BansilalRamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Curriculum for
T. Y. B. Tech
2020 Pattern
(Mechanical Engineering)

Department of
Mechanical Engineering

VISION

Excellence in Mechanical Engineering for Global Acceptance

MISSION

- Make spirited mechanical engineers with morals, values and principles for sustainable development of society.
- Strive continuously to impart knowledge and skills of the highest standards.
- Our engineers will respond to the current and future needs of the industry, higher studies as well as research.

Program Educational Objectives-

1. Graduates of the program will become competent engineers suitable for the mechanical engineering based industry and higher edueation.
2. Graduates of the program will acquire the necessary foundation in fundamental mechanical engineering subjects for development of mathematical and analytical abilities.
3. Graduates of the program will acquire the knowledge and skills in mechanical engineering to provide technological solutions.
4. Graduates of the program will learn managerial, financial and ethical practices such as, project and financial management skills, multidisciplinary approach and soft skills.
5. Graduates of the program will respond to growing demands of society through lifelong learning.

Program Outcomes-

At the end of the program, a student 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

Program Specific Outcomes-

At the end of the mechanical engineering program, a student will be able to-

1. Identify, automate and apply manufacturing processes for production of mechanical components considering effective use of man, machines, and material resources.
2. Design, formulate, develop and analyze mechanical components and systems using design engineering principles and modern CAD/CAE tools
3. Specify, analyze, evaluate, audit, design and build thermal and fluid systems using modern engineering tools

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Department of Mechanical Engineering

T.Y. B. TECH (MECHANICAL ENGINEERING), SEMESTER V (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
MEUA31201	Numerical Methods*	TH	3	-	2	20	30	20	30	25	125	4
MEUA31202	Heat Transfer*	TH	3	-	2	20	30	20	30	25	125	4
MEUA31203	Kinematics and Theory of Machines*	TH	3	-	2	20	30	20	30	25	125	4
MEUA31204	Design of Machine Elements	TH	3	-	-	20	30	20	30	- -	100	3
MEUA31205	Professional Elective-I	TH	3	-	2	20	30	20	30	25	125	4
MEUA31206	Programming for Mechanical Engineers	CE	1	-	2	-	-	-	-	25	25	2
M3	Mandatory course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	16	0	10	100	150	100	150	100	650	21

*Courses having Practical/Oral

CIE: Continuous Internal Evaluation SCE: Skill and Competency Examination

ISE: In-Semester Examination ESE: End Semester Examination

Professional Elective-I-

MEUA31205A	IC Engines and Alternate Fuels
MEUA31205B	Composite Materials
MEUA31205C	Advanced Manufacturing Processes
MEUA31203D	Energy Conservation and Management

List of Mandatory Courses-

Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

BoS Chairman **Dean Academics** **Director**

V.I.I.T. PUNE 48. Vishwakarma Institute of Information Technology

Bansilal RamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

Department of Mechanical Engineering

T.Y. B. TECH (MECHANICAL ENGINEERING), SEMESTER VI (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
MEUA32201	Transmission System Design*	TH	3	-	2	20	30	20	30	25	125	4
MEUA32202	Professional Elective II	TH	3	-	2	20	30	20	30	25	125	4
MEUA32203	Mechanical Vibration*	TH	3	-	2	20	30	20	30	25	125	4
MEUA32204	Professional Elective III	TH	3	-	2	20	30	20	30	25	125	4
IOEUA32205	Open Elective-I (Humanities & Social Scie)	TH	3	--	--	20	30	20	30	--	100	3
MEUA32206	Computer Aided Engineering	CE	1	-	2	-	-	-	-	25	25	2
M3	Mandatory course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	16	0	10	100	150	100	150	125	625	21

*Courses having Practical/Oral

Professional Elective-II		Professional Elective-III		Open Elective-I	
MEUA32202A	Refrigeration and Air Conditioning	MEUA32204A	Hydraulics & Pneumatics	IOEUA32205A	Information and Cyber Security
MEUA32202B	Operation Research	MEUA32204B	Digital Manufacturing and Automation	IOEUA32205B	Automotive Electronics
MEUA32202C	ML and AI	MEUA32204C	Electric Vehicles	IOEUA32205C	Industrial Engineering
		MEUA32204D	Product Design Engineering	IOEUA32205D	Artificial Neural Network in Engineering
				IOEUA32185E	Social Media Analytics

List of Mandatory Courses-

Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

BoS Chairman **Dean Academics** **Director**

V.I.I.T. PUNE 48.

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THIRD YEAR B. TECH. SEMESTER-I			
1	MEUA31201	Numerical Methods	
2	MEUA31202	Heat Transfer	
3	MEUA31203	Kinematics of Machines	
4	MEUA31204	Design of Machine Elements	
5	MEUA31205A	IC Engines and Alternate Fuels	
6	MEUA31205B	Composite Materials	
7	MEUA31205C	Advanced Manufacturing Processes	
8	MEUA31205D	Energy Conservation and Management	
9	MEUA31206	Project-I (Programming for Mechanical Engineers)	
10	M3	Mandatory Course	
THIRD YEAR B. TECH. SEMESTER-II			
11	MEUA32201	Transmission System Design	
12	MEUA32202A	Refrigeration and Air Conditioning	
13	MEUA32202B	Operation Research	
14	MEUA32202C	Machine Learning and Artificial Intelligence	
15	MEUA32203	Mechanical Vibration	
16	MEUA32204A	Hydraulics & Pneumatics	
17	MEUA32204B	Digital Manufacturing &Automation	
18	MEUA32204C	Electric Vehicles	
19	MEUA32204D	Product Design Engineering	
20	IOEUA32205A	Information and Cyber Security	
21	IOEUA32205B	Automotive Electronics	
22	IOEUA32205C	Industrial Engineering	

23	IOEUA32205D	Artificial Neural Network in Engineering	
24	IOEUA32185E	Social Media Analytics	
25	MEUA32206	Project-II (Computer Aided Engineering)	
26	M3	Mandatory Course	

Semester – I

Numerical Methods (MEUA31201)

Teaching scheme	Examination Scheme						
Credits: 4 Lectures (L): 3 Hrs./week Tutorial (T): - Practical (P): - 2 Hrs./Week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	--	125

Prerequisite: Engineering Mathematics.

Course objectives:

- To recognize the difference between analytical and numerical methods and to provide the necessary concepts of a few numerical methods for solving complex Mechanical engineering Problems
- To offer hands-on experience for developing programming skills to provide solutions to mechanical problems using numerical methods.

Course Outcomes: By the end of the course, students will be able to

1. Determine the root to given equations using appropriate numerical method.
2. Implement appropriate numerical method to solve linear systems of equations.
3. Demonstrate the use of regression/interpolation methods to find values based on the graphical and/or tabulated data.
4. Apply numerical methods to obtain approximate integration for given problem.
5. Evaluate an approximate solution of ordinary differential equation.
6. Solve a partial differential equation using finite difference approach.

Unit I – Errors, Approximations and Roots of Equation

Errors & Approximations: Significant figures, Accuracy & Precision, Errors Round-Off Error, Truncation Error, Error Propagation
Roots of Equations: Bisection Method, Newton Raphson method, Successive approximation method, Convergence and Divergence

Unit II - Simultaneous Equations

Gauss Elimination Method, Partial Pivoting, Gauss-Scidal method and Thomas algorithm for Tri-Diagonal Matrix.

Unit III - Curve Fitting and Interpolation

Curve Fitting: Least Square Technique- Straight Line, Power Equation, Exponential Equation and Quadratic Equation.
Interpolation: Lagrange's Interpolation, Newton's Forward Difference interpolation, Inverse Interpolation

Unit IV - Numerical Integration

Trapezoidal rule, Simpson's $1/3^{rd}$ Rule, Simpson's $3/8^{th}$ Rule, Gauss Quadrature Method. Double Integration

Unit V - Ordinary Differential Equations

Taylor series method, Euler Method, Modified Euler Method, Runge-Kutta Second Order Method, Runge-Kutta fourth order Method, Simultaneous equations using RungeKutta2nd order method.

Unit VI - Partial Differential Equations

Finite-Difference Approximations to Partial Derivatives, Solution of Elliptical and Parabolic Equations, Solution of One-Dimensional Heat Equation, Solution of Wave Equation

List of Practicals /Pragramms

1. Program on Roots of Equation
   a) Bisection Method or False position Method,
   b) Newton Raphson method or Successive approximation method
2. Program on Simultaneous Equations
   a) Gauss Elinination Method,
   b) Gauss-Seidal method.
3. Program on Numerical Integration
   a) Trapezoidal rule,
   b) Simpson's Rules ($1/3^{rd}$ & $3/8^{th}$)[In one program only]
   c) Double integration
4. Program on Curve Fitting
   a) Straight line,
   b) Power equation Or Exponential equation
   c) Quadratic equation
5. Program on Interpolation
   a) Lagrange's Interpolation,
   b) Newton's Forward interpolation,
6. Program on Ordinary Differential Equations
   a) Euler Method
   b) Runge-Kutta Methods- Second order,
7. Program on Partial Differential Equations

Text Books:

1. B. S. Garewal, Numerical Methods in Engineering and Science: With Programs in C, C++ and MATLAB, New Delhi, Khanna Publishers
2. Jain M K, Iyengar S R K, Jain R K, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd. Publisher
3. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishers

Reference Books:

1. Mathews John H, Fink Kurtis , Numerical Methods Using MATLAB, Dorling Kindersley (India) Pvt. Ltd
2. Stanton Ralph G , Numerical Methods for Science and Engineering, Prentice Hall of India
3. Chapra Steven C; Canale Raymond P , Numerical Methods for Engineers: with Software and Programming Applications, Tata McGraw Hill
4. Balagurusamy, Numerical Methods, Tata McGraw Hill
5. Thangaraj, Computer Oriented Numerical Methods, Prentice Hall of India
6. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India

Course Coordinator: Prof. Prashant Anerao
BoS Member: Dr. Nitin Ambhore
BoS Chairman: Dr. Dinesh Kamble

Heat Transfer (MEUA32202)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week.	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisite: Thermodynamics, Fluid Mechanics, Engineering Mathematics

Course objectives:

- The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course Outcomes: Upon the completion of the course, students will able to

1. Understand the various modes of heat transfer and implement the basic heat conduction equations for Steady, one dimensional thermal system with and without internal heat generation.
2. Apply heat conduction in extended surfaces.
3. Formulate and analyze a transient heat transfer problem.
4. Determine the heat transfer rate in natural and forced convection.
5. Interpret heat transfer by radiation between objects with simple geometries.
6. Analyze the heat exchangers and investigate the performance.
7.

Unit I - Steady State Conduction

Introduction-Applications of heat transfer, Modes of heat transfer, Thermal conductivity, Thermal diffusivity

Unidirectional steady state conduction without internal heat generation-Fourier's law, Application of Fourier's law to infinite slab, infinite long hollow cylinder and hollow sphere, Electrical Analogy of conduction, concept of conduction and film resistances, critical insulation thickness, (Numerical) Three dimensional general differential equation of conduction in Cartesian, cylindrical and spherical geometry (no derivation for Cylindrical and spherical geometry), Laplace, Fourier's and Poisons equation.

Unidirectional steady state conduction with internal heat generation-Boundary conditions, Application of Poisons equation (No Numerical)

1D steady state heat conduction problems-implicit and explicit methods.

Unit II - Heat conduction through Extended Surfaces – Fins

Types of fins and its applications, Fin effectiveness and fin efficiency, concept of pin fin, Differential equation of pin fin, boundary condition based classification of pin fins, Analysis of pin fin. Analytical methods and numerical techniques solving fin problems
Unit III - Unsteady state conduction
Validity and criteria of lumped system analysis, Biot and Fourier number, Time constant and response of thermocouple, (Numerical) Transient heat analysis using Heislerand Grober charts. Simple transient heat conduction problems-implicit and explicit methods.
Unit IV- Convection
Fundamentals of Convection-Heat convection, velocity and thermal boundary layers (No Numerical) **Forced Convection-**Governing equation of forced convection, physical significance of dimensionless numbers, Correlations for flow through Duct/Internal flow and flow over flat plate/ External flow (Numerical) **Natural Convection-**Mechanism of natural convection, Governing equation of natural convection, physical significance of dimensionless numbers, correlations for simple geometry cases (Numerical) **Condensation and boiling-**Film wise and drop wise condensation, Typical pool boiling curve (No Numerical) **Analysis of internal flow through pipe using any open source software to analyze tbe fluid flow.**
Unit V-Radiation
Fundamental concepts, Laws of radiation, solid angle, intensity of radiation, (No Numerical); Radiation between two black surfaces, shape factor, concept of electrical analogy, Radiation between two finite grey surfaces, Radiation shields (Numerical)
Unit VI- Heat Exchanger
Types of heat exchangers, Overall heat transfer coefficient with scaling effect, Analysis and design of heat exchangers using both LMTD and NTU – ε method, Introduction mass transfer, Similarity and difference between heat and mass transfer. Introduction to software used for analysis of heat exchanger.
List of Practical
Lab practice consists of any Eight of the following - 1. Determination of Thermal Conductivity of metal rod. 2. Determination of Thermal Conductivity of insulating powder. 3. Determination of Thermal Conductivity of Composite wall. 4. Determination of heat transfer coefficient in Natural Convection. 5. Determination of heat transfer coefficient in Forced Convection. 6. Determination of temperature distribution, fin efficiency in Natural Convection. 8. Determination of Emissivity of a Test surface. 8. Determination of Stefan Boltzmann Constant. 9. Determination of critical heat flux.

10. Determination of NTU/effectiveness of a heat exchanger (Evaporator/Condenser).

Text Books:

1. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, JohnWiley.
2. Mahesh M. Rathod, Engineering Heat and Mass Transfer, Third Edition, UniversityScience Press,2016
3. Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications,Tata McGraw Hill Education PrivateLimited.

Reference Books:

1. S.P. Sukhatme, A Textbook on Heat Transfer, UniversitiesPress.
2. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New AgeScience.
3. P.K. Nag, Heat & Mass Transfer, McGraw Hill Education Private Limited.
4. V. M. Domkundwar, HeatTransfer
5. Holman, Fundamentals of Heat and Mass Transfer, McGraw – Hillpublication

Prepared by-Dr. S. S .Kore
BOS Member- Dr. A. D .Kale
BOS Chairman- Dr. Dinesh Kamble

Kinematics and Theory of Machines (MEUA31203)

Teaching Scbeme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week.	20	30	20	30	25	-	125

Prerequisite: Engineering Mathematics, Engineering Physics, Engineering Graphics & Design

Course objective:

1. Make the student conversant with commonly used mechanisms for industrial applications.
2. Develop competency in solving kinematic problems.
3. Determine different parameters of mechanism.

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

1. Identify different mechanisms used in simple mechanieal systems.
2. Apply graphical or analytical method for kinematic analysis of simple mechanisms.
3. Analyze motion conversion of mechanism using relative polygon method.
4. Explain fundamental concepts required for gear design.
5. Compute speed and torque in different gear trains
6. Calculate various parameters involved in clutch and brake system.

Unit I -Fundamentals of Kinematics and Mechanisms

Kinematic link, Kinematic Pair, Mechanism, Machine, Degree of freedom, Kutzbach Criterion, Grubler's criterion, our bar chain and its inversions, Grashoff's law, Slider crank chain and its inversion, Double slider crank chains and its inversion, Universal Joint. Pantograph and Geneva mechanism.

Unit II -Kinematic Analysis of Mechanisms – I

Instantaneous center of rotation (ICR) method- Definition & Types of ICR, Kennedy's Theorem, Methods of locating ICRs, Analytical method for displacement, velocity and acceleration analysis of slider crank Mechanism, Loop closure equation, Velocity and acceleration analysis of slider crank mechanisms using complex algebra method

Unit III - Kinematic Analysis of Mechanisms – II

Relative polygon method- Velocity & acceleration polygons for simple mechanisms. Velocity and acceleration diagrams for the mechanisms involving Coriolis component of acceleration. Klein's construction.

Unit IV –Gears

Classification, spur gear- definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and under cutting, force analysis.

Unit V - Gear Trains

Types of Gear Trains, Analysis of epicyclic gear trains, Holding torque , Simple, compound and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel epicyclic Gear train.

Unit VI - Friction Clutches and Brakes
Torque transmitting capacity of Pivot and collar friction, Plate clutches, Cone clutches, Centrifugal clutch, Braking torques of different types of brakes, introduction to dynamometer.
List of Practical
Lab practice shall be consisting of any Eight from the following assignments- 1. Draw (any 4) configurations of mechanisms and determine types of pairs, links, degree of freedom. 2. Build a working model or CAD model of any one quick return motion mechanism or straight-line motion mechanism or inversion of slider crank mechanism. 3. Build and execute a computer program to solve problem on velocity and acceleration analysis using analytical methods and compare results. 4. Velocity analysis using Instantaneous center of rotation (ICR)method. 5. Perform velocity and acceleration analysis using relative polygon method for mechanism involving Coriolis component. 6. Perform velocity and acceleration analysis for mechanism using MSC ADAMS Software. 7. Measure torque transmitting capacity of friction clutch or power transmitted by the dynamometer or power absorbed by the brake 8. Draw conjugate profile for any general type of gear tooth. 9. Generate involute gear tooth profile using rack shift model 10. Perform analysis of the epicyclic gear train Velocity ratios of simple, compound and differential geartrains
Text Books:
4. Rattan S.S., "Theory of Machines", 2nd., TataMcGraw-hill publishing, 2005, ISBN 008-059120-2 5. Thomas Bevan, "Theory of machines", CBS publishers and Distributors, 1984.ISBN-8131829656
Reference Books:
1. Ghosh Amitabh and Malik Ashok Kumar, "Theory of mechanisms and Machines",3ed, Affiliated East West press, 2000, ISBN 81-85938-93-8 2. Allen Strickland, Jr. Hall, "Kinematics and Linkage Design", Waveland PrInc (1986)ISBN 10- 0881332820 3. Wilson C.E., Sandler J. P. "Kinematics and Dynamics of Machinery", PersonEducation. ISBN 020135099-8 6. Erdman A.G. and Sandor G.N., "Mechanism Design, Analysis and Synthesis"Volume-I, Prentice–Hall ofIndia. 7. Shigley Joseph Edward and Vicker John Joseph. "Theory of Machines andMechanisms", 3ed., 1995, Oxford University Press. ISBN 0-19-515598-x. 8. Ballaney P. L., "Theory of Machines and Mechanisms", Khanna Publisher Delhi,1999. ISBN-818409122X.

Prepared by- Mr. A.R. Deshpande
BOS Member- Dr. N.H.Ambhore
BOS Chairman- Dr.D.N.Kamble

Design of Machine Elements (MEUA31204)

Teaching scheme	Examination Scheme						
Credits: 3 Lectures (L): 3 Hrs./week Tutorial (T): --- Practical (P): - -	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	--	--	100

Prerequisite: Strength of Materials, Engineering Mechanics,

Course objectives:

1. Understand the various design considerations, design procedure and select materials for a specific application
2. Calculate the stresses in machine components due to various types of loads and failure
3. Analyze machine components joints subjected to variable loading.
4. Design various machine components such as shafts, couplings, keys, screws, joints, springs and vessels

Course Outcomes: On completion of the course, learner will be able to

1. Identify failure modes for mechanical elements and design of machine element based on strength.
2. Design the simple machine elements along with shaft keys and coupling.
3. Analyze different stresses in power screws and apply those in the procedure to design screw jack.
4. Evaluate the stress developed on the different type of welded, threaded and rivet joints.
5. Apply the design procedure for different types of springs.
6. Analyze the stresses in pressure vessels

Unit I-Introduction to Design Procedure and Components

Introduction to stresses, FOS, Basic Procedure of machine design , Design considerations, Use of preferred series, Standards and codes, Design of Cotter joint, Knuckle joint, Design of lever for safety valve, bell crank lever, Design of components subjected to eccentric loading (Theoretical treatment only).

Unit II-Design of Shaft , Key & Coupling

Shaft design on the Strength basis, torsional rigidity basis and lateral rigidity basis, Design of shaft as per A.S.M.E. code. Design of square and rectangular keys, Kennedy key and splines. Design of Flange Coupling and Bushed-Pin Flexible Coupling (Theoretical treatment only)

Unit III-Design of Power Screw

Terminology of Power Screw, Torque analysis and Design of power screws with square and trapezoidal threads, Collar friction torque, Self-locking screw, Efficiency of square threaded screw, Efficiency of self-locking screw, Design of screw, nuts and C-Clamp. Design of screw jack, Differential and Compound Screw and Re-circulating Ball Screw (Theoretical treatment only).

Unit IV- Design of Joints

Introduction to welded joints, Strength of butt, parallel and transverse fillet welds, Axially loaded unsymmetrical welded joints, Eccentric load in plane of welds, Welded joints subjected to bending and torsional moments. Introduction to Rivet Joints and its design. Introduction to threaded joints, Bolts of uniform strength, locking devices, eccentrically loaded bolted joint in shear, Eccentric load

perpendicular and parallel to axis of bolt, Eccentric load on circular base. (Theoretical treatment only)

Unit V-Design of Spring

Types and applications of springs, Stress and deflection equations for helical compression Springs, Springs in series and parallel, Design of helical springs, concentric helical springs, surge in spring, Design of Multi-leaf springs, Nipping of Leaf springs, Shot Peening. Design of Leaf Spring, standard suspensions in Automobiles.

Unit VI-Design of Pressure Vessel

Classification of Pressure Vessel, Stresses in vessels, Thin and Thick cylinders subjected to internal pressure, compound cylindrical shells, stresses in compound shells, cylinder heads and cover plates, recent vessels

Design of vertical vessels- , Compressive stress caused by dead loads, The axial stresses (tensile and compressive) due to wind loads on self-supporting tall vertical vessel, The stress resulting from seismic loads,. Stress due to eccentricity of loads (tensile or compressive),. Estimation of height of the tall vessel (x) (Theoretical treatment only)

Text Book

1. Bhandari V.B. – " Design of Machine Elements" – Tata McGraw Hill Publ. Co. Ltd., ISBN-0080681891
2. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. Ltd., ISBN- 0081088839

Reference Books :

1. Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
2. Juvinal R.C., Fundamentals of Machine Components Design, John Wiley and Sons.
3. Black P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
4. Willium C. Orthwein, Machine Components Design, West Publishing Co. and Jaico Publications House
5. Hall A.S., Holowenko A.R. and Laughlin H.G, Theory and Problems of Machine Design, Schaum's Outline Series.
6. C. S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learing Pvt. Ltd.
7. D. K. Aggarwal & P. C. Sharma, Machine Design, S.K Kataria and Sons.
8. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learing Pvt. Ltd.
9. Design Data - P.S.G. College of Technology, Coimbatore.
10. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers.

Prepared by- Dr. D. N. Kamble

BOS Member-Dr. A.R. Mache

BOS Chairman- Dr. D. N. Kamble

I C Engine and Alternative Fuels (MEUA31205A)

Tcaching Scheme	Examination Scheme						
Credits : 4 Lectures : 3 Hrs/week Practical : 2 Hrs/week Tutorial : Nil	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Engineering Chemistry, Thermodynamics, Applied Thermodynamics

Course objectives:

- To get familiar with the fundamentals of IC engines, construction and working principle of an engine, and testing of an engine for analyzing its performance.
- To study the combustion and its controlling factors.
- To study emissions from IC engines and its controlling methods and emission norms.
- To study various alternative fuels for IC engines.

Course Outcomes:

By the end of the course, students will be able to

1. Classify various types of Engines, Compare Air standard, Fuel Air and Actual cycles and make out various losses in real cycles.
2. Understand SI & CI Engine systems.
3. Describe the stages of combustion in SI and CI engines.
4. Understand the basics of alternative fuels for IC engines.
5. Describe alternative fuels for SI and CI engines.
6. Explain the testing and analysis of I. C. Engines performance.

Unit I - Basics of IC Engines

Heat Engine, IC and EC engines / Engine classification, IC Engine construction - components and materials, Engine nomenclature, Valve timing diagram, Intake and exhaust system, IC Engine Applications.

Fuel air standard cycle, Assumptions, Comparison with air standard cycle, Effect of variables on performance, Actual cycle, and various losses.

Unit II - Engine Systems

Fuel Injection System for S. I. Engines- Principle of carburetion, Simple or elementary carburetor, Complete carburetor, Types of carburetors, MPFI System.

Fuel Injection System for C. I. Engines- Direct & Indirect Fuel Injection System, Types of fuel pump and Injector.

Cooling System, Lubrication System, Ignition System, Starting System, Supercharging and turbo-charging methods and their limitations, Timing System.

Unit III - Combustion in SI & CI Engines

Stages of combustion, Factors affecting combustion, Flame propagation, Rate of pressure rise, abnormal combustion, Phenomenon of Detonation in SI engines, Effect of engine variables on Detonation. Phenomenon of knocking in CI engine. Effects of knocking, Methods to control knock, Comparison of knocking in SI & CI engines.

Unit IV - Testing of IC Engines

Objective of testing, Various performance parameters for IC Engine - Indicated power, brake power, friction power, SFC, A/F ratio etc. Methods to determine various performance parameters, characteristic curves, Heat balance sheet.

Unit V – Introduction to Alternative Fuels for IC Engine

Need for alternate fuel, Availability and properties of alternate fuels, General use of Alcohols, LPG, Hydrogen, Ammonia, CNG and LNG, Vegetable oils and Biogas, Merits and demerits of various alternate fuels

Unit VI- Performance and Emission Characteristics of Alternate fuel

Requirements of blends, neet (Pure) form, Reformed fuels, Storage & safety, Performance and Emission Measurement Technique, Emission Norms & characteristics (BS & EURO), Emission Control Methods

Term-Work

Any **eight** experiments of the following-

1. Demonstration & study of commercial exhaust gas analyzers.
2. Test on multi cylinder Petrol / Gas engine for determination of friction power (Mores Test).
3. Test on diesel engine to determine various efficiencies,
4. Test on variable speed diesel / petrol engine.
5. Study of multi cylinder Petrol / Gas engine using alternative fuel to study performance parameters.
6. Assignment on alternative fuels used for IC engines.
7. Visit to Automobile service station / engine manufacturing plant.
8. Assignment using any engine simulation software.
9. Assignment on any one advanced technology related to I.C. Engine such as VVT, VGT, HCCI, CRDI etc.

Text Books

1. V. Ganesan - Internal Combustion Engines, Tata McGraw-Hill
2. M.L. Mathur and R.P. Sharma - A course in Internal combustion engines, Dhanpat Rai
3. H.N. Gupta - Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd.

Reference Books :

1. Heywood - Internal Combustion Engine Fundamentals, Tata McGraw-Hill
2. Domkundwar & Domkundwar - Internal Combustion Engine; Dhanpat Rai
3. R. Yadav - Internal Combustion Engine, Central Book Depot, Allahabad
4. Alternate Fuels – Dr. S. S. Thipse – Jaico Publications
5. Richard. L. Bechfold, Alternative Fuels Guide BooK, SAE International Warrendale – 1997.
6. Alternative Fuels Guidebook – Bechtold R
7. The properties and performance of modern alternative fuels" – SAE Paper no. 841210

Course Coordinator: Mr. C.R.Ramtirthkar
BoS Member: Dr. A.D.Kale
BoS Chairman: Dr. D. N. Kamble

Composite Materials (MEUA31205B)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hr./week Tutorial (T): -- hr Practical (P): 2 hrs./week	20	30	20	30	--	25	125

Prerequisite: Strength of Material, Design of Machine Elements, Material Science

Course Objectives :

- To understand importance of composite materials in various applications such as aerospace, automotive
- To understand various fabrication methods of composite material
- To know various composite testing methods and standards of testing
- To develop an understanding of the micro and macro mechanical analysis of composite materials

Course Outcomes : By the end of the course, students will be able to

1. Identify different types of composite materials and its constituents and list its applications in various fields
2. Understand the various manufacturing methods of composite materials
3. Apply various ASTM testing standards for characterizing composite materials
4. Apply strength of material approach to analyze a lamina at micromechanical level
5. Analyze composite lamina at macro-mechanical level
6. Apply Classical Lamination Theory for the analysis of composite laminates

Unit I - Introduction to Composite Material

Introduction to Composite Materials, classification of composite materials, Matrices and Reinforcement, Types of Fiber Reinforcement, Types of matrix materials- Thermoset and Thermoplastic, Advantages and Disadvantages, Applications of composite materials, Mechanics Terminology

Unit II -Manufacturing of Composite Material

Composite manufacturing processes for fiber reinforced polymer composite- Hand Lay-up process, Compression molding process, Vacuum Impregnation Methods, Resin Transfer molding, Filament winding , Pultrusion, Prepregs, Composite Manufacturing Processes for- metal matrix composite, ceramic matrix composite.

Unit III -Composite Material Characterization

Composite testing, Need for testing ,Major types of testing, Physical testing, Mechanical testing as per ASTM standards- Tensile, compression, shear, flexural, impact, fatigue and creep test, Chemical testing , Thermal testing

Unit IV -Micromechanical Analysis of a Lamina

Volume and Mass Fractions, Density, and Void Content , Evaluation of the Elastic Moduli- Strength of material approach- Representative Volume Element (RVE), Rule of Mixtures, Inverse Rule of Mixtures. Ultimate Strengths of a Unidirectional Lamina, Coefficient of thermal expansion , Coefficient of moisture expansion

Unit V - Macromechanical Analysis of Lamina

Hooke's Law for Different Types of Materials- Anisotropic Material, Orthotropic/Specially Orthotropic, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Two-Dimensional Angle Lamina, Strength Failure Theories of an Angle Lamina- Tsai–Wu Failure Theory

Unit VI - Analysis of Laminates

Laminate Code, Classical Lamination Theory- Stress–Strain and Strain-Displacement Equations, Strain and Stress in a Laminate, Force and Moment resultants related to Midplane Strains and Curvatures, extensional, coupling, and bending stiffness matrices, analyzing a laminated composite. Special Cases of Laminates- Symmetric Laminates, Cross-Ply Laminates, Angle Ply Laminates, Antisymmetric Laminates, Balanced Laminate, Quasi-Isotropic Laminates

Term Work

The Term work is consisting of following Assignments: (Any 8)

1. Demonstration on manufacturing of fiber reinforced composite laminate using compression molding machine.
2. Demonstration on manufacturing of fiber reinforced composite laminate using vacuum bagging technique
3. To determine experimentally volume fraction of fiber reinforcement and resin in composite laminate
4. To determine experimentally Estimation of void fraction in composite laminate
5. Study of composite material testings using ASTM standards
6. Study of energy absorption of composite material using impact testing
7. Any one assignment from (i) Micromechanical Analysis of lamina using MATLAB; (ii) Macromechanical Analysis of lamina using MATLAB; (iii) Macromechanical Analysis of laminate using MATLAB
8. Finite Element simulation of composite laminate using any suitable software

Industrial visit to nearby composite manufacturing industry

Text Books :

1. Autar K. Kaw, Mechanics of Composite Materials, , CRC, Taylor and Francis 2006, ISBN-10-0-8493-1343-0.
2. Robert M. Jones, Mechanics of Composite Materials, Taylor and Francis 2010, ISBN-10-1-56032-812-X.
3. Madhujit Mukhopodhyay , Mechanics of Composite Materials and Structures , University Press (India) PVT Ltd, 2009, ISBN- 9888183814881
4. Mallick PK, Fiber-reinforced composites- materials, manufacturing, and design. CRC press, Taylor and Francis Group 2008; ISBN- 13- 988-0-8493-4205-9.

Reference Books :

1. Isaac M. Daniels, Orilshai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials- Engineering and Science", CRC Press, Boca Raton, 03.
4. Mazumdar S. K., "Composite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 02.

Prepared by: Dr. A.R. Mache –
BOS Member: Dr. S.V.Dravid
BOS Chairman: Dr. Dinesh Kamble

Advanced Manufacturing Processes (MEUA31205C)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hr./week Tutorial (T): -- hr Practical (P): 2 hrs./week	20	30	20	30	--	25	125

Perquisites: Manufacturing Processes, Manufacturing Technology, Metrology and Quality Control, and Material Science

Course Objectives:

- To demonstrate working principles, process parameters and applications of advanced manufacturing processes
- To demonstrate working principles and applications of material characterization techniques for knowing composition and structure of a material

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

1. Compare details of special forming processes.
2. Differentiate advanced joining processes.
3. Distinguish hybrid non-conventional machining techniques.
4. Explain distinguish characteristics of micro and nano fabrication techniques.
5. Elaborate additive manufacturing processes
6. Explain material characterization techniques to identify composition and structure

Unit I: Special Forming Processes

Principle, Process variables, characteristics, advantages, limitations and applications of high energy rate forming process, high velocity forming, explosive forming, magnetic pulse forming, electro hydraulic forming, metal spinning, flow forming, stretch forming, incremental sheet metal forming, petro-forge forming, micro forming, micro coining, micro extrusion, micro bending/laser bending, fine blanking.

Unit II: Advanced Joining Processes

Friction stir welding, Electron Beam welding, Laser beam welding, Ultrasonic welding, Under water welding, Cryogenic welding, Thermal spray coatings, Welding of plastics and composites, Explosive joining, Adhesive bonding

Unit III: Hybrid Non-conventional Machining Techniques

Introduction to hybrid processes, Abrasive flow finishing, Magnetic abrasive finishing, Abrasive water-jet machining, Wire electric discharge machining, Electrochemical grinding, Electrochemical Deburring, Shaped tube electrolytic machining, Electro-jet Machining, Electrolytic In-process dressing, Ultrasonic assisted EDM, Rotary EDM, Electrochemical discharge Machining, Laser surface treatments.

Unit IV: Micro Machining and Nano Fabrication Techniques

Introduction, need of micro and nano machining, Machine/setup, Process parameters, Mechanism of material removal, Applications, Advances of the Diamond Turn machining, Ultrasonic micromachining, Focused Ion Beam Machining, Lithography, photochemical machining, Challenges in micro and nano fabrication techniques.

Unit V: Additive Manufacturing Processes

Introduction and principle of the additive manufacturing process; generalized additive manufacturing process chain; classification of additive manufacturing processes and its principle, process steps and materials; post-processing of parts manufactured by Additive Manufacturing (AM) processes, software issues in AM, Design For Additive Manufacturing (DFAM), applications of AM in medical and aerospace technologies

Unit VI: Material Characterization Techniques

Introduction: Material Characterization Microscopy: Electron Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope, Field Ion Microscope; Spectroscopy: Energy-dispersive X-ray spectroscopy, X-Ray Diffraction, X-Ray Photoelectron Spectroscopy (XPS), Nuclear Magnetic Resonance Spectroscopy (NMR), Electron Backscatter Diffraction (EBSD)

Term Work(Any 6)

1) Case study on any one special forming process (List of Industries, applications, state-of-the-art, and patents filed).
2) Case study on advanced joining processes (Industry visit and state-of-the-art, and patents filed).
3) Manufacturing using any one non-conventional machining techniques
4) Report on challenges in micro machining and nano fabrication techniques to be prepared on interacting with the industry, research, and academic experts.
5) Manufacturing of complicated geometry using 3D printing
6) Metallurgical lab/Industry/Research institute visit report on material characterization techniques.
7) A review on machine learning techniques in advanced manufacturing processes

Text Books:

1. V. K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd.
2. M. P Groover., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 6th Edition, Wiley 2015 3.
3. A. Ghosh, A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd., New Delhi

Reference Books:

1. ASM: Metal Handbook, Volume 6, "Welding, Brazing and Soldering", Metal Park, Ohio.
2. ASM: Metal Handbook, Volume 14, "Forming", Metal Park, Ohio.
3. V. K. Jain, Micro manufacturing Processes, CRC Press ISBN-13: 978-1138076426 ISBN-

Course Coordinator: Prof. Satish Chinchanikar

BoS Member: Dr. A.P.Kulkarni

BoS Chairmau: Dr. Dinesh Kamble

Project I (MEUA31206)

(Programming for Mechanical Engineers)

Teaching Scheme	Examination Scheme					
Credits: 2	CIE	ISE	SCE	ESE	PR/OR/TW	Total
Lecture (L): 1 hr./week Tutorial (T): -- hr Practical (P): 2 hrs./week	-	-	-	-	25	25

Prerequisite:

Course objectives:

- To impart fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.

Course Outcomes:

On completion of the course, learner will be able to

1. Use the syntax and semantics of java programming language and basic concepts of OOP.
2. Develop java programs using the concepts of inheritance, methods overloading and polymorphism.

Unit I- Introduction to JAVA

Fundamentals of Object-Oriented Programming; Object and Classes, Java Features.
Variables and Data Types, Constant, Data Types, Scope of variable, Symbolic Constant, Type casting, Operator and Expression: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operator Increment and Decrement Operator, Conditional Operator, Bit wise Operator, Special Operator.
Decision making and Branching: Decision making with if statement, The if else statement, The else if ladder, The switch statement.
Decision making and Looping: The While statement, The do statement, The for statement,
Arrays, One Dimensional array, Creating an array, Two-Dimensional array, Strings

Unit II- Classes, Objects and Methods

Defining a class, creating object, Accessing class members, Visibility Control: Public access, Protected access, Private access, Private Protected access
Constructor, Methods Overloading, Static Member
Inheritance, Extending a Class, Types of inheritance,
Polymorphism, Overriding Methods, Final variable and Methods, Final Classes, Abstract method and Classes

List of Practical:

Lab practice shall be consisting of any Eight from the following assignments -

1. Installation of JDK, source code editor and HelloWorld program.
2. Write a Java program to convert temperature from Celsius degree to Fahrenheit.
3. Write a Java program to accept a number and check the number is even or odd.
4. Write a Java program that takes a number as input and prints its multiplication table upto 10.
5. Write a Java program to print the area and perimeter of a circle.
6. Write a Java program to create 2-dimentional matrix and perform matrix multiplication.
7. Write a Java program called IncomeTaxCalculator for salaried Employee. Design employee class with attributes like Emp_id, Emp_name, Age, Annual_income, Tax etc and calculate total income tax for a particular financial year. (Use java methods)
8. Write a Java program called IncomeTaxCalculator for salaried Employee. Design employee

class with attributes like Emp_id, Emp_name, Age, Annual_income, Tax etc and calculate total income tax for a particular financial year. (Use constructor methods)

9. Write a Java program to calculate area and perimeter of basic geometric figures using method overloading.
10. Design a bank account class with constructor and methods to deposit, to withdraw from, change the name, charge a fee and print a summary of the account using toString() method. Derive saving and current account from Account, overrides method and print summary of saving and current account.
11. Design Vehicle class hierarchy to implement different kinds of inheritance. Use Super, this, static keywords.
12. Design Shape class hierarchy. Implement Polymorphism on draw method.
13. Write a Java program to implement Interface
14. Demonstration of data structures in Java

Text Books:

1. Jeff Friessen; "Beginning java 6 platform from Novice to Professional", press/Springer,9788181288769
2. Gallardo, Burnette, McGrovern ," Eclipse in action: a guide for java Developers", Manning,9788177224986

Reference Books :

1. Khalid A Mughal, "A programmer's guide to Java SCJP Certification", Third Edition, Pearson Education ,978-81-317-2688-4

Prepared by- Mr. Prashant R. Anerao
BOS Member-
BOS Chairman- Dr. Dinesh N. Kamble

Semester II

Transmission System Design (MEUA32201)

Teaching Scheme	Examination Scheme						
Credits : 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L) : 3 hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Pre-requisite: Engg. Graphics, Strength of Materials, Theory of Machines, CAMD, Design of Machine Elements

Course objectives:

1. Enable students to apply fundamentals for the design and/or selection of elements in transmission systems.
2. Broaden skills in team work, critical thinking, communication, planning and scheduling through design projects.
3. Enable students to apply engineering tools/techniques to product design.
4. Give practice in longer open-ended problems using design methodology.

Course Outcomes: Upon the completion of the course students will able to

1. Evaluate dimensions of machine components under fluctuating loads.
2. Understand and apply principles of gear design to spur and Helical gears for required applications.
3. Design the Bevel Gears for required applications.
4. Design and select different types of bearings from manufacturer's Catalogue.
5. Apply various concepts to Design Machine Tool Gear box, for different applications.
6. Design belt conveyer system for material handling system.

Unit 1 – Design Against Fluctuating Stresses

Stress concentration and its factors, Reduction of stress concentration factors, fluctuating stresses, fatigue failures, endurance limit, S-N curve, Notch sensitivity, Endurance limit, Endurance strength modifying factors, Reversed stresses – Design for Finite and Infinite life, Cumulative damage in fatigue failure, Soderberg, Gerber, Goodman Lines, Modified Goodman diagrams, Fatigue design under combined stresses.

Unit 2 - Design of Spur and Helical Gear

Gears basics: Selection of materials for gears, Standard systems of gear tooth, and Basic modes of gear tooth failures.

Spur Gears: Number of teeth and face width, Beam strength (Lewis) equation, 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, Design of spur gear, Force analysis.

(Self-Learning): Velocity factor, Service factor, Load concentration factor

Helical Gears: Beam and wear strengths, Effective load on gear tooth, Estimation of dynamic load by velocity factor and Buckingham's equation, Design of helical gears, Force

Unit 3 – Design of Bevel gears

Bevel Gear: Beam strength of bevel gears, Wear strength of bevel gears, and effective load on gear tooth, gear design for maximum power transmission Force analysis

(Self-Learning): Spiral Bevel Gears. Gear Terminology, Virtual number of teeth

Unit 4 - Sliding & Rolling contact Bearing

Sliding contact bearing: Introduction to sliding contact bearing, classification, Reynolds's equation (2D), Petroff's equations, Sommerfeld number, Parameters of bearing design.
Rolling Contact Bearings: Types of rolling contact Bearings and its selection, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent bearing load, Load-life relationship, Selection of bearing life, Selection of rolling contact bearings from manufacturer's catalogue, Design for cyclic loads, Types of failure in rolling contact bearings - causes and remedies.

Unit 5 – Design of M/C Tool Gear Box

Introduction to Machine Tool Gearboxes, classification, basic considerations in design of drives and its Applications, Determination of variable speed range, Graphical representation of speed and structure diagram, Ray diagram, selection of optimum ray diagram, Kinematic /Gearing Diagram, Deviation diagram, Difference between numbers of teeth of successive gears in a change gear box.

Unit 6 – Design of belt conveyor system for Material Handling

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt eonveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.

List of Practical

1) To Demonstrate and determine a material's fatigue behavior by using Fatigue testing Machine.
2) To study the performance of Brittle/Ductile Material using Rotating beam fatigue Testing Machine.
3) Design Project 1 (Any one)
a] Design of gearbox for wind mill application or sluice gate. b.] Design of gearbox for building Elevator. c.] Design of gearbox for Hoist.
4) Design Project 2 (Any one)
a.] Design of Conveyor System, b.] Design of multispeed Gearbox. c.] Design of Pressure Vessel.

***The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D Any 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.

Reference Books :

1. Spotts M.F. and Shoup T.E. – "Design of Machine Elements" – Prentice Hall International. ISBN-8177584219.
2. Design Data Book– P.S.G. College of Technology, Coimbatore.
3. Juvinal R.C. – "Fundamentals of Machine Components Design" – John Wiley and Sons. ISBN-1118214110
4. Allen Strickland Hall, A. Holowenko, Herman G. Laughlin – "Schaum's Outline of Machine Design". ISBN-0070255954
5. R. L. Norton-"Machine Design: An Integrated Approach"; Pearson Education India. ISBN-8131705331

Course Coordinator: Mr. M.N. Jagdale.
BoS Member: Dr. N.H.Ambhore
BoS Chairman: Dr. Dinesh Kamble

Refrigeration and Air-conditioning (MEUA32202A)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Basics of thermodynamics, Fluid Mechanics and Heat Transfer

Course objectives:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Understand various refrigeration cycles and evaluate performance using Mollier charts and/ or refrigerant property tables.
3. Comparative study of different refrigerants with respect to properties, applications and environmental issues.
4. Study the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
5. Studyof the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

Course Outcomes: By the end of the course, students will

1) Understand the fundamental principles of refrigeration and air conditioning
2) Explain working details of Vapour Compression Cycle and system.
3) Calculate cooling capacity and coefficient of performance of vapor compression refrigeration systems.
4) Present the properties, applications and environmental issues of different refrigerants.
5) Calculate cooling load for air conditioning systems used for various applications.
6) Demonstrate the analysis process of refrigeration and air conditioning systems.

Unit I - Fundamentals & Applications of Refrigeration and Air Conditioning

Reverse Carnot cycle, block diagram of refrigerator & heat pump, modified reverse Carnot cycle (Bell Coleman cycle), Applications of Refrigeration and Air Conditioning, Refrigerants, environmental issues and selection of Compressor

Unit II - Vapour Compression Cycle and systems

Working of simple vapour compression system, representation of vapour compression cycle (VCC) on T-s and P-h diagram, COP, EER, SEER, IPLV, NPLV, effect of operating parameters on performance of VCC(Numerical), actual VCC, methods of improving COP using flash chamber, sub-cooling and liquid vapour heat exchanger, comparison of VCC with Reverse carnot cycle. Analysis of VCC using Cool Pack/ VAP software.

Unit III - Vapour Absorption System

Introduction, Working of simple vapour absorption system (VAS), desirable properties of binary mixture (aqua-ammonia), performance evaluation of simple VAS (simple numerical treatment), actual VAS, Li-Br absorption system, three fluid system (Electrolux refrigeration), applications of VAS, comparison between VCC and VAC.

Unit IV - Psychrometry and Air conditioning Processes

Introduction to air conditioning, psychrometry, psychrometric properties and terms, psychrometric relations, Psychrometric processes and its representation on psychrometric chart, BPF of coil, ADP, adiabatic mixing of two air streams. (Numerical)

Unit V - Air conditioning system- Cooling Load Calculations

Psychrometric chart with numerical on SHF, RSHF, GSHF, ESHF. factors contributing to cooling load. Cooling Load Calculations (Numerical), Concept of infiltration and ventilation
Thermodynamics of human body, comfort and comfort chart, factors affecting human comfort, , Indoor air quality requirements,

Unit VI - Air Conditioning systems and Ducts

Air handling unit, Classification of ducts, duct material, pressure in ducts, pressure losses in duct (friction losses, dynamic losses), Working of summer, winter and all year round AC systems and their materials, all air system, all water system, air water system, unitary and central air conditioning. Design of duct using software's like cool pack, McQuay Duct Sizer etc.

Term-Work

The Term-Work shall consist of any eight experiments

1) Test on Domestic Refrigerator for evaluation of EER
2) Test on vapour compression test rig
3) Test on air conditioning test rig
4) Test on ice plant test rig
5) Test on vapour absorption test rig
6) Visit to Vapour absorption refrigeration plant
7) Estimation of cooling load of simple air conditioning system (case study)
8) Case study on cold storage
9) Visit to any refrigeration or air conditioning plant
10) Thermal analysis of refrigeration cycle using suitable software

Text Books:

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill
2. Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpatrai& Company, New Delhi
3. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi,1994.
4. Sapali S.N., Refrigeration and Air Conditioning, PHI learning Pvt. Ltd, New Delhi.

Reference Books :

1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000
2. Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International editions 1982.
3. Threlkeld J.L, Thermal Environmental Engineering, Prentice Hall Inc., New Delhi
4. Aanatnarayan, Basics of refrigeration and Air Conditioning, Tata McGraw Hill Publications
5. Roger Legg, Air Conditioning System Design, Commissioning and Maintenance
6. ASHRAE & ISHRAE handbook

Course Coordinator: Dr. A.D.Kale
BoS Member: Dr. S.S.Kore
BoS Chairman: Dr. Dinesh Kamble

Operations Research (MEUA32202B)

Teaching scheme	Examination Scheme						
Credits: 4 Lectures (L): 3 Hrs./week Tutorial (T): - Practical (P): - 2 Hrs./Week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	--	25	125

Prerequisitc: Engineering Mathematics

Course objectives:

- To familiarize the students with various tools of optimization, probability and statistics as applicable scenarios in industry for better management of various resources

Course Outcomes:

By the end of the course, students will be able to

7. Solve linear programming problems using appropriate techniques
8. Propose the best strategy using decision making methods under uncertainty and game theory
9. Apply the concept of transportation/assignment models to optimize available resources
10. Develop mathematical skill to solve inventory and replacement problems
11. Perform minimization of process time
12. Apply CPM and PERT techniques, to plan, schedule, and control project activities.

Unit I - Introduction to Operations Research

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem: Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, Two-phase method, Duality. Self-learning exercise: Some case studies referring to research papers.

Unit II – Decision Theory and Theory of Games

Decision Theory: Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, Decision under Risk, Decision under Uncertainty, Decision Trees. Theory of Games: Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance, Solution by Graphical Method, m x n size Game Problem. Self-learning exercise: Some case studies referring to research papers.

Unit III – Transportation and Assignment Model

Transportation Model: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment model: Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Self-learning exercise: Some case studies referring to research papers.

Unit IV – Inventory Control and Replacement Analysis

Inventory Control: Basic Concepts, fixed order quantity inventory model, economic order quantity

inventory models, probabilistic inventory model. Replacement Analysis: Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly: Individual replacement policy, Group replacement policy. Self-learning exercise: Some case studies referring to research papers.

Unit V – Queuing Theory and Sequencing Model

Queuing Theory: Introduction, Basis Structure, Terminology (Kendal's Notations), Queuing Model M/M/1: /FIFO, M/M/c. Sequencing models: Solution of sequencing Problem - Processing of n jobs through two machines, Processing of n jobs through three machines, Processing of two jobs through m Machines, Processing of n jobs through m Machines. Self-learning exercise: Some case studies referring to research papers.

Unit VI – Project Management

Fundamentals of CPM and PERT networks, CPM: Construction of networks, Fulkerson's rule , Critical paths, Forward and backward pass, Activity Float analysis, Crashing Analysis, PERT: Time estimates, Construction of networks, Probability of completing projects by given date. Self-learning exercise: Some case studies referring to research papers.

Practical

1. Linear Programming Problem: Graphical solution of LPP, simplex method, and two-phase method
2. Decision Trees and solution by graphical method, m x n size Game problem
3. Transportation and Assignment model: Optimality test and solving unbalanced problem
4. Economic order quantity inventory models, Individual and group replacement policies
5. Queuing and sequencing models. Case study referring to research papers.
6. CPM and PERT: Crashing Analysis, case study referring to research papers

Text Books:

4. Sharma S.D., "Operations Research", Kedarnath Ramnath and company publications. ISBN-13:1234567142552
5. Gupta P.K., Hira D.S., "Operations Research", S Chand and Co. Ltd., New Delhi. ISBN 13:9788121902816
6. Taha H.A., "Operations Research - An introduction", Prentice Hall Pvt. Ltd. ISBN-13: 978-0132555937

Reference Books:

1. Hillier F.S., Lieberman G.J., "Introduction to Operations Research", Tata McGraw-Hill. ISBN 978-0-07-337629-5
2. Wagner H.M., "Principles of Operations Research", Prentice-Hall India ISBN 978-0-9843378-2-8
3. Ravindran A., "Operations Research", Tata McGraw-Hill. New Delhi ISBN-13: 978-0471086086
4. Basu S.K., Pal D.K., and Bagchi H., "Operations Research for Engineers", Oxford and IBH Publishing ISBN 81-204-1251-6
5. Panneerselvam R., "Operations Research", Prentice Hall of India Ltd., New Delhi ISBN 81-203-1923-0

Course Coordinator: Prof. Prashant Anerao

BoS Member: Dr. S.S.Chinchanikar

BoS Chairman: Dr. Dinesh Kamble

Artificial Intelligence and Machine Learning (MEUA32202C)

Teacbing Scheme	**Examination Scheme**						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): --. Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	--	25	125

Prerequisite: Linear Algebra, Probability and Statistics, Data Analytics

Course Objectives:
1. Familiarize with fundamentals of artificial intelligence and machine learning.
2. Realize basic algorithms used in classification and regression problems.
3. Implement and Analyze machine learning model in mechanical engineering problems.

Course Outcomes: Upon completion of the course, students will be able to
1. Demonstrate fundamentals of artificial intelligence and machine learning.
2. Apply feature extraction and selection techniques.
3. Apply machine learning algorithms for classification and regression problems.
4. Devise and develop a machine learning model using various steps.
5. Explain concepts of reinforced and deep learning.
6. Simulate machine learning model in mechanical engineering problems.

Unit I : Introduction to Artificial Intelligence and Machine

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

Unit II: Feature Extraction and Selection

Feature extraction: Statistical features, Principal Component Analysis
Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering.

Unit III: Classification and Regression

Classification: Decision tree, Random Forest, Naive Bayes, Support vector machine. **Regression:** Logistic Regression, Support Vector Regression. **Regression trees:** Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Mechanical Engineering.

Unit IV: Development of ML Model

Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predietions.

Unit V : Reinforced Learning

Characteristics of reinforced learning; **Algorithms:** Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; **Models**: Markov Decision Process, Q Learning. Application of Reinforced in Mechanical Engineering.
Unit VI: Deep Learning
Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network. Application of Deep Learning in Mechanical Engineering.
List of Practical:
1. To study supervised/unsupervised/Reinforcement learning approach. 2. To acquire, visualize and analyze the data set (from time-domain/ frequency-domain/ etc.) . 3. To extract features from given data set and establish training data. 4. To select relevant features using suitable technique. 5. To use Principal Component Analysis for dimensionality reduction. 6. To classify features/To develop classification model and evaluate its performance (any one classifier). 7. To develop regression model and evaluate its performance (any one algorithm). 8. Markov process for modelling manufacturing processes. **Note:** Students need to apply the computational algorithms using suitable software / programming language.
Text Books:
1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020. 2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020. 3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015 4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.
Reference Books :
1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018. 2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018. 3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021. 4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018) 5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Prepared By- Dr. Pravin P Hujare

BOS Member- Dr.A.P.Kulkarni

BOS Chairman- Dr.Dinesh N Kamble

Mechanical Vibration (MEUA32203)

Teaching Scheme	Examination Scheme						
Credits :4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Engineering Mathematics, Strength of Materials, Theory of Machines.

Course objectives:

- To understand the fundamentals of free and forced vibrations.
- To develop analytical competency in solving vibration problems.
- To study vibration characteristics of the multi degrees of freedom system.
- To familiar with various vibrations measurement instruments and vibration control techniques.

Course Outcomes:

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

1. Demonstrate and create mathematical model of vibratory system
2. Analyze the mathematical model of a linear vibratory system to determine its response
3. Estimate natural frequency for single DOF undamped and damped free vibratory systems.
4. Determine response to forced vibrations due to harmonic excitation, base excitation and excitation due to unbalance forces.
5. Estimate natural frequencies, mode shapes for 2 DOF undamped free longitudinal and torsional vibratory systems.
6. Apply technique to use vibration measuring instruments for industrial/real life applications along with suitable method for vibration control.

Unit I- Fundamentals of Vibration

Brief history of mechanical vibration, importance of the study of vibration, Terminology of vibratory system, Elements of vibratory system, modeling of system. degree of freedom, discrete and continuous system, Equivalent systems- Springs in series and parallel, types of vibration, Resonance Phenomenon-practical examples.

Unit II- Undamped Free Vibration of Single Degree Freedom System

Evaluation of natural frequency,Equilibrium method, Energy method and Rayleigh's methods, Natural frequency for longitudinal, transverse,and torsional vibratory systems.

Unit III- Damped Free Vibration of Single Degree Freedom System

Different types of damping, Damped free vibrations with viscous damping, study of vibration response of over damped, critically damped and under damped systems, logarithmic decrement, introduction to damped free torsional vibrations.

Unit IV- Forced Vibrations- Single Degree Freedom System

Types of source of excitation, resonance phenomenon, forced damped vibrations of longitudinal systems with constant harmonic excitation,magnification factor, frequency response to harmonic excitation phase difference, excitation due to reciprocating and rotating unbalance, forced vibration due to base excitation. Force and Motion transmissibility. Quality factor and bandwidth.
Critical speed of shaft having single rotor of undamped systems (Theoretical treatment)

Unit V- Undamped Vibration of Two Degree Freedom Systems

Introduction of two degree of freedom system, Free undampedlongitudinal vibrations of two degrees of freedom system, natural frequency and mode shapes, Evaluation of Eigen value and Eigen vector by Matrix method. Free torsional vibrations of two rotor system.

Uuit VI- Measurement and Control of Vibration

Vibration measurements- vibration measuring devices, accelerometers, impact hammer, vibration shaker-construction, principles of operation and uses, vibration analyzer, analysis of vibration spectrum, standards related to measurement of vibration and accepted levels of vibration.
Vibration control- vibration control methods, passive and active vibration control, control of natural frequency, vibration isolators and undamped dynamic vibration absorbers. Types of failures on account of uncontrolled vibrations.

Tutorials-

List of tutorials-

1. To determine natural frequency and stiffness of spring-mass system.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
3. To determine natural frequency of transverse vibration of beam using vibration analyzer.
4. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration.
5. To verify natural frequency of torsional vibration of two rotor system and position of node.
6. Analysis of machine vibration signature using any analysis software package.
7. Noise measurement and analysis using vibration Analyzer
8. Experimental verification of principle of Dynamic Vibration Absorber.
9. To determine critical speed of shaft with single rotor
10. Determine the free response of an SDOF damped system with different damping using suitable software.
11. Determine total response of SDOF damped system to harmonic excitation using suitable software.

Text Books:

1. S. S. Rao, "Mechanical Vibrations", 4th Edition, Pearson Education Inc. New Delhi, ISBN-9888188588843
2. G. K.Grover, "Mechanical Vibrations", 8th Edition, New Chand and Bros,Roorkee, ISBN-988-81-85240-56-5
3. V. P.Singh, " Mechanical Vibrations", DhanpatRai and Sons, New Delhi, ISBN- 1234568150209

Reference Books :

1. W.T. Thomson, Marie Dillon Dahleh, "Theory of vibrations with applications", 5th Edition, Pearson Education Pvt. Ltd., ISBN- 9888131804820
2. Leonard Meirovitch, "Fundamentals of vibrations", Waveland PrInc; Reissue edition, ISBN-10-1588666918
3. J. P. Den Hartog, "Mechanical Vibrations", Dover Publications INC, New York, ISBN- 0-486-64885-4

Prepared by- /Dr.. N.H.Ambhore
BOS Member-Dr. A.R.Mache
BOS Chairman-Dr. D. N. Kamble

Hydraulic and Pneumatics (MEUA32204A)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3 hrs./week Practical (P): 2 hrs./week Tutorial (T): -- hr.	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	--	25	125

Prerequisite: Engineering Mechanics, Engineering Mathematics, Fluid Mechanics and machines.

Course Objectives:

- This course elaborates working principles of hydraulic and Pneumatic components, overview of various controls and will develop ability to design hydraulic and pneumatic systems according to system requirements.
- The practical session will develop the ability of hands on experience by demonstration of pumps, hydraulic and pneumatic circuits on trainer and design circuits as per the requirement by using manufacturing catalog.

Course Outcomes:

By the end of the course, students will able to

1. Explain the performance of pumps used in hydraulic systems.
2. Understand the working principle of actuators, power units and reservoirs of hydraulic system.
3. Explain the construction and working principle of various control valves used in hydraulic system.
4. Analyze and select appropriate hydraulic circuits for industrial/mobile applications
5. Explain the working principle of various components and circuits of Pneumatic system.
6. Design and draw Hydraulic and Pneumatic system according to system requirements by using manufacturing catalog.

Unit 1: Basics of Fluid Power and Pumps

Fluid power basics, advantages and limitations, Hydraulic fluid – types, properties and requirements, applications, ISO standards and API standards etc.
Pumps - types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and effieiency calculations, characteristics curves, selection and applications of pumps, API, ASME and IS standards.

Unit 2: Actuators and Power Unit

Linear and rotary actuators- types, construction and characteristics. Cylinder mountings, cushioning of cylinders, Contamination control: Contamination, sources of contamination, suction strainer, filters, filtration, filter ratings.
Power units and accessories - types of power units, reservoir assembly, constructional details. Accumulators, Intensifiers, Pressure and Temperature switches /sensors, level sensors. Pressure and temperature transmitters, Accessories for mounting of actuators

Unit 3: Fluid Power Control

Direction control valves - center positions, methods of actuation, two stage valves, Flow control valves - pressure and temperature compensated. Pressure control valves – pressure relief and reducing valves, sequence valve, unloading valve, counter balance valve, check valves, solenoid valves, proportional valves, gate valves and globe valves etc, Selection and Testing methods of valves.

Unit 4: Hydraulic Circuits & applications

Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc.

Unit 5: Pneumatics – Components, Control Valves and Circuits

Compressors - Types, principle of working and constructional details. Comparison of pneumatic & hydraulics, filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two pressure valve, quick exhaust valve and time delay valves. Speed regulating methods, pneumatic circuit applications (speed, reciprocating, time delay & quick exhaust).

Unit 6: System Analysis and Design

Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads, design considerations for cylinders, selection of different components such as reservoir, control elements, actuators, accumulator, intensifier, filters, pumps by using manufacturing catalog, Design and analysis of hydraulics circuit with open source software.

List of Practical :

Practical consist of **any eight** experiments of the following –

1. Test on Gear / Piston pump and plotting of performance characteristics.
2. Study and demonstration of various control valves (pressure / directional / flow)
3. Study and demonstration of compressed air generation and distribution system.
4. Study & demonstration of various hydraulic circuits on hydraulic trainer.
5. Study & demonstration of various pneumatic circuits on pneumatic trainer.
6. Industrial visit to automation system and repot based on it.
7. Assignment on ISO symbols for different components of Hydraulic and Pneumatic system.
8. Assignment: Standard specifications of hydraulic/ pneumatic components using manufacturer's catalogues.
9. Design of simple hydraulic systems used in practice using manufacturers' catalogue and analysis using open source software.
10. Design of simple Pneumatic systems used in practice using manufacturers' catalogue and analysis using open source software.

Text Books:

1. Esposito A, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
4. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference Books:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Course Coordinator: Mr. D. B. Nalawade

BoS Member: Dr. S. S. Kore

BoS Chairman: Dr. D. N. Kamble

Digital Manufacturing &Automation (MEUA32204B)

Teaching scheme	Examination Scheme						
Credits: 4 Lectures (L): 3 Hrs./week Tutorial (T): - Practical (P): - 2 Hrs./Week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	--	25	125

Prerequisite: Engineering Graphics, Computer aided Machine drawing, Automation in Manufacturing, Computer aided Engineering

Course Objectives:

- Create the design of an object suitable for additive manufacturing processes
- Evaluate and select appropriate 3D manufacturing technologies for specific applications
- Demonstrate proficiency in the use of additive manufacturing and 3D scanning technologies
- To understand the importance of automation in the field machine tool based manufacturing
- To get the knowledge of various elements of manufacturing automation CAD/CAM
- To understand the basic of product design and the role of manufacturing automation

Course Outcomes:

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

1. Prepare solid model for a given component
2. Understand different direct digital manufacturing technologies
3. Understand materials for direct digital manufacturing
4. Comprehensive picture of computer-based automation of manufacturing operation
5. Recognize the need of automation and RP in industry and total functionality of an industrial robot
6. Apply various sensors, transducers etc. in a manufacturing system

Unit I: Direct Digital Manufacturing

Introduction to direct digital manufacturing, manufacturing trends, 3D scanning technologies, solid modelling and CAD for DDM Design tools, pre-processing, and strength criteria, exploring design freedoms

Unit II: Direct Digital Manufacturing technologies:

Selective Laser Sintering (SLS), Stereolithography (SLA), Fused Deposition Modeling (FDM), Parameters: quality, resolution, slicing, speed, time

Unit III: Materials for Direct Digital Manufacturing

Liquid Polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems, 3D Printing, safety and sustainability, other features/ benefit, Current and Future Applications

Unit IV Computer Aided Manufacturing (CAM)

Numerical Control Machines, Computer Numerical Control, Types of CNC, Coordinate Systems, Direct & Distributed Numerical Control Machines, CNC part program, Computer aided part programming, Tooling, Controllers used, Computer Integrated Manufacturing, Computer Aided Process Planning, Computer Aided Quality Control

Unit V: Automation

Automation: Introduction, Automation strategies, Types of Automation - Hard and Soft Automation, Flexible Manufacturing System Types, Advantages, Limitations, AGVs and AS/RS, Group Technology

Unit VI: Robotics

Robotics: RIA, definition of Robot, Laws of robotics, Classification of robots, robot anatomy, Joints, End Effectors

List of Practical's (Any 8):

1. Tool path generation and simulation for Turning, Grooving, Threading and drilling with help of suitable software.
2. Tool path generation and simulation for Milling Facing, Pocketing., Contouring and drilling with help of suitable software.
3. DFAM: Powder Bed Fusion (PDF) & Direct Metal Printing (DMP)
4. 3D Scanning & Reverse Engineering
5. Manufacturing of product using additive manufacturing.
6. Case Study/ Industrial Visit based on Rapid prototyping
7. Case Study/ Industrial Visit based on Automation
8. Computer Simulation of Robot
9. Design for Additive Manufacturing (DFAM): Fused Thermoplastics
10. File Conversion, Formatting & Mesh Manipulation

Text Books:

1. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill
2. S.K. Sinha, CNC Programming using Fanuc Custom Macro B, McGraw-Hill Professional
3. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
4. Radhakrishnan P; Subramanyan S, CAD/CAM/CIM , New Age International

Reference Books:

1. Ibraim Zeid, Mastering CAD/CAM Tata McGraw Hill Publishing
2. Groover M. P, Automation Production Systems and Computer Integrated Manufacturing, PHI
3. Rao P. N., Introduction to CAD/CAM Tata McGraw Hill
4. M.P Groover, Automation, Producyion System and Computer integrated manufacturing, Prentic Hall

Course Coordinator: Prof. Avinash Somatkar
BoS Member: Dr. A.P.Kulkarni
BoS Chairman: Dr Dinesh Kamble

Electric Vehicles (MEUA32204C)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3 hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	--	25	125

Prerequisite: IC Engines, automobile Engineering

Course objective:
To understand the comprehensive overview of Electric Vehicles.

Course Outcomes:
After successful completion of this course, students will able to
1. Understand the importance of electrical vehicle and its performance.
2. Describe battery storage unit.
3. Analyze different types of electric motor for selecting in electric vehicle.
4. Design electric drive train and its components.
5. Apply different drive cycles to model the EV and select the motor after sizing.
6. Identify the advancement in Electric Vehicles

Unit I- Introduction to Electric Vehicles

History electric vehicles, social and environmental importance of electric vehicles, EV Technology, Significance of e-Vehicle. Types of electric vehicles and its components. Conventional Vehicles: Basics of vehicle performance, transmission characteristics, overview of Tesla Car

Unit II- Battery Storage Unit

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Basics – Battery Types, Battery-Lead acid batteries, lithium batteries, Nickel-Metal Hydride Batteries, Introduction to BMS, Fuel Cell based energy storage, Hybridization of different energy storage devices.

Unit III- Electric Motors

Introduction to motors, AC and DC Motors Types used in electric vehicles-Three Phase AC Induction Motors, Permanent Magnet Synchronous Motor (PMSM), DC Series Motor, Brushless DC Motor, Switched Reluctance Motors (SRM), Speed and Torque Characteristic of Motor, Comparison of all motors, selection and size of motors.

Unit IV- Electric Vehicle Drive Train

Electric Vehicle (EV) Configurations, Electric Vehicle (EV) Drivetrain Alternatives Based on Power Source Configuration, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking.

Unit V– Drive cycle & Sizing of Electric Machine

Power Train Drive Cycles, New York City Cycle (NYCC), Japanese (JP-10-15), Extra Urban Driving Cycle (EUDC), Federal Test Procedure (FTP-75), New European Driving Cycle (NEDC), Sizing of

Electric machine, Peak Torque and Power, Constant Power Speed Ratio, EM Sizing, Sizing Power Electronics, Switch Technology Selection.

Unit VI Advancement in e-vehicles

Integration of IoT in e-vehicle, Wireless sensor networks need for IoT, Intelligent Transport Systems, Degradation and disposal of batteries, modes of fast and efficient charging, and availability of charging stations as per Indian road conditions. Types of standards. Safety rules and regulations.

Term Work

Any 8 from the following list.

1. Study practically layout of electric vehicle and its Components.
2. Design Discharge circuit of Li-Ion battery
3. Design of Convention Vehicle Powertrain.
4. Design of Electric Vehicle Drivetrain
5. Electric Vehicle Modeling.
6. study and analyze Electric vehicle using Advisor tool.
7. Gradeability and Acceleration test of EV using Advisor tool.
8. Analyze Vehicle Behavior using Adam's software
9. Four-wheel alignment test
10. Industrial Visit

Text Books :

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Reference Books :

1. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000.

Course Coordinator: Mr. P.P.Rathod

BoS Member: Dr. S. S. Kore

BoS Chairman: Dr. D. N. Kamble

Product Design Engineering (MEUA32204D)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Basic Engineering Science , Material Science, Engineering Metallurgy, Manufacturing processes, Machine Design, Computer Aided Engineering

Course Objectives:

- To understand basic techniques for particular phases of product development.
- To understand basic Customer needs, satisfaction and commercialization of product.
- To understand Forward and Reverse Engineering and its role in designing a product

Course Outcomes:

Upon completion of the course, students will be able to

1. Describe an engineering design and development process.
2. Design product as per customer needs and satisfaction.
3. Apply engineering, scientific, and mathematical principles to execute a design from concept to finished product.
4. Analyze methods and processes of Forward and Reverse engineering
5. Analyze methods of Design for manufacturing and analysis.
6. Explain the product life cycle and product data management.

Unit I : Introduction to Product Design

Definition of product design, Essential Factors for product design, Modern approaches to product design, Characteristics of Successful Product Development, Innovative Thinking, Challenges to Product Development, product development versus product design.

Unit II: Product development: Technical Concerns

Technical Questioning, Technology Forecasting and S Curve, Customer Needs and Satisfaction, Types of customer need, Customer need model, Tools for gathering Customer Needs, Market segmentation, Economic Analysis of Product.

Unit III: Product Development Process

Product development process- Identification of customer needs- customer requirements, product development process flows, Product specifications, concept development and concept generation, concept selection, concept screening, concept scoring, concept testing.

Unit IV: Reverse Engineering

Introduction of reverse engineering, Product Teardown Process, Tear Down Methods, Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used in Benchmarking, Indented Assembly Cost Analysis, Function –Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product

Portfolio and Product Architecture.
Unit V: Design for X
Design for manufacture, Design for assembly, Design for robustness, Design for safety, Design for reliability, Design for environment, Design for piece part production, manufacturing cost analysis. Local, Regional and Global issues, basic life cycle assessment - basic method, Design Failure mode effect analysis.
Unit VI: Product Life Cycle Management
Introduction, Concept of Product Life Cycle management, Components/Elements of PLM, Customer Involvement, Product Data and Product Workflow, The Link Between Product Data and Product Workflow, Different Phases of Product Life Cycle and corresponding technology. Case study related to Product Life Cycle Management.
List of Practical:
1) Design of concept of Innovative product. 2) Development of concept of Innovative product using any modelling software. 3) Development of standard process for gathering customer needs related to new product. 4) Prepare product development process flows for new innovative product. 5) Application of reverse engineering technique using benchmarking of product. 6) Application for design for manufacturing and assembly. 7) Application for design for safety. 8) Application of PLM techniques in mass production system.
Text Books:
1. Product Design-Techniques in Reverse Engineering and New Product Development, Kevin Otto, Kristion Wood, Pearson Education, ISBN 978-81-7758-821-7. 2. Karl T.U. And Steven D.E., Product Design and Development, McGraw Hill, Ed 2000 3. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice Hall India.
Reference Books :
1. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000 2. Grieves, Michael, Product Lifecycle Management McGraw Hill 3. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub

BOS Member- Dr A.P.Kulkarni

BOS Chairmau- Dr. D. N. Kamble

Industrial Engineering (IOEUA32205C)

Teaching scheme	Examination Scheme						
Credits: 3 Lectures (L): 3 Hrs./week Tutorial (T): - Practical (P): - -	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-		100

Prerequisite(s): Manufacturing Processes, Engineering Mathematics, Computer Fundamentals

Course Objectives:

- To introduce the concepts, principles and framework of contents of Industrial Engineering.
- To acquaint the students with various productivity enhancement techniques.
- To acquaint the students with different aspects of Production Planning and Control and Facility Design.
- To introduce the concepts of various cost accounting practices as applied in industries
- To acquaint students with different aspect of simulation modeling for various industrial engineering applications.

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

1. Compute the partial productivity and total productivity indexes considering different influencing factors
2. Analyse each operation with a view to eliminate unnecessary operations, avoidable delays and other forms of waste.
3. Compute the standard time for a qualified worker to carry out a specified job at a defined level of performance.
4. Design a physical arrangement of facilities most economically at optimum plant location.
5. Design the production system considering an estimate of future event through past data.
6. Calculate optimum inventory level by establishing the relationship among the factors affecting profit.

Unit I: Introduction to Industrial Engineering and Productivity

Definition, Industrial engineering approach, Objectives of Industrial Engineering Role of Industrial Engineer, Techniques of industrial Engineering, Industrial engineering in service sector, Measurement of productivity: Factors affecting the productivity, Productivity Models and Index, Productivity improvement techniques. Some case studies on applications of industrial engineering to different service sectors

Unit II: Method Study

Work Study: Definition, Objectives, Procedure, Concept of work content, Method Study: Definition, Objectives, Scope and Steps involved in method study, Recording techniques, Micro-motion study, Cycle graph and chronocycle graph, Critical examination, Principles of motion economy, Concepts of value engineering and value analysis. Some case studies on method study referring to research papers.

Unit III: Work Measurements

Work Measurements: Definition, Objectives and techniques of work measurement, Steps in making time study, Types of elements, Time study equipment's, Performance rating, Allowances, Computation of standard time, Comparison of various techniques, Introduction to PMTS, MTM and MOST. Some case studies on work measurements referring to research papers.

Unit IV: Plant Location and Plant Layout

Need for selecting a suitable plant location, Factors influencing plant location, Comparison between urban and rural locations, Quantitative method for evaluation of plant location, Plant Layout: Objectives, Principles, Types, Factors affecting plant layout, Types of manufacturing systems, Tools and techniques of plant layout, Computer packages for layout analysis. Some case studies on plant layout based on actual industry visit and referring to research papers.

Unit V: Production Planning and Control – I (PPC - I)

Production Planning and Control (PPC): Need, Objectives, Functions, Production procedure, Measures of capacity, Capacity planning, Factors influencing effective capacity, Aggregate planning: Methods, advantages and limitations, Demand forecasting: Need and classification (Least square method, moving average, weighted moving average, exponential smoothing method and Casual forecasting method. Some case studies on production planning and control referring to research papers and visit to industry.

Unit VI: Production Planning and Control – II (PPC - II)

Inventory types, Inventory control: Objectives and benefits, Inventory cost relationships, Inventory models: Basic inventory models, (with and without shortage and discount), Selective control of inventory: ABC and VED analysis, Production cost concepts and break-even analysis, Cost-volume-profit analysis. Some case studies on production planning and control referring to research papers and visit to industry.

Textbooks:

1. M Mahajan, Industrial Engineering and Production Management, Dhanpat Rai and Co.
2. O. P. Khanna, Industrial engineering and management, Dhanpat Rai publication
3. Martend Telsang, Industrial Engineering, S. Chand Publication.
4. Banga and Sharma, Industrial Organization& Engineering Economics, Khanna publication

Reference Books:

1. Askin, Design and Analysis of Lean Production System, Wiley, India
2. Barnes, Motion and time Study design and Measurement of Work, Wiley India
3. Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008.
4. H. B. Maynard, K Jell, Maynard 's Industrial Engineering Hand Book, McGraw Hill Education

Course Coordinator: Prof. Mahendra Gadge
BoS Member: Dr. S.S.Chinchanikar
BoS Chairman: Dr. Dinesh Kamble

Project-II (MEUA32206)
Computer Aided Engineering

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 1 hr./week	-	-	-	-	-		
Tutorial (T): -- hr						25	25
Practical (P): 2 hrs./week							

Prerequisite: Engineering Graphics, Engineering Mathematics, Computer Aided Machine Drawing, Strength of Materials.

Course objectives:

1. To develop geometrical transformations of 2D/3D CAD entities.
2. Understand the fundamentals of discretization process and criteria for quality mesh.

Course Outcomes:

On completion of the course, learner will be able to

1. Apply homogeneous transformation matrix for geometrical transformations of 2D & 3D CAD entities.
2. Understand the use of Computer tools and Apply the various meshing techniques for better evaluation of approximate results.

Unit I- Computer Aided Modeling

Computer Graphics Module, Transformations-Introduction, Formulation, Translation, Rotation, Scaling and Reflection. Homogenous Representation, Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations. Projections: Orthographic and Isometric.
Modeling, Parametric Modeling, Constraint Based Modeling

Unit II- Computer Aided Analysis

Introduction to Computer Aided Analysis (CAA), Use of CAA in Product development, Discretization methods – Finite Element Method (FEM), Finite Difference Method (FDM) and Finite Volume Method (FVM), Key steps- Pre-processor, Solver and Post-Processor.
Types of Analysis (Introduction) : Linear static analysis, Non-linear analysis, Dynamic analysis, Linear buckling analysis, Thermal analysis, Fatigue analysis, Crash analysis.
Introduction to meshing. Types of element, meshing Techniques. 1D, 2D and 3D Meshing, Mesh Quality Check. Effect of Mesh Density in the critical Region, Effect of biasing in the critical region, Quality check

Term Work: (A Project Report/ Engineering Problem using suitable Computer Tools)

1. Build and execute a computer program on concatenated Transformation
2. Demonstration of Computer Aided Analysis
3. 1D meshing and quality check
4. 2D meshing and quality check
5. 3D meshing and quality check
6. Static structural analysis of Beams and Trusses
7. Static structural analysis of any mechanical element/part/component
8. Static structural analysis of any mechanical assembly
9. Modal analysis of any mechanical element/part/component

10. Mini project using the Computer Aided Tools.

Text Books:

1. Nitin Gokhale, "Practical Finite Element Analysis",Finite to Infinite
2. J. N. Reddy, "An Introduction to the Finite Element Method", Tata McGraw Hill
3. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill
4. C.S. Krishnamurthy, "Finite Element Analysis: Theory & Programming", Tata McGrawHill.

Reference Books :

1: Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering -Prentice Hall India.
2. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
3. IbraimZeid, Mastering CAD/CAMTata McGraw Hill Publishing

BOS Member- Dr. A.P.Kulkarni

BOS Chairman- Dr. D. N. Kamble