerants for CFC's, HCFC'S, ozone depletion potential (ODP), Global warming Potential (GWP).		
Unit III	Multi pressure Vapour compression system, Vapour absorption systems	(06 Hrs.)
Multi Pressure Systems Introduction to multistage compression, two stage compression with flash gas removal, with liquid intercooler, Cascade systems. Vapour absorption systems Introduction, Simple Vapour absorption system, practical vapour absorption system, COP of an ideal vapour 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, by pass 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 system, all water system, 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, humidistat, Solenoid, 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 simple duct system, equivalent diameter, for determination of duct size Food Preservation: Cold storage, control and modified atmosphere (CAMA) storages, mobile refrigeration and air conditioning, refrigerant piping selection, pressure drop, valves, fitting, insulating materials.		

Term Work

Any ten experiments from the following:

1. Test on Computerized vapour compression test rig
2. Test on Computerized air conditioning test rig
3. Test on Computerized ice plant test rig.
4. Study of non-conventional refrigeration system.
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 refrigeration system.
8. Visit to any refrigeration or air conditioning plant.
9. Trial on Computerized heat pump test rig
10. Test on vapour 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

Text Books

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 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 problem.
11. Preliminary design of air conditioning system for real life problem.

Unit Tests

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

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 understand the scope, objective and application of industrial engineering tools and management practices in manufacturing.
Course Outcomes:-	The students should be able to– 1. Understand definition, principles and functions of management and apply in organization 2. Understand organization structures and business organizations and select for their organization. 3. Understand functioning of Production, Personnel, Marketing and Finance Department. 4. Understand method study tool and apply for standardizing the method 5. Understand work measurement tool and apply for standardizing the time. 6. Understand ergonomically accepts, safety and industrial laws in manufacturing organization.

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 approach.		
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 its 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 stop watch 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 number of cycles time study for indirect functions such as Maintenance, Marketing etc., Most Technique. Works Sampling: Definition, Objectives, theory of Work Sampling. Other applications of work sampling, errors in 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 human body, anthropometrics, bio mechanical factors environment effects. Industrial Safety: Importance of safety, planning, training, safety precautions, safety equipment's, 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	Industrial Engineering & Management		
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 <ol style="list-style-type: none"> 1. Basic math's and reasoning, and comprehensive ability 2. Basic knowledge of communication process, soft skills 3. Basic knowledge and idea about leaders and leadership qualities, ethics, etiquettes and values
Course Objectives:-	1. The Quantitative Techniques, Communication and Values aims to augment students to face the campus recruitment test and train them on applying short techniques/ tricks to solve questions of Maths, reasoning and English in very less amount of time. The communication and values section focuses on the aspects of communication and soft skills such as grooming personality for leading team, presentation, business communication which would enable graduates to project themselves as a professionals in the corporate sector and/or otherwise.
Course Outcomes:-	The students should be able to– <ol style="list-style-type: none"> 1. Solve the aptitude test in the recruitment and competitive exam by applying short techniques and solve the question in less amount of time 2. Apply the short mnemonics and techniques to solve the questions of logical reasoning in the placement and competitive exam in lesser time. 3. Develop the verbal ability to communicate effectively using suitable vocabulary and proper sentence pattern 4. Understand the concept of soft skills and its implication at workplace 5. Build up the ability to study employment business correspondences and its proper implications 6. Understand business ethics, etiquettes and values and apply them in the professional ventures.

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 Business World, Respect for Individuality and diversity at workplace values of a good manager Key features of corporate etiquette, Corporate grooming & dressing, etiquettes in social & office Setting-Understand the importance of professional behavior at the work place, Corporate social responsibility (CSR) its importance and need.		

Project Based Learning

1. Prepare mock Tests on Unit –I and solve it in given time(use of PSD lab manual)
2. Prepare mock Tests on Unit –I and solve it in given time(use of PSD lab manual)
3. Prepare online model test based on Unit-II and solve it in specific time(use of PSD lab manual)
4. Prepare online model test based on Unit-II and solve it in specific time(use of PSD lab manual)
5. Form a model for spoken and written communication skills which 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. Analysing differences between Soft Skills, Hard skills, and Personal skills
9. Develop Bruce Tuchman’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 conduct activities for effective implementation of it.
12. Form a model to develop LSRW and communication Skills
13. Conduct mock interview and practice GD activities to build competencies for actual selection process
14. Preparing a model for evaluating Values and Ethics of Good Managers
15. Preparing a model of dress codes and attire for different professional situations Corporate etiquettes and its implications

16. Develop some good activities to understand 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 InduSijwali
Business Communication by Meenakshi Raman, Prakash Singh published by Oxford University press, second edition
5. Communication Skills by Sanjay Kumar, PushpLata, 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. KalyanaChakravarthi and Dr. T. LathaChakravarthi 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 have knowledge of <ol style="list-style-type: none"> 1. Statics and dynamics 2. Computer Aided Machine Drawing 3. Machine design & Analysis I & II 4. Theory of machine
Course Objectives:-	To provide the knowledge of <ol style="list-style-type: none"> 1. To study basic concepts of vibration analysis 2. To acquaint with the principles of vibration measuring instruments 3. To develop competency for system visualization and design. 4. To enable student to design pressure vessels and to use IS code. 5. To introduce student to optimum design and use optimization methods to design mechanical components.
Course Outcomes:-	The students should be able to– <ol style="list-style-type: none"> 1. Understand the concept of free undamped single DOF and evaluate vibrating parameters. 2. Understand the concepts of force single DOF and evaluate transmissibility and critical speed of shaft. 3. Understand the concept of free undamped multi DOF vibration system and analyze it for vibration parameters 4. Understand the various stresses in different components of pressure vessels and apply it to design different types of pressure vessels 5. Understand the design consideration of Machine tool Gear box and evaluate speed at each stage by using ray diagram. 6. Understand optimum design with normal specifications and apply optimum design method for different 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, torsion 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 geared system; Dunkerley's and Rayleigh's method for 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, Thick Cylindrical Shell Subjected to an Internal Pressure, Compound Cylindrical Shells, Stresses in Compound Cylindrical Shells, Cylinder Heads and Cover Plates, Auto-fretting.		
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 numbers of teeth of successive gears in a change gear box.		
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 factor of safety.		

Term Work

Part A (Any 4)

1. To determine the natural frequency of damped vibration of single degree freedom system and to find its damping coefficient.
2. To obtain frequency response curves of single degree freedom system of vibration for different amount of damping
3. Free vibration of simply supported beam
4. Free Vibration of a Two-DOF System
5. Forced vibration of SDOF system
6. To determine natural frequency of vibration of beam using vibration analyzer.
7. Noise measurement and analysis using 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 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 so as to make it 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 design of mechanical systems like multispeed gear box.

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 beam using FFT vibration analyzer
5. Case study on : Noise measurement using FFT vibration Analyzer.

Text Books/ 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 have knowledge of <ol style="list-style-type: none"> 1. Fundamentals of Thermodynamics Principles and applications. 2. Fundamentals of Heat transfer and RAC
Course Objectives	<ol style="list-style-type: none"> 1. To provide the knowledge of materials used, piping systems, maintenance and installation of RAC systems 2. Analyze the fault in Refrigeration and A/C systems
Course Outcomes:-	The students should be able to– <ol style="list-style-type: none"> 1. Understand various materials used in RAC systems 2. Understand RAC piping systems 3. Understand Specialist tools and accessories 4. Analyze mechanical and electrical faults in RAC systems 5. Understand RAC installation techniques 6. Analyze Cooling & heating load calculations

Course Contents

Unit I	Refrigeration & Air-conditioning Material	(04 Hrs.)
Introduction, desired properties of ideal insulating material, factors effecting 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 lose.		
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's, 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 a system analyzer, transferring and handling liquid refrigerant		
Unit IV	Mechanical and Electrical Fault Finding	(04 Hrs.)
Compressor motor fails to start, compressor motors 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 when the compressor is not running, abnormal noise problem, 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 to drain water, Installation of split air conditioner, providing arrangement for pipes and pipe, pipe insulations		
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 & trouble shooting of air conditioning system, Refrigerant gas charging procedure & Servicing of heater system, Air Conditioning Control - Common controls such as thermostats, humidistat, control dampers, pressure cut outs, relays.		

Term Work

Any ten experiments from the following:

1. Introduction of various insulating material, properties, fire hazard
2. Technique of glass wool filling method in conventional refrigerant
3. Leak detection in 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 air ducting system
7. To study hermetically sealed compressor, condensing units, performance, volumetric efficiency
8. To design the AC System for the automobile according to the use.
9. To diagnose the fault in Central Air conditioning System.
10. To diagnose the fault in Automobile AC System
11. Refrigeration systems and air conditioning system simulation analysis using METLAB, Java, ASPA, Suma soft, lab view.

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. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore
5. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger

Text Books

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. C316)

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 have knowledge of 1. Linear Algebra, Probability, Statistics, Logical Reasoning
Course Objectives	To explore the fundamental concepts of data analytics. 1. To understand the various search methods and visualization techniques. 2. To apply various machine learning techniques for data analysis.
Course Outcomes:-	The students should be able to– 1. Understand the basics of data analytics using concepts of statistics and probability. 2. Understand the basics of data mining using concepts of statistics and probability 3. Apply various inferential statistical analysis techniques to describe data sets withdraw useful conclusions from acquired data set. 4. Explore the data analytics techniques using various tools. 5. Apply data science concept and methods to solve problems in real world context. 6. Apply an advanced techniques to conduct thorough and insightful analysis and interpret the results.

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 to identify anomalies in the process, which help in preventive maintenance. Estimate the demand for product, raw material etc. based on historical data and current scenario. Forecast possible outcomes based on data obtained from the process.		
Unit III	Prescriptive Analytics	(08 Hrs.)
Prescriptive Analytics is used identify ways in which an industrial process can be improved like action need to take to avoid the failure, plan the maintenance schedule, review your supplier, etc		
Unit IV	Descriptive Analytics	(08 Hrs.)
Descriptive Analytics, describe the problem by diagnosing the symptoms, analytics method 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, descriptive analytics in the form of charts and graphs.		
Unit VI	Diagnostic Analytics	(08 Hrs.)
Root cause analysis, data discover, correlation, and down and drill.		

Term work

Any 8 experiments on 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 apply the computational algorithms using suitable software /programming language.

Text Book

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.