K. K. Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223001-: Machine Design-I

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory :03 hrs/week	03	Continuous Comprehensive Evaluation: 20Marks In Sem Exam: 20Marks End Sem Exam: 60Marks

Prerequisites: The basics of material elastic behavior, stress, strain, its relationship, failure modes, different theories of failure and its applications. The design cycle, basis of design considerations like strength, rigidity, manufacture, assembly and cost, standards and codes. The preferred sizes and series, tolerances and types of fits. Construction of SMD and BMD. Roots of equations, Interpolation rule. .

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 subjected to variable loading for finite and infinite life
4. **DESIGN** various machine components such as shafts, couplings, keys, screws, joints.

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

	Course Outcomes	Bloom's Level
CO1	**DESIGN AND ANALYZE** the cotter and knuckle Joints, levers and components subjected to shafts, keys and couplings under static loading /eccentric loading conditions.	3-Apply
CO2	**ANALYZE** different stresses in power screws and **APPLY** those in the procedure to design screw jack.	3-Apply
CO3	**EVALUATE** dimensions of machine components under fluctuating loads.	3-Apply
CO4	**EVALUATE & INTERPRET** the stress developed on the different type of welded and threaded joints.	4-Analyze

COURSE CONTENTS

Unit I	**Design of Simple Machine Elements**	**(08 hrs)**	**COs Mapped - CO1**

Factor of safety, Selection of Factor of Safety, Service factor, Design of Cotter joint, Knuckle joint, Design of hand / foot lever, lever for safety valve, bell crank lever, Design of components subjected to eccentric loading.

Unit II	**Design of Shafts, Keys and Couplings**	**(07hrs)**	**COs Mapped - CO1**

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 key and splines. Design of Rigid and Flexible Coupling.

Unit III	**Design of Power Screws**	**(07hrs)**	**COs Mapped – CO1, CO3**

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,			
Unit IV	**Design against Fluctuating loads**	**(07hrs)**	**COs Mapped – CO1, CO3**
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.			
Unit V	**Threaded and Welded joints**	**(07hrs)**	**COs Mapped – CO1,C04**
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. 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.			

Text Books

Text Books:

1. Bhandari V.B., Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
2. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. Ltd.

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.

Strength of CO-PO Mapping														
	PO													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	3	--	1	1	--	1	2	--	--	1	1	--
CO2	3	3	3	--	1	1	--	1	2	--	--	1	1	--
CO3	3	3	3	--	1	1	--	1	2	--	--	1	1	--
CO4	3	3	3	--	--	--	--	1	2	--	--	1	1	--
Average	3	3	3	--	1	1	--	1	2	--	--	1	1	--

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	**20**

K. K. Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223002 : Heat Transfer

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory : 03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any:

Course Objectives:

1. **Identify the important modes of heat transfer and their applications**
2. **Formulate and apply the general three dimensional heat conduction equations**
3. **Analyze the thermal systems with internal heat generation and lumped heat capacitance**
4. **Understand the mechanism of convective heat transfer**
5. **Determine the radiative heat transfer between surfaces**
6. **Evaluate the performance of heat exchanger**

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

	Course Outcomes	**Bloom's Level**
CO1	Apply heat transfer laws and electrical analogy to analyze one dimensional Cartesian, cylindrical and spherical coordinate systems	3-understand
CO2	Analyze thermal systems with and without internal heat generation and transient heat conduction	3- Analyze
CO3	Evaluate heat transfer rate in convection and radiation heat transfer	3-Understand
CO4	Apply heat transfer principles to design and estimate performance of thermal equipment's	4-Understand

COURSE CONTENTS

Unit I	**Fundamentals of Heat Transfer**	**(8 hrs)**	**COs Mapped – CO1, CO2**

Basic Concepts: Different Modes and Laws of heat transfer, 3-D heat conduction equation in Cartesian coordinates (with derivation), and its simplified equations, simplified equations in cylindrical and spherical coordinates (simplified equations, no derivation) thermal conductivity, thermal diffusivity, electrical analogy, Thermal contact Resistance.

Boundary and initial conditions: Temperature boundary condition, heat flux boundary condition, convection boundary condition, radiation boundary condition.

1-D steady state heat conduction without and with heat generation: Heat conduction without heat generation in plane wall, composite wall, composite cylinder, composite sphere. Heat conduction with heat generation in Plane wall, Cylinder and Sphere with different boundary conditions.

Unit II	**Heat Transfer through Extended Surfaces & Transient Heat Conduction**	**(7 hrs)**	**COs Mapped - CO2**

Heat Transfer through Extended Surfaces: Types of fins and its applications, Governing Equation for constant cross sectional area fins, solution for infinitely long & adequately long (with insulated end) fins, efficiency & effectiveness of fins.

Transient heat conduction: Validity and criteria of lumped system analysis, Biot and Fourier number, Time constant and response of thermocouple, Transient heat analysis using charts. Introduction to Two Dimensional heat conduction

Unit III	Convection	(7 hrs)	COs Mapped – CO3

Fundamentals of convection: Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity and thermal boundary layers. Dimensionless numbers and their physical significance,

Forced convection: Empirical correlations for external and internal flow for both laminar and turbulent flows. (Numericals)

Jet impingement cooling , Film cooling

Natural convection: Empirical correlations for natural convection. (Numericals)

Condensation and Boiling: Boiling heat transfer, types of boiling, pool boiling curve and forced boiling phenomenon, condensation heat transfer, film wise and drop wise condensation

Unit IV	Radiation	(7 hrs)	COs Mapped - CO3

Fundamental concepts, Spectral and total emissive power, real and grey surfaces, Stefan Boltzmann law, Radiation laws – Plank's, Wien's, Kirchhoff's and Lambert's cosine law with simple applications, Irradiation and radiosity, Electrical analogy in radiation, Radiation shape factor, radiation heat exchange between two black and diffuse gray surfaces, radiation shield. Gas radiation –basic approach

Unit V	Heat Transfer Equipment's	(7 hrs)	COs Mapped - CO4

Heat exchangers: Classification and applications, heat exchanger analysis – LMTD for parallel and counter flow heat exchanger, effectiveness– NTU method for parallel and counter flow heat exchanger, cross flow heat exchanger, Fouling factor, LMTD correction factor, design criteria for heat exchanger, Introduction to TEMA standards. Introduction to heat pipe, Loop heat pipe, pulsating heat pipe and Heat wheel

Heat Transfer Enhancement techniques used in heat exchanger

Text Books

1. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley.
2. Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, Tata McGraw Hill Education Private Limited.
3. S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press.
4. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science. 5. P.K. Nag, Heat & Mass Transfer, McGraw Hill Education Private Limited.
6. M. M. Rathod, Engineering Heat and Mass Transfer, Third Edition, Laxmi Publications, New Delhi

Reference Books

1. A.F. Mills, Basic Heat and Mass Transfer, Pearson.
2. S. P. Venkatesan, Heat Transfer, Ane Books Pvt. Ltd.
3. Holman, Fundamentals of Heat and Mass Transfer, McGraw – Hill publication.
4. M. Thirumaleshwar, Fundamentals of Heat and Mass Transfer, Pearson Education India.
5. B. K. Dutta, Heat Transfer: Principles and Applications, Prentice Hall India.
6. C.P. Kothandaraman, S. V. Subramanyam, Heat and Mass Transfer Data Book, New Academic Science.

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Four Assignments on unit-1, Unit-2, Unit-3 and Unit-4	10
2	Group Presentation on Unit-5	05
3	LMS Test on Each Unit	05
	Total	**20**

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T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223003: Numerical and Statistical Methods

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks** **Termwork: 25Marks** **PR/Oral: 25Marks**

Prerequisite Courses, if any: - System of linear equations, Partial differentiation, Statistics, Probability, Problem solving and programming

Course Objectives:

1. UNDERSTAND applications of systems of equations and solve mechanical engineering applications
2. APPLY numerical differentiation and integration techniques to solve engineering applications.
3. COMPARE the system's behavior for the experimental data.
4. INTERPRET Statistical measures for quantitative data.
5. ANALYZE datasets using probability theory and linear algebra.

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

	Course Outcomes On completion of the course the learner will be able to;	Bloom's Level
CO1	APPLY system of equations for engineering applications using direct and iterative numerical methods	3-Apply
CO2	APPLY numerical differentiation and integration techniques to solve engineering applications.	3-Apply
CO3	APPLY curve fitting and interpolating techniques to solve engineering applications.	3-Apply
CO4	ANALYZE quantitative data using statistical technique	4-Analyze
CO5	RELATE the data, using the concepts of probability and linear algebra	4-Analyze

COURSE CONTENTS

Unit I	Solution of Equations: Algebraic, Transdental and Simultaneous Equations	(07 hrs)	COs Mapped - CO1

Algebraic, Transdental Equations: Bracketing method : Bisection Method, Open End Method: Newton-Raphson Method
Simultaneous Equations: Gauss Elimination Method with Partial pivoting, Gauss Seidel Method

Unit II	Numerical Differentiation and Integration	(07 hrs)	COs Mapped - CO1, CO2

Ordinary Differential Equations [ODE]: Euler Method, Runge-Kutta 2nd order method, Runge-Kutta 4th order method
Partial Differential Equations [PDE]: Finite difference method, PDE's Parabolic explicit solution,
Numerical Integration (1D): Trapezoidal rule, Simpson's 1/3$_{rd}$Rule, Simpson's3/8$_{th}$Rule

Unit III	Curve Fitting and Interpolation	(08hrs)	COs Mapped - CO1, CO3

Curve Fitting: Least square technique- first order, power equation, exponential equation and quadratic equation.

Interpolation: Lagrange's interpolation, Newton's forward interpolation method

Unit IV	Statistics	(08hrs)	COs Mapped - CO1, CO4

Measures of central tendency: mean, median, mode. Measurement of variability and dispersion: Standard deviation, standard error, variance, range. Measure of shape: skewness, kurtosisStatistical diagram: scattered diagram, histogram, pie charts, and measure of association between two variables. Correlation: Karl Pearson's Coefficient of correlation and its mathematical properties, Spearman's Rank correlation and its interpretations

Unit V	Probability	(08hrs)	COs Mapped - CO1, CO5

Probability: Joint, conditional and marginal probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, random variables. Probability distributions: Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Normal and Chi square

Text Books

1. Steven C. Chapra, 'Applied Numerical Methods with MATLAB for Engineers and Scientist',
2. Tata Mc-Graw Hill Publishing Co. Ltd.
3. B. S. Grewal, 'Numerical Methods in Engineering and Science', Khanna Publication.
   B. S. Grewal, 'Higher Engineering Mathematics', Khanna Publication.

Reference Books

1. Erwin Kreyszig, 'Advanced Engineering Mathematics', Wiley India
2. Joe D. Hoffman, 'Numerical Methods for Engineers and Scientists', CRC Press
3. Sheldon M. Ross, 'Introduction to Probability and Statistics for Engineers and Scientists', 5e, by Elsevier Academic Press
4. Deisentoth, Faisal, Ong, 'Mathematics for machine learning', Cambridge University Press.
5. Kandasamy, 'Numerical methods', S Chand.
6. Jason Brownlee, 'Statistical Methods for Machine Learning', Machine learning Mastery.

Strength of CO-PO Mapping														
	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	-	2	-	-	-	-	-	3	2	2
CO2	3	3	2	2	-	2	-	-	-	-	-	3	2	2
CO3	3	3	2	2	-	2	-	-	-	-	-	3	2	2
CO4	3	3	2	2	-	2	-	-	-	-	-	3	2	2
CO5	3	3	2	2	-	2	-	-	-	-	-	3	2	2
Average	3	3	2	2	-	2	-	-	-	-	-	3	2	2

Components for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments 01 on Unit-1 & 2, Assignments 02 on Unit-3, 4 & 5	05
2	Pre Insem on Unit-1 & 2, Pre Endsem on Unit-3, 4 & 5	10
3	LMS on Each Unit	05
	Total	**20**

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S. Y. B. Tech. **Pattern 2022 Semester: IV (Mechanical Engineering)** **MEC223004 : Heat Transfer lab**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical :02 hrs/week	**01**	**Term Work : 25 marks** **Oral: 25 marks**
Prerequisite Courses, if any: - Basic Thermodynamics		
Course Objectives: **Course Objectives:** 6. **To use conduction concepts in analyzing thermal systems** **7. To analyse Natural and Forced convection systems** 8. **To use radiative heat transfer concepts in analyzing thermal systems** 9. **To Evaluate the performance of heat exchanger**		
Course Outcomes: On completion of the course, students will be able to–		

	Course Outcomes	**Bloom's Level**
CO1	**Analyze thermal systems using concept of 1-D heat conduction**	2-Understand
CO2	**Analyze Natural and Forced convection systems using convection basics**	2-Understand
CO3	**Analyze thermal systems using concept of Radiation heat transfer**	2-Understand
CO4	**Evaluate the performance of heat exchanger**	2-Understand

List of Laboratory Experiments (Any Eight)

Sr. No.	**Laboratory Experiments / Assignments**	**CO Mapped**
1.	Determination of Thermal Conductivity of metal rod	CO1
2.	Determination of Thermal Conductivity of insulating powder	CO1
3.	Determination of Thermal Conductivity of Composite wall	CO1
4.	Determination of heat transfer coefficient in Natural Convection	CO2, CO3
5.	Determination of heat transfer coefficient in Forced Convection	CO2, CO3
6.	Determination of temperature distribution, fin efficiency in Natural / Forced Convection	CO1,CO2, CO3
7.	Determination of Emissivity of a Test surface	CO2, CO3
8.	Determination of effectiveness of heat exchanger	CO1,CO2, CO3, CO4
9.	Study of pool boiling phenomenon and determination of critical heat flux	CO2
10.	Visit to any industry related to heat transfer	CO4

Guidelines for Laboratory Conduction

1. Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.
2. Apparatus and equipment's required for the allotted experiment will be provided by the lab assistants using SOP.

3. Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.
4. After performing the experiment students will check their readings, calculations from the teacher.
5. After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, setup diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for thirty marks based on three rubrics.
2. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.

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T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223005: Numerical and Statistical Methods Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical :02 hrs/week	**02**	**PR: 50 Marks**

Prerequisite Courses, if any: - System of linear equations, Partial differentiation, Statistics, Probability, Problem solving and programming

Course Objectives:
Course Objectives:

10. UNDERSTAND applications of systems of equations and solve mechanical engineering applications
11. APPLY numerical differentiation and integration techniques to solve engineering applications.
12. COMPARE the system's behavior for the experimental data.
13. INTERPRET Statistical measures for quantitative data.
14. ANALYZE datasets using probability theory and linear algebra.

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

	Course Outcomes **On completion of the course the learner will be able to;**	**Bloom's Level**
CO1	APPLY system of equations for engineering applications using direct and iterative numerical methods	3-Apply
CO2	APPLY numerical differentiation and integration techniques to solve engineering applications.	3-Apply
CO3	APPLY curve fitting, regression and interpolating techniques to solve engineering applications.	3-Apply
CO4	APPLY statistical Technique for quantitative data analysis.	3-Apply
CO5	RELATE the data, using the concepts of probability and linear algebra	4-Analyze

List of Practical

Term Work shall consist of:
Group A – (Any four programs using suitable programming language)
1. Roots of equation
2. Simultaneous equations
3. Ordinary differential equation
4. Partial differential equation
5. Numerical Integration

Group B (Any two programs for simple dataset using suitable programing)
6. Curve fitting using least square technique
7. Determine statistical measures
8. Probability distribution

Group C (Mandatory)
10. One program based mini project using mechanical engineering application dataset

Text Books

4. Steven C. Chapra, 'Applied Numerical Methods with MATLAB for Engineers and Scientist',
5. Tata Mc-Graw Hill Publishing Co. Ltd.
6. B. S. Grewal, 'Numerical Methods in Engineering and Science', Khanna Publication.
   B. S. Grewal, 'Higher Engineering Mathematics', Khanna Publication.

Reference Books

7. Erwin Kreyszig, 'Advanced Engineering Mathematics', Wiley India
8. Joe D. Hoffman, 'Numerical Methods for Engineers and Scientists', CRC Press
9. Sheldon M. Ross, 'Introduction to Probability and Statistics for Engineers and Scientists', 5e, by Elsevier Academic Press
10. Deisentoth, Faisal, Ong, 'Mathematics for machine learning', Cambridge University Press.
11. Kandasamy, 'Numerical methods', S Chand.
12. Jason Brownlee, 'Statistical Methods for Machine Learning', Machine learning Mastery.

Strength of CO-PO Mapping														
	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	3	2	-	-	3	-	-	3	2	2
CO2	3	3	2	2	3	2	-	-	3	-	-	3	2	2
CO3	3	3	2	2	3	2	-	-	3	-	-	3	2	2
CO4	3	3	2	2	3	2	-	-	3	-	-	3	2	2
CO5	3	3	2	2	3	2	-	-	3	-	-	3	2	2
Average	3	3	2	2	3	2	-	-	3	-	-	3	2	2

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T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223006A : Machining Technology

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **In Sem Exam: 20Marks** **End Sem Exam: 60Marks**

Prerequisite Courses, if any: - Fundamentals of Mechanical Engineering - Knowledge of Materials and their properties, Stress-Strain Diagrams, Mechanics, Gear terminology, Degree of freedom etc.

Course Objectives:

- Know about fundamentals of metal cutting process, tool wear and tool life.
- Impart the knowledge of machining phenomenon like milling, gear and thread manufacturing.
- Select, describe and perform finishing of parts using standard tools
- Understand the basic concepts, importance and functions of Jigs, Fixtures.
- Select appropriate non-conventional machining process depending upon desired output characteristics

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

	Course Outcomes	**Bloom's Level**
CO1	**Calculate** the tool life for a single-point cutting tool based on the principles and mechanics of metal cutting	3-Apply
CO2	**Apply** appropriate gear and thread manufacturing processes.	3-Apply
CO3	**Select** appropriate grinding wheel and demonstrate the various surface finishing processes	4-Analyse
CO4	**Analyze and interpret** engineering drawings to determine the requirements for jigs and fixtures.	4-Analyse
CO5	**Select** various non-conventional machining processes such as electrochemical machining (ECM), electro discharge machining (EDM), laser cutting, abrasive jet machining (AJM), and ultrasonic machining (USM).	4-Analyse

COURSE CONTENTS

Unit I	**Mechanics of Metal Cutting**	**(08 hrs)**	**COs Mapped - CO1**

Introduction to metal cutting, Geometry of single-point cutting tool, Orthogonal and Oblique cutting processes, Chip formation, Types of chips, Chip thickness ratio, Process parameters and their effect on machining, chip breakers, Merchant's Circle of forces analysis – forces and energy calculations, power consumed – MRR- Effect of Cutting variables on forces, Concepts of Machinability- Factors affecting machinability, Machinability Index, Tool Life, Tool life equation of Taylor, Tool wear and its types, Factors affecting on tool life.

Unit II	Gear and Thread Manufacturing	(07 hrs)	COs Mapped - CO2
Introduction, Materials of gears, Methods of gear manufacturing-casting, forging, forming etc, milling of gears (indexing methods and numerical), Helical gear cutting, Gear Shaping and Gear hobbling, Gear inspection. Thread Manufacturing: Various methods of thread manufacturing, thread rolling, die threading & tapping, Thread milling, Thread grinding etc.			
Unit III	**Grinding and Finishing processes**	**(07 hrs)**	**COs Mapped – CO3**
Types and Operations of grinding machines, Grinding wheel– Shapes, Designation and selection, Abrasives & classification, Bond & bonding, Grit, Grade & Structure of wheels, Types of grinding wheels, mounting of grinding wheels, Glazing and loading of wheels, Dressing and truing of wheels, Balancing of wheels, Diamond wheels. Super-finishing processes – Introduction to Honing, Lapping, Buffing and Burnishing. (Construction, working and controlling parameters)			
Unit IV	**Jigs and Fixtures**	**(07 hrs)**	**COs Mapped – CO4**
Significance and purpose of jigs and fixtures and their functions in the manufacturing processes, Concept of degree of freedom, 3-2-1 principle of location. General guidelines to design jigs and fixtures, advantages of jigs and fixtures. Jigs- Definition, Elements of jig with the types, Location guidelines, Principles of clamping, Principles of guiding, Channel jig, Template jig, Plate jig, Angle plate jig, Turn over jig, Box jig, Latch type jig. Fixtures: Definition. Elements of fixtures, Location guidelines, Principles of clamping, Principles of setting element, turning fixture, welding fixture, Milling fixture, Assembly and Inspection fixtures.			
Unit V	**Advanced Machining Processes**	**(07 hrs)**	**COs Mapped – CO5**
Introduction, classification of advanced machining processes. Principles, Working, Process Parameters, Estimation of MRR (simple numerical), Advantages, Limitations and Application for following processes: Electric Discharge Machining (EDM), LASER Beam Machining (LBM), Abrasive Jet Machining (AJM), Ultra Sonic Machining (USM) and Electro Chemical Machining (ECM)			

Text Books

1. A Text Book of Production Technology, P. C. Sharma, S.Chand Publications
2. A Text Book of Manufacturing Technology, R. K. Rajput, Laxmi Publications (p) LTD
3. A Text book of Manufacturing Technology, Metal Cutting and Machine Tools, P. N. Rao, Vol. 2, 2nd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2002
4. Elements of Workshop Technology, Vol-II, S. K. HajraChaudhary, Media Promoters &Publications Pvt Ltd.

Reference Books

1. Theory of Metal Cutting, M. C. Shaw, 1st Edition, Oxford and I.B.H. publishing, 1994
2. Jigs & Fixtures, P.H. Joshi, Third edition, McGraw Hill, 2017
3. Production Technology Manufacturing Systems VOL-I & II, R. K. Jain, Khanna Publishers
4. Production Technology –HMT, Tata McGraw Hill publication
5. Manufacturing Science, Amitabh Ghosh and AshokKumar Mallik, Affiliated East-West Press, 2010

Strength of CO-PO/PSO Mapping														
	PO's												PSO	
CO's	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	-	-	-	2	-	-	-	-	-	2	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO 3	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO 4	3	3	2	-	-	2	-	-	-	-	-	2	-	-
Average	3	3	2	-	-	-	-	-	-	-	-	2		-
Level	3	3	2	-	-	2	-	-	-	-	-	2	2	-

Strength of CO-PO Mapping														
	PO													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	2	-	-	2	2	-
CO2	3	2	-	-	-	-	-	-	2	-	-	1	2	-
CO3	2	2	-	2	-	-	-	-	2	-	-	2	2	-
CO4	3	2	2	2	-	2	-	-	2	-	-	2	2	-
CO5	3	-	-	-	3	-	2	-	2	-	-	2	2	-
Average	3	2	2	2	3	2	2	-	2	-	-	2	2	-

Guidelines for Continuous Comprehensive Evaluationof Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

Third Year B. Tech.
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223006B : Energy Audit and Management

Teaching Scheme: 3 Hrs /week	**Credit Scheme: 03**	**Continuous Comprehensive Evaluation: 20Marks** **In Sem Exam: 20Marks** **End Sem Exam: 60Marks**

Prerequisite Courses, if any: - Fundamentals of Thermal And Electrical Engineering

Course Objectives

1. To introduce the concepts of energy conservation.
2. To understand energy audit practices
3. To acquire knowledge on energy audit of thermal and electrical systems
4. To understand the financial analysis of energy audit.

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

	Course Outcomes	**Bloom's Level**
CO1	UNDERSTAND the energy scenario.	2-Understand
CO2	UNDERSTAND thermal and electrical systems	2-Understand
CO3	APPLY the concepts to evaluate the thermal systems and electrical systems.	3-Apply
CO4	SELECT and PREPARE the energy conservation option	3-Apply
CO5	DEMONSTRATE understanding of financing decisions of energy audit	4-Analyze

COURSE CONTENTS

Unit I	**Introduction**	**(08 hrs)**	**Cos Mapped – CO1**

Global primary energy reserves and consumption pattern, Indian energy scenario, sector wise energy consumption, energy needs of growing economy, energy pricing in India, energy security importance of energy conservation and introduction of energy conservation act 2001**,** Introduction to ECSBC codes.

Unit II	**Energy Economics**	**(07 hrs)**	**Cos Mapped – CO1,CO3**

Energy economics: Simple payback period, time value of money, return on investment, net present value and internal rate of return.
Energy Audit: Methodology, analysis and reporting, portable and online instruments required for energy audit, Sankey diagram and specific energy consumption.

Unit III	**Thermal Audit**	**(07 hrs)**	**Cos Mapped – CO1,CO2**

Boiler efficiency calculation by direct and indirect method. Various losses, steam distribution and steam traps, energy conservation opportunities in boiler. Efficiency calculation of oil fired furnace, heat losses and energy conservation opportunities in furnace, Refrigeration and air conditioning

systems, pumps, fans, D. G. set and cooling tower. Thermal insulation, types of insulation, economic thickness of insulation.			
Unit VI	**Electrical audit**	**(07 hrs)**	**Cos Mapped – CO1,CO4**
Demand control, billing structure, power factor improvement, benefits and ways of improving PF, load scheduling. **Electric motors**: Losses and efficiency, energy efficient motors, speed control methods of motor. **Lighting:** Illumination level, fixtures, timers, energy efficient illumination. Compressed air systems.			
Unit V	**Cogeneration and Waste Heat Recovery**	**(07 hrs)**	**Cos Mapped – CO1,CO5**
Cogeneration: Concept, technical options, classification of cogeneration system i.e. topping and bottoming cycle, selection criteria, applications. Waste Heat Recovery: Introduction, classification and applications, benefits, waste heat recovery equipments i. e. recuperator, regenerator, economizer, heat wheel, heat pipe, thermo-compressor, heat pump.			

Text Books

1. Guide Books for National Certification Examination vol.1, 2, 3 & 4 by Bureau of Energy Efficiency (BEE) (https://aipnpc.org/Guidebooks.aspx)
2. Practical Energy Audit Manual, Indo – German Energy Efficient Project, Tata Energy Research Institute (TERI)

Reference Books

1. Albert Thumann, "Plant Engineers and Managers Guide to Energy Conservation", CRC Press.
2. Steve Doty "Commercial Energy Auditing Reference Handbook", Third Edition, River Publishers Series,2016
3. Albert Thumann; Terry Niehus; William J. Younger "Handbook of Energy Audits" River Publishers
4. L. Ashok Kumar, Gokul Ganesan, "Energy Audit and Management-Concept, Methodologies, Procedures, and Case Studies", CRC press, 2023

Website:

1. https://beeindia.gov.in/en/about-bee

Strength of CO-PO/PSO Mapping

Strength of Cos	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	2	2
CO 1	2	1	-	-	-	2	2	-	-	-	-	2	-	-
CO 2	3	2	-	3	1	2	2	1	-	1	2	2	2	2
CO 3	3	2	-	3	1	2	2	1	-	1	2	2	2	2
CO 4	3	3	2	3	3	2	2	1	-	-	-	2	2	2
CO 5	3	3	2	3	3	2	2	1	-	-	-	2	2	2
Avg	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**1**	**2**	**2**	**2**	**2**

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Three assignments on five units	10
2	One LMS Test on each Unit (10 marks)	10
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech. **Pattern: 2022 Semester: V (Mechanical Engineering)** **MEC223006C: Design of Pressure Vessel and Piping**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Lecture: 03 hr / week	03	Insem – 20Marks Endsem – 60 Marks CCE – 20 Marks
Prerequisite Courses: - Mechanism and Machines, Mathematics for Mechanical Engineers, Solid Mechanics, Machine Design-I, Machine Design-II.		

Course Objectives:

Understand pressure vessel and piping fundamentals, including types, design codes, and material selection.

Apply design criteria to develop pressure vessel designs suitable for various operating conditions.

Explore advanced topics like welding, corrosion protection, and recent innovations in pressure vessel design.

Gain proficiency in piping design, including stress analysis, support systems, and compliance with standards.

	Course Outcomes	Bloom's Level
CO1	Understand basic concepts of pressure vessel and piping	2- Understand
CO2	Design pressures vessels and piping as per ISO standards	3- Apply
CO3	Analyze pressure vessels and piping design to effectively manage stress and ensure efficient fluid transport.	4 - Analyze

COURSE CONTENTS

I	Introduction to Pressure Vessels	(08hrs)	COs Mapped – CO1

Overview of Pressure Vessels, Types of Pressure Vessels, Design Codes and Standards for Pressure Vessels, Material Selection for Pressure Vessels, Stress Analysis Fundamentals

II	Design of Pressure Vessels	(07 hrs)	COs Mapped – CO2

Pressure Vessel Design Criteria, Design Considerations for Different Operating Conditions, Design of Cylindrical Pressure Vessels, Design of Spherical Pressure Vessels, Design of Pressure Vessel Supports

III	Advanced Topics in Pressure Vessel Design	(07 hrs)	COs Mapped – CO2, CO3

Welding and Fabrication Techniques, Corrosion and Erosion Protection Methods, Inspections, Testing, and Quality Assurance, Recent Trends and Innovations in Pressure Vessel Design

IV	Introduction to Piping Design	(07 hrs)	COs Mapped – CO1, CO2

Basics of Piping Systems, Types of Pipes and Pipe Fittings, Piping Materials and Selection Criteria, Piping Layout and Routing

V	Design of Piping Systems	(07 hrs)	COs Mapped – CO1, CO3

Pipe Stress Analysis, Pipe Support and Hanger Design, Expansion Joints and Flexibility Analysis, Piping Codes and Standards

Text Books

1. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.

Reference Books

1. Design Data- P.S.G. College of Technology, Coimbatore.
2. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.
3. Charles Becht IV: Process Piping: The Complete Guide to ASME B31.3, ASME Press.
4. Roy A. Parisher and Robert A. Rhea - Pipe Drafting and Design, Cengage Learning.

Codes / Handbooks

1. Design Data- P.S.G. College of Technology, Coimbatore.
2. I.S. 2825: Code for unfired pressure vessels.

T. Y. B. Tech. Pattern 2022 Semester: V (B.Tech Mechancial) MEC223007A : Machining Technology Lab		
Teaching Scheme: --	**Credit Scheme:**	**Examination Scheme:**

Practical : 02 hrs/week	**01**	**Termwork:25Marks** **Oral : 25 Marks**

Prerequisite Courses, if any: -

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

	Course Outcomes	Bloom's Level
CO1	**Calculate** the tool life for a single-point cutting tool based on the principles and mechanics of metal cutting	3-Apply
CO2	**Apply** appropriate gear and thread manufacturing processes.	3-Apply
CO3	**Select** appropriate grinding wheel and demonstrate the various surface finishing processes	4-Analyse
CO4	**Analyze and interpret** engineering drawings to determine the requirements for jigs and fixtures.	4-Analyse
CO5	**Select** various non-conventional machining processes such as electrochemical machining (ECM), electro discharge machining (EDM), laser cutting, abrasive jet machining (AJM), and ultrasonic machining (USM).	4-Analyse

List of Laboratory Experiments / Assignments

Sr. No.	Laboratory Experiments / Assignments	CO Mapped
1	Demonstration of cutting tool geometry and nomenclature of the tools used in conventional machines.(Cutting Inserts)	**CO1**
2	Machining of a mechanical component using conventional machines such as lathe, drilling, milling, grinding and any additional machine tool or processes as per requirement. Manufacturing drawing with appropriate geometrical and dimensional tolerances, detailed process planning to be included.	**CO1**
3	Industrial Visit for Demonstration on gear manufacturing	**CO2**
4	Demonstration of Additive Machining technology (from modelling to printing) (To be performed Batch-wise)	**CO5**
5	Demonstration of various types of jigs and fixtures, and a case study on design and use of Jigs & Fixture for any given component.	**CO4**
6	Visit to an Industry which uses manufacturing processes	**CO5**
7	Preparing Online Calculator/Catalogue for selection of cutting parameters by using programming languages like C, Python etc	**CO1**

Guidelines for Laboratory Conduction

Practical are to be performed under the guidance of concerned faculty member.
Guidelines for Student's Lab Journal
Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.
Guidelines for Termwork Assessment
1. Each experiment from lab journal is assessed for thirty marks based on three rubrics. 2. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journalwriting where each rubric carries ten marks. 3. Journal should consist of Job, appropriate write-up and shall be part of term-work submission. 4. Job drawing essentially consisting of Geometric Dimensioning and Tolerance.

T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223007B Energy Audit and Management

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical :02 hrs/week	01	Term work : 25 marks Oral: 25 marks

Prerequisite Courses, if any: - Basic Thermodynamics, Fluid Mechanics , Heat Transfer , Basic Electrical Engineering

Course Objectives:

1. Theoretical insights in Energy conservation.
2. Practical exposure to energy audit
3. Skill building in Techno economic analysis of energy systems
4. Exposure to Industry and sustainable development goals

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

	Course Outcomes	Bloom's Level
CO1	Report technical and economical analytical findings from case studies.	3-Apply
CO2	Analyze theoretically thermal and electrical utilities	4-Analyze
CO3	Measure and analyze energy conservation in Thermal & Electrical utilities	4-Analyze

List of Laboratory Experiments (Any Five)

Sr. No.	Laboratory Experiments / Assignments	CO Mapped
1.	Electricity bill analysis (Residential, Commercial and Industrial)	**CO1**
2.	Study of Tariff policy and analysis of MERC orders	**CO1**
3.	Demonstration of Energy Audit instruments	**CO2, CO3**
4.	Case study of energy performance assessment of Boiler/Furnace	**CO2**
5.	Case study of energy performance assessment of Air compressor/HVAC system	**CO2**
6.	Case study of energy performance assessment of Transformer /fans /blowers /motors / water pumps etc.	**CO2**
7.	Case study of Energy conservation recommendations with financial analysis	**CO2**
8.	Illumination study of Classroom/ office building/auditorium etc.	**CO2, CO3**
9.	Identifying energy saving opportunities in Educational institute/commercial establishment /Industry	**CO2, CO3**

Guidelines for Laboratory Conduction
1. Teacher will brief the given experiment to students its procedure, observations, calculation, and outcome of this experiment. 2. Apparatus and equipment's required for the allotted experiment will be provided by the lab assistants. 3. Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant. 4. After performing the experiment students will check their readings, analysis, visit report from the teacher. 5. After checking they have to write the conclusion of the final result.
Guidelines for Student's Lab Journal
Write-up should include title, aim, setup diagram/layout, working principle, procedure, observations, graphs, calculations-technical and economics and conclusion.
Guidelines for Term work Assessment
3. Each experiment from lab journal is assessed for thirty marks based on three rubrics. 4. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.

K.K.Wagh Institute of Engineering Education and Research, Nashik
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T. Y. B. Tech.
Pattern: 2022 Semester: V (Mechanical Engineering)
MEC223007C: Design of Pressure Vessel and Piping Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Lecture: 02 hr / week	01	Term Work – 25Marks Oral – 25 Marks

Prerequisite Courses: - Mechanism and Machines, Mathematics for Mechanical Engineers, Solid Mechanics, Machine Design-I, Machine Design-II.

Course Objectives:
Understand pressure vessel and piping fundamentals, including types, design codes, and material selection.
Apply design criteria to develop pressure vessel designs suitable for various operating conditions.
Explore advanced topics like welding, corrosion protection, and recent innovations in pressure vessel design.
Gain proficiency in piping design, including stress analysis, support systems, and compliance with standards.

	Course Outcomes	**Bloom's Level**
CO1	Understand basic concepts of pressure vessel and piping	2- Understand
CO2	Design pressures vessels and piping as per ISO standards	3- Apply
CO3	Analyze pressure vessels and piping design to effectively manage stress and ensure efficient fluid transport.	4 - Analyze

COURSE CONTENTS

Term Work shall consist of following assignments:

One Design Project on pressure Vessel:
The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D CAD software) - one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances must be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted.

Each student shall complete any two of the following assignments.

1. Write assignment on codes and standard used in piping design
2. A case study on piping design calculations for any system.
3. An assignment on specialty components used in piping system.
4. An assignment on occasional loads calculations for the piping system.
5. Use any suitable software and complete one design project on piping system.

Text Books

1. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.

Reference Books

5. Design Data- P.S.G. College of Technology, Coimbatore.
6. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.
7. Charles Becht IV: Process Piping: The Complete Guide to ASME B31.3, ASME Press.
8. Roy A. Parisher and Robert A. Rhea - Pipe Drafting and Design, Cengage Learning.
9. Phillip Ellenberger - Piping And Pipeline Calculations Manual

Codes / Handbooks

3. Design Data- P.S.G. College of Technology, Coimbatore.
4. I.S. 2825: Code for unfired pressure vessels.
5. Mohinder Nayyar – Piping Handbook

Guidelines for Continuous Comprehensive Evaluationof Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Timely completion of Assignments/Sheet	10
2	Understanding of Assignments/Sheet	10
3	Presentation / Writing of Assignments/Sheet	05
	Total	**25**

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223008: Environmental Economics

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :02 hrs/week	**02**	**Continuous Comprehensive Evaluation: 50Marks** --

Prerequisite Courses, if any: -Economics for Sustainability

Course Objectives

1.To expose the students to environmental problems and concept of sustainable development
2. To explain the concepts of carbon footprint and its calculations.
3.To train the students to analyze environmental damage
4.To help students internalize the tools needed for the evaluation of projects such as cost-benefit analysis, and environmental impact

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

	Course Outcomes	**Bloom's Level**
CO1	Explain environmental questions both local and global and limitations of applying economic principles to environment questions	2-Understand
CO2	Calculate carbon footprint and develop broader understanding of economics of climate change	4- Analyze
CO3	Analyze environment policy issues like environmental damage using cost benefit analysis	4- Analyze
CO4	Design environmental policy for local environmental problems and understand the design and implementation of international environment policy	5- Create

COURSE CONTENTS

Unit I	Economics and Financial concept of electricity sector	**(04hrs)**	**COs Mapped - CO1, CO2**
Understand basic investment concept, making an investment decision top built a new power plant , financing power project			
Unit II	Electricity Traiff	**(05hrs)**	**COs Mapped - CO1, CO2**
Method of cost and traiff determination , method of tariff determination in India , consumer traiff			
Unit III	Carbon footprint	**(05hrs)**	**COs Mapped - CO1, CO3, CO4**
Carbon footprint measurement and its numerical			
Unit IV	Coase theorem	**(05hrs)**	**COs Mapped - CO1, CO3, CO4**
Coase theorem , introduction , objective, advantages , limitation with case study			
Unit V	Pigouvian taxes& subsidy	**(5hrs)**	**COs Mapped - CO1,**

			CO4
introduction , objective, advantages , limitation with case study			

Text Books

3. 4. Kolstad, C. (2010). Intermediate environmental economics, 2nd ed. Oxford University Press.
4. Stephen Smith (2011) Environmental Economics: A Very Short Introduction ,Oxford University Press

Reference Books

1 This Changes Everything: Capitalism vs. the Climate by Naomi Klein

2. Cropper, M., Oates, W. (1992). Environmental economics: A survey, Journal of Economic Literature, 30, 675-740.

3. Heal, G. (2012). Reflections – defining and measuring sustainability. Review of Environmental Economics and Policy, 6, 147-163.

4. Newell, R., Pizer, W., Raimi, D. (2013). Carbon markets 15 years after Kyoto: Lessons learned, new challenges. Journal of Economic Perspectives, 27, 123- 46.

5. Perman, R., Ma, Y., McGilvray, J., Common, M. (2011). Natural resource and environmental economics, 3rd ed. Pearson Education/Addison Wesley.

6. Stavins, R. (ed.) (2012). Economics of the environment: Selected readings, 5th ed. W. W. Norton.

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	1	-	-	3	3	1	2	2	2	2	2	2
CO 2	2	2	2	2	1	2	3	1	2	2	2	2	2	2
CO 3	2	2	2	2	1	2	3	1	2	2	2	2	2	2
CO 4	2	2	2	2	-	2	3	1	2	2	2	2	2	2
Avg	2	2	2	2	1	2	3	1	2	2	2	2	2	2

Guidelines for Continuous Comprehensive Evaluationof Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	One Assignments on Unit-1, Unit-2, Unit-3	30
2	Sincerity in class work	20
	Total	**50**

T. Y. B. Tech.
Pattern 2022 Semester: V (Mechanical Engineering)
MEC223009 : Mechatronics

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory : 03hrs/week	**03**	**InSem Exam: 20 Marks** **EndSem Exam: 60 Marks** **Continuous Comprehensive Evaluation: 20 Marks**

Prerequisite Courses, if any: -
Basics of Electrical and Electronics Engineering, Engineering Mathematics, Mechanics

Course Objectives:

- Understand the concept of sensors ,actuators & Data Acquisition system
- Understand the Physical system through Modelling and block diagram
- Understand the given system for Time , Frequency Domain and stability
- Understand the concept of PLC & PID controller for different applications.

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

	Course Outcomes	Bloom's Level
CO1	**Demonstrate** the concept of sensors ,actuators & Data Acquisition system	2- Understand
CO2	**Interpret** the Physical system through Modelling and block diagram	3 - Apply
CO3	**Analyze** the given system for Time , Frequency Domain and stability	4 - Analyze
CO4	**Evaluate** the concept of PLC & PID controller for different applications.	5 - Evaluate

COURSE CONTENTS

Unit I	**Fundamentals of Instrumentation, Sensors and Actuators**	**(7hrs)**	**COs Mapped - CO1**

Elements of Measurement System and Mechatronics, Static and Dynamic Characteristics of Measuring Instruments, Domains of Mechatronics
Sensors: Classification of sensors / Transducers; Motion Sensors – Encoder (Absolute & incremental), Lidar, Proximity (Optical, Inductive, Capacitive), Accelerometer (MEMS & Piezoelectric); Temperature sensor –Pyrometer, Infrared Thermometer; Force Sensors – Strain gauges, Flow sensors – Electromagnetic, Ultrasonic, Hot-wire anemometer;
Actuators: Linear (Solenoid) and Rotary (Stepper, Servo)

Unit II	**Data Acquisition and Signal Communication**	**(8hrs)**	**COs Mapped – CO1**

Signal Communication: Serial, Parallel; Synchronous, Asynchronous
Introduction to DAQ, Types, Components of a Data Acquisition System
Data Conversion: Sampling, Aliasing, Sample and hold circuit, Quantization, Analog-to-digital converters (4 bit Successive Approximation type ADC), Digital-to-Analog converters (4 bit R2R type DAC)

Unit III	**Control systems & Transfer function based modelling**	**(7hrs)**	**COs Mapped – CO2**

Introduction to control systems, need, Types- Open and Closed loop, Concept of Transfer Function, Block Diagram & Reduction principles and problems;
Transfer Function based Modeling of Electrical, Mechanical, Thermal and Fluid system;

Unit IV	System Analysis	(7hrs)	COs Mapped –CO3
Time Domain Analysis - Unit step Response analysis via Transient response specifications (Percentage overshoot, Rise time, Delay time, Steady state error etc.) Frequency Domain Analysis – Frequency Domain Parameters - Natural Frequency, Damping Frequency and Damping Factor; Stability Analysis - Concept of Poles & Zeros; Pole zero plot, Mapping of Pole Zero plot with damping factor, natural frequency and unit step response, Stability Analysis using Routh Hurwitz Criterion, and Bode Plot			
Unit V	**Controllers**	**(7hrs)**	**COs Mapped – CO4**
Classification of Controllers PID Controller - PI, PD and PID control systems in parallel form; Manual tuning of PID control, Ziegler–Nichols method, PLC Controller - Introduction to PLC; Architecture of PLC; Ladder Logic programming for different types of logic gates; Latching; Timers, Counters;			
Text Books			
Text Books: 1. William Bolton, Mechatronics: Electronics Control Systems in Mechanical and Electrical Engineering, 6th Ed, 2019 2. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008			
Reference Books			
1. Alciatore and Histand, Introduction to Mechatronics and Measurement Systems, 5th Ed, 2019 2. Bishop (Editor),Mechatronics – An Introduction CRC 2006 3. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hillpublication, New Delhi 4. C.D.Johnson, Process Control Instrumentation Technology, Prentice Hall,New Delhi 5. Bolton, Programmable Logic Controller, 4th Ed, Newnes, 2006			

Strength of CO-PO/PSO Mapping														
	PO												PSO	
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	2	2	2	2	2	2	-	2	2	2	2	2	2	2
CO 2	2	2	2	2	2	-	-	-	2	-	-	2	3	2
CO 3	3	3	2	2	2	-	-	-	2	-	-	2	3	2
CO 4	3	3	2	2	2	2	2	2	2	2	2	2	3	2
Average	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2.75	2
Level	3	3	2	2	2	2	2	2	2	2	2	2	3	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course			
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**	**Evaluation Rubrics**

1	One Assignment on each unit	10	R1 – Timely Completion (10marks) R2 – Understanding (10marks) R3 – Presentation & Clarity (10marks) 5 Assignments each of 30 marks, total 150 marks converted to 10 marks
2	Class Test	05	Pre Insem – 30 Marks, Pre end Sem – 60 Total 100 marks converted to 05 marks
3	LMS Test on Each Unit	05	MCQ test marks, 5 test one on each Unit of 10 marks each Total 50 converted into 5 marks
	Total	**20**	

K.K.Wagh Institute of Engineering Education and Research, Nashik

(Autonomous from Academic Year 2022-23)

T. Y. B. Tech.
Pattern 2023 Semester: III (Mechanical Engineering)
MEC223010 PBL

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Tutorial : 01hrs/week **Practical: 02hrs/week**	**02**	**Tutorial (TU) 25** **Term Work (TW) 25** **Total : 50 Marks**

Prerequisite Courses, if any: - Machine Design-I, Machine Design-II, Mechatronics etc.

Course Objectives

1. INTRODUCE the skills required in an industry such as design, development, assembly & disassembly.
2. DEVELOP the skills required for fault diagnose of engine and transmission of different automotive and various home appliances.
3. ESTABLISH the skills required for maintenance of any machine tool.
4. CREATE awareness about industrial environment.

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

	Course Outcomes	Bloom's Level
CO1	Understand procedure of assembly & disassembly of various machines.	2
CO2	Examine & Model a working/model of machine parts or any new product.	3
CO3	Illustrate fault with diagnosis on the machines, machine tools and home appliances.	3
CO4	Analyze the various activities performed in an industry such as maintenance, design of components, material selection.	4

COURSE CONTENTS

1. Assembly and Disassembly of any of the following mechanical systems/ subsystems: bicycle (Geared), e-Bikes, e-Motor Cycles, Drones, Flying devices, gear box, IC engines, centrifugal pump etc.
2. Assembly- Disassembly/ Fault diagnosis of home appliances such as mixer, grinder, washing machine, fan, ovens, gas geyser, chopping machine, kneading machine, exercise machines, etc.
3. Development and demonstration of working/animation model of any mechanism.
4. Design a circuit of electric and hydraulic system of 4 wheelers and its verification.

OR

Circuit design /PCB design using software for control of BLDC electric motors used in e-Vehicles.

5. Undertake total preventive maintenance for any machine tool or mechanical system.
6. Visit to an industry for awareness about preventive maintenance.
7. Use of ergonomic principles for the design of hand tools, control in automobile dashboards, human operated mobile devices.
8. Use of alternative materials in the construction of daily activity machine and tool components
9. Interpretation of Drawings; Exercises in identifying the type of production, extracting important

functional dimensions, checking the number of parts in an assembly. Checking and listing missing dimensions.
10. Exercises in -preparation of detailed production drawings as per BIS standard of simple machine parts having relevant notes and indications (limits/tolerances, surface finish, the process of production, relevant tools, materials, measuring instruments).
The documentation activity as a part of the Term work shall not be restricted to merely generation of 2D/3D CAD Drawings with dimensions (as applicable), Exploded View, Flowchart of Maintenance Work etc. but can be beyond.
Skill Development Documentation Diary must be maintained by every student.

Strength of CO-PO/PSO Mapping														
Strength of Cos	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	2	-	-	2	-	-	-	-	2	2	2	2
CO 2	2	2	2	-	-	2	-	-	-	-	2	2	2	2
CO 3	2	2	2	-	-	2	-	-	-	-	2	2	2	2
CO4	2	2	2	-	-	2	-	-	-	-	2	2	2	2
Avg.	2	2	2	-	-	2	-	-	-	-	2	2	2	2

K. K. Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech.
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223011 : Machine Design-II

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **In Sem Exam: 20Marks** **End Sem Exam: 60Marks**

Prerequisite Courses, if any: - Classification of Gears, Gear Terminology, Terminology of Helical gear, Virtual number of teeth. Classification, selection and application of Belt and chain drives.

Course Objectives:

- To apply fundamentals of the design and/or selection of elements in mechanical systems.
- To understand the philosophy that real engineering design problems are open-ended and challenging.
- To demonstrate design skills for the problems in real life industrial applications.
- To develope an attitude of team work, critical thinking, communication, planning and scheduling through design projects.

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

	Course Outcomes	**Bloom's Level**
CO1	**Apply** the principle of Spur, Helical, Bevel, Worm gear and Drive design for industrial application and prepare a manufacturing drawing with the concepts of GD&T.	3-Apply
CO2	**Categorize** Rolling and Sliding Contact Bearings from manufacturer's catalogue for a particular application using suitable design parameters.	3-Apply
CO3	**Illustrate** design of various drives and spring for mechanical applications.	3-Apply
CO4	**Analyze** various concepts of Gear box for design of different applications.	4-Analyze

COURSE CONTENTS

Unit I	**Spur and Helical Gears**	**(08hrs)**	**COs Mapped - CO1, CO4**

Introduction to gears: Material selection for gears, Modes of gear tooth failure, Gear Lubrication Methods. Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, design of gear

Unit II	**Bevel and Worm Gear**	**(07hrs)**	**COs Mapped - CO1,CO4**

Bevel Gears: Types of Bevel gears, Terminology, Virtual number of teeth, and force analysis of Straight Bevel Gear. Design of Straight Bevel Gear based on Beam Strength, Wear strength and estimation of effective load based on Velocity factor (Barth factor) and Buckingham's equation.
Worm Gears: Terminology and proportions of worm and worm gears, Force analysis of drives, Friction in Worm gears, efficiency of worm gears, material selection, Strength and wear ratings of worm gears (Bending stress factor, speed factor, surface stress factor, zone factor) IS 1443-1974, Thermal consideration in gear drive

Unit III	Sliding and Rolling Contact Bearing	(07hrs)	COs Mapped – CO2, CO4

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.

Unit IV	Drives : Belt and Chain Drives	(07hrs)	COs Mapped – CO1, CO3

Belt Drives: Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition, Selection of Flat and V-belts from manufacturer's catalog, belt tensioning methods, relative advantages and limitations of Flat and V- belts, construction and applications of timing belts.

Chain Drives : Types of chains and its Geometry, selection criteria for chain drive, Polygon effect of chain, Modes of failure for chain, Lubrication of chains

Unit V	Mechanical Springs	(07hrs)	COs Mapped – CO3

Types, applications and materials for springs, Stress and deflection equations for helical compression Springs, Style of ends, Design of helical compression and tension springs, Springs in series and parallel, Surge in springs, Design of Multi-leaf springs. Helical torsion Spring

Text Books

1. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. ltd.
2. Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
3. Bhandari V.B, Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
4. Juvinal R.C, Fundamentals of Machine Components Design, John Wiley and Sons.

Reference Books

1. Design Data - P.S.G. College of Technology, Coimbatore.
2. Vehicle Powertrain Systems by Behrooz Mashadi, David Crolla. A John Wiley & Sons, Ltd
3. Automobiles–Power trains and Automobiles–Dynamics by Crolla, David, A John Wiley &Sons, Ltd
4. Automotive Engineering Powertrain, Chassis System and Vehicle Body by David A Crolla, Elsevier B H New York, London, Oxford.
5. lack P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
6. Willium C. Orthwein, Machine Components Design, West Publishing Co. and Jaico Publications House.
7. P. Kannaiah, Design of Transmission systems‖, SCIETCH Publications Pvt Ltd.
8. C.S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learning Pvt. Ltd.
9. D.K. Aggarwal& P.C. Sharma, Machine Design, S.K Kataria and Sons.
10. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learning Pvt. Ltd.
11. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
12. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers.

Strength of CO-PO Mapping														
	PO													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	2	-	-	-	2	-	-	-	-	2	2	-
CO2	3	2	3	-	-	1	1	-	-	-	-	1	2	-
CO3	2	-	-	1	-	1	-	-	-	-	-	2	1	-
CO4	3	-	2	-	-	1	-	-	-	-	-	2	1	-

Average	3	2	3	1	-	1	1	-	-	-	-	2	2	1

Guidelines for Continuous Comprehensive Evaluationof Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

Third Year B. Tech. **Pattern: 2022 Semester: VI (Mechanical Engineering)** **MEC223012: Energy Engineering**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Lecture: 03 hr / week	03	INSEM : 20 ENDSEM : 60 CCE : 20

Prerequisite Courses: - Linear algebra and calculus, Engineering Thermodynamics, Fluid Mechanics and Heat transfer

Course Objectives:

- To study the energy scenario, the components of thermal energy based plant, improved Rankine cycle.
- To understand details of steam condensing plant, cooling tower system, analysis of condenser, the environmental impacts and methods to reduce various pollution from energy systems
- To study layout, component details of diesel engine power plant, hydel and nuclear energy systems
- To understand components; layout of gas and improved power cycles
- To learn basic principles of energy management, storage and economics of power Generation
- To study the working principle , construction of renewable energy systems

	Course Outcomes	**Bloom's Level**
CO1	EXPLAIN the power generation scenario, the layout components of conventional and non-conventional power plants and their environmental impacts.	2
CO2	Apply energy analysis for performance determination of power plants	3
CO3	ANALYZE the performance of power plants from technical aspects	4
CO4	Evaluate the actual performance of thermal and solar power plants through case studies.	5

COURSE CONTENTS

I	**Energy Scenario and Thermal Power Plant**	(08 hrs)	COs Mapped – CO1

Energy Scenario: Global and Indian energy scenario, role of Government and Private Organizations, Energy crisis, energy security, energy policy.

Thermal Energy Based Plant: layout of modern thermal energy based plant with different circuits, site selection, classification of coal, coal benefication, selection of coal for thermal power plant, slurry type fuels, in-plant handling of coal, pulverized fuel handling systems, FBC systems, high pressure boilers, improved Rankine cycle with reheating and regeneration separately

II	**Steam Turbines and Condenser and Impact on Environment**	(07 hrs)	COs Mapped – CO1, CO2, CO3

Steam Turbine: Principles of Working of Steam Turbines, Classifications of Steam Turbine, Simple and Compound Steam Turbines. Energy losses in Steam Turbines, Actual Reheat factor, Velocity diagrams, Graphical and analytical Methods, Work done, Thrust and Power, Efficiencies, Condition for Maximum Efficiency, Governing of Steam Turbine.

Condensers and Cooling Towers: Types of Condensers, Classification of Condenser, Quantity of cooling water Required, Daltons Law of Partial Pressures, vacuum efficiency, condenser efficiency, Sources of Air Leakage and Air Removal, Cooling Towers, Cooling Ponds.

Environmental impact of power plants:

Different pollutants produce by power plants, methods to control pollutants, carbon credits and footprints

III	**Nuclear and Hydro-Electric Power Plant**	(07 hrs)	COs Mapped – CO1

Nuclear Power plant: Nuclear fission/fusion, elements of nuclear reactor, types of nuclear reactor: PWR, BWR, CANDU, LMCR, GCR, Nuclear waste disposal, Nuclear power development programme of India.

Hydro-electric Power Plant: Introduction to hydrology, hydrograph, flow duration curve, mass curve, Hydroelectric power plant site selection, classification, criteria for turbine selection, Types hydraulic turbines, components of Hydroelectric power plant - dams; spillways; surge tank and forebay.

IV	**Gas Turbine and Diesel Engine Power Plant**	(07 hrs)	COs Mapped – CO1, CO2,CO3

Diesel engine power plant: general layout; different systems of DEPP, plant layout of high/medium /low capacity DEPP, performance operating characteristics including heat rate and incremental heat rate.

Gas turbine power plant: components, general layout of GTPP, open and closed cycle gas turbine plant, Brayton cycle analysis for thermal efficiency, work ratio, maximum & optimum pressure ratio, methods to improve thermal efficiency of GTPP: inter-cooling, reheating, regeneration cycle.

Combined cycle: gas and steam combined cycle plant, Cogeneration, introduction to tri-generation, steam power plants with process heating, Integrated Gasification Combined Cycle (IGCC) plant, Kalina (Cheng) Cycle.

V	**Renewable Energy Systems**	(07 hrs)	COs Mapped – CO1, CO4

Solar thermal and photovoltaic energy: solar thermal plant based on flat plate collector; solar photovoltaic systems, applications, economics and technical feasibility.

Wind Energy: wind availability, basic components of wind mills, performance operating characteristics, wind solar hybrid power plants, Cost economics and viability of wind farm. Geothermal Energy: typical geothermal field, superheated steam system, flash type, binary cycle plant, economics of geothermal energy.

Tidal Energy: components, single basin, double basin systems

Ocean Thermal Energy: working principle, Claude /Anderson /hybrid cycle

Wave Energy: dolphin type wave machines

MHD Power Generation: working principle, open/ close cycle MHD generator

Fuel cell: main components, working Principle

Biomass Energy: Biomass gasifier

Hydrogen Energy: principle of hydrogen production, hydrogen storage, applications.

Text Books

1. Domkundwar & Arora, Power Plant Engineering, Dhanpat Rai & Sons, New Delhi
2. R.K.Rajput, Power Plant Engineering, Laxmi Publications New Delhi
3. D. P. Kothari, K. C. Singal and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., Delhi

Reference Books

1. E.I.Wakil, Power Plant Engineering, McGraw Hill Publications New Delhi
2. P.K.Nag, Power Plant Engineering, McGraw Hill Publications New Delhi.
3. R.Yadav , Steam and Gas Turbines ,Central Publishing House, Allahabad.
4. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers, Delhi
5. S.P.Sukhatme, Solar Energy,Tata McGraw-Hill Publications, New Delhi
6. G R Nagpal, Power Plant Engineering , Khanna Publication.

CCE Assessment: Unit wise assignment (each of 20marks) including review, calculation, case study and design of system.

Strength of CO-PO/PSO Mapping														
	PO's												PSO	
CO's	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO 2	3	3	1	-	-	-	-	-	-	-	-	2	2	-
CO 3	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO 4	3	3	2	-	-	2	-	-	-	-	-	2	2	2
Average	3	3	2	-	-	-	-	-	-	-	-	2		-
Level	3	3	2	-	-	2	2	-	-	-	-	2	2	2

K. K. Wagh Institute of Engineering Education and Research, Nashik
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T. Y. B. Tech. Pattern 2022 Semester: VI (B.Tech Mechancial) MEC223013 : Machine Design Lab I & II		
Teaching Scheme: --	**Credit Scheme:**	**Examination Scheme:**
Practical : 02 hrs/week	**01**	**Term work : 25Marks Practical : 25 Marks**
Prerequisite Courses, if any: - DME-I & DME-II		
Course Outcomes: On completion of the course, students will be able to –		

	Course Outcomes	**Bloom's Level**

List of Laboratory Experiments / Assignments		
Sr. No.	**Term Work**	**CO Mapped**
Student shall complete the following activity as a Term Work; The Submission shall consist of completion of Two Design projects and study Assignments. Oral examination shall be based on the practical undertaken during the semester		
1	Design a Simple Machine Elements : (Cotter Joints/ Knuckle Joint/ Lever etc.,)	**DME-I**

2	Design of Screw Jack/ C Clamp : (Automobile Application / Industrial Application, etc.,)	
3	Design of Gearbox for following any one problem statements or application 1. wind mill application or sluice gate 2. building Elevator 3. Industrial Hoist. 4. Sugar Industry. 5. Automobile drives etc.	**DME-II**
4	Design a Conveyer System for following any one application (Stone Crusher, Industry Pallet Transformation, Thermal power plant(Coal transportation), Sugar Industry (Sugar Bag transportation), Airport Luggage transportation etc.)	

Guidelines for Laboratory Conduction

Practical are to be performed under the guidance of concerned faculty member.

Guidelines for Student's Lab Journal

Projects shall be in the form of design of mechanical systems, etc.

The design project shall consist of two full imperial (A1) size sheets involving assembly drawing with a part list and overall dimensions and drawings of individual components. (For sheets use software for Project 1 & 3 and sheets should be manually drawn for project 2 & 4)

Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file.

Design data book shall be used wherever necessary to achieve selection of standard components.

Guidelines for Termwork Assessment

1. Each project will be assessed for thirty marks based on three rubrics.
2. Rubric R-1 for timely completion, R-2 for understanding and R-3 for design report and sheets where each rubric carries ten marks.
3. File should consist of Design Report and Sheets for every project.

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T. Y. B. Tech. **Pattern 2022 Semester: Vi (Mechanical Engineering)** **MEC223014A : Finite Element Analysis**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**
Prerequisite Courses, if any: - Mechanics of materials, Thermodynamics, Machine Design		
Course Objectives: 15. To understand fundamentals of FEA for finite element formulation 16. To understand the 1D structural member for displacement, stress 17. To understand 2D structural member for displacement, stress 18. To understand the heat transfer problems for temperature, thermal stress, heat flux 19. To understand the mechanical component for dynamic conditions		
Course Outcomes: On completion of the course, students will be able to–		

	Course Outcomes **On completion of the course the learner will be able to;**	**Bloom's Level**

CO1	Apply fundamentals of FEA for finite element formulation	3 (Apply)
CO2	Analyze the 1D structural member for displacement, stress	4 (Analyze)
CO3	Analyze the 2D structural member for displacement, stress	4 (Analyze)
CO4	Analyze the heat transfer problems for temperature, thermal stress, heat flux	4 (Analyze)
CO5	Analyze the mechanical component for dynamic conditions	4 (Analyze)

COURSE CONTENTS

Unit I	**Fundamentals Concepts of FEA**	**(08 hrs)**	**COs Mapped – CO1**

Introduction– Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads & constraints) General FEM procedure, Applications of FEM in various fields, P & h formulation, Advantages and disadvantages of FEM. Consistent units system. Shape Function
Introduction to different approaches used in FEA such as direct approach and energy approach

Unit II	**1D Elements**	**(07 hrs)**	**COs Mapped - CO2**

Types of 1D elements. Displacement function, Global and local coordinate systems, Order of element, primary and secondary variables, shape functions and its properties.
Formulation of elemental stiffness matrix and load vector for spring, bar, truss. Transformation matrix for truss, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, Boundary conditions elimination method, Symmetric boundary conditions, Stress calculations.

Unit III	**2D Elements**	**(07 hrs)**	**COs Mapped – CO3**

Types of 2D elements, Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal‘s triangle , primary and secondary variables, properties of shape functions. Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement)

Unit IV	**1D Steady State Heat Transfer Problems**	**(07 hrs)**	**COs Mapped – CO4**

Introduction, Governing differential equation, steady-state heat transfer formulation of 1D element for conduction and convection problem, boundary conditions and solving for temperature distribution

Unit V	**Dynamic Analysis**	**(07 hrs)**	**COs Mapped – CO5**

Types of dynamic analysis, General dynamic equation of motion, point and distributed mass, lumped and Consistent mass, Mass matrices formulation of bar and beam element.
Undamped-free vibration- Eigenvalue problem, Evaluation of eigenvalues and eigenvectors (natural frequencies and mode shapes).

Text Books

1. A First Course in the Finite Element Method, Daryl L. Logan
2. Concepts and Applications of Finite Element Analysis, R. D. Cook, et al. Wiley, India

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. Bathe K. J., ―Finite Element Procedures‖, Prentice-Hall of India (P) Ltd., New Delhi.
4. Fagan M. J., ―Finite Element Analysis, Theory and Practice‖, Pearson Education Limited
5. Kwon Y. W., Bang H., ―Finite Element Method using MATLAB‖, CRC Press, 1997
6. S. Moaveni, ―Finite element analysis, theory and application with Ansys‖,
7. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
8. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., ―Practical Finite Element Analysis‖, Finite to Infinite, Pune

Strength of CO-PO Mapping														
	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	-	-	3	2	-	-	2	-	-	3	2	2
CO2	3	3	3	-	3	2	-	-	2	-	-	3	2	2
CO3	3	3	3	-	3	2	-	-	2	-	-	3	2	2
CO4	3	3	3	-	3	2	-	-	2	-	-	3	2	2
CO5	3	3	3	-	3	2	-	-	2	-	-	3	2	2
Average	3	3	3	-	3	2	-	-	2	-	-	3	2	2

Components for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments 01 on Unit-1 & 2, Assignments 02 on Unit-3, 4 & 5	05
2	Pre Insem on Unit-1 & 2, Pre Endsem on Unit-3, 4 & 5	10
3	LMS on Each Unit	05
	Total	**20**

K. K. Wagh Institute of Engineering Education and Research, Nashik
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Third Year B. Tech.

Pattern: 2022 Semester: VI (Mechanical Engineering)

MEC223014B : Renewable Energy

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Lecture: 03 hr / week	03	INSEM : 20 ENDSEM : 60 CCE : 20

Prerequisite Courses: - Engineering Thermodynamics, Fluid Mechanics and Heat Transfer

Course Objectives:

5. To understand the basics of renewable energy sources and technologies.
6. To design solar thermal conversion systems and solar photovoltaic systems for different applications.
7. To understand wind energy sources and technologies and also to design a wind energy systems.
8. To study the biomass energy conversion systems.
9. To study the Geothermal , Tidal and Wave energy
10. To explain principle and working of fuel cell and hydrogen energy technologies

	Course Outcomes	Bloom's Level
CO1	Understanding of solar systems for a given energy utility by applying principles of solar energy conversion.	
CO2	Estimate the wind energy potential and analyse the wind energy conversion System.	
CO3	Design bio-energy based systems for a given utility by applying principles of bio-mass to bio-energy conversion.	
CO4	Characterize energy conversion systems: Geothermal, Tidal and Wave energy, Fuel Cells and Hydrogen Energy.	

COURSE CONTENTS

I	**Solar Radiation and Solar Systems**	(08 hrs)	COs Mapped – CO1

Extra-terrestrial and terrestrial radiation, Solar radiation measuring instruments, Estimation of solar Radiation, solar geometry, Solar Energy Conversion Systems

Solar thermal systems: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, Solar ponds, solar cooling and refrigeration, Solar thermal power generation.

Solar Photovoltaic Systems: Principle of photovoltaic conversion of solar energy, Solar cells, Home lighting systems, Solar lanterns, Solar PV pumps, Govt. policies. Introduction to Solar Photovoltaic, Solar energy storage options: Electrical and Thermal Energy storage options

II	**Wind Energy Conversion Systems**	(07 hrs)	**COs Mapped – CO2**

History of wind energy and potential, Wind energy in India, Power available in the wind, Wind speed prediction and forecasting, Betz limit, Components of wind energy conversion systems, Horizontal and Vertical axis wind turbine, Wind turbine power and torque characteristics, Tip speed ratio,

III	**Biomass Energy**	(07 hrs)	**COs Mapped – CO3**

biochemical conversion: anaerobic digestion, ethanol fermentation, biogas production, types of biogas plant, installation, operation and maintenance of biogas plants, factors affecting biogas production, biogas utilization and storage, biogas for motive power generation, design calculations

for biogas plants, Biodiesel, the mechanism of trans esterification, fuel characteristics of biodiesel, technical aspects of biodiesel/Ethanol utilization in engine. Biomass gasification system and types, producer gas, biomass resources development in India.

IV	**Geothermal , Tidal and Wave energy**	(07hrs)	COs Mapped – CO4

Geothermal Energy: structure of earth's interior, geothermal sites, geothermal field and gradients, types of geothermal resources, power generation by liquid dominated and vapor dominated sites, geothermal preheat to conventional plant, utilization of geothermal energy.

Tidal Energy: Tidal energy, tidal characteristics, range, power of tides, site selection types tidal power plant

Wave Energy: factors affecting wave energy, analysis of wave energy, wave energy conversion machines.

V	**Fuel Cells and Hydrogen Energy**	(07 hrs)	COs Mapped – CO4

Fuel cells: principle of operation of fuel cell, Technical parameters of fuel cell, hydrogen fuel cell, Methanol fuel cell, Types fuel cells, performance of fuel cell.

Hydrogen Energy: Benefits of hydrogen Energy, Hydrogen production Technologies, characteristics and applications of hydrogen, Hydrogen energy Storage, Use of hydrogen Energy, Problems associated with hydrogen energy.

Text Books

4. D. P. Kothari, K. C. Singal and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., Delhi
5. Domkundwar & Domkundwar- Solar Energy and Non Conventional Sources of Energy, Dhanpat Rai& Sons, New Delhi.
6. R. K. Rajput, Non-Conventional Energy Sources and Utilization, S. Chand Publication.

Reference Books

7. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers, Delhi
8. S.P.Sukhatme, Solar Energy,Tata McGraw-Hill Publications, New Delhi
9. B. H. Khan, Non-conventional energy resources, Mc Graw Hill publication.

CCE Assessment: Unit wise assignment (each of 20 marks) including review, calculation, case study

and design of system.

Strength of CO-PO/PSO Mapping														
	PO's												PSO	
CO's	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	3	2	-	-	2	1	-	-	-	-	2	2	2
CO 2	3	3	2	-	-	2	1	-	-	-	-	2	2	1
CO 3	3	3	2	-	-	-	1	-	-	-	-	2	2	2
CO 4	3	2	1	-	-		1	-	-	-	-	2	2	-
Average	3	3	2	-	-	2	1	-	-	-	-	2	2	2
Level	3	3	2	-	-	2	1	-	-	-	-	2	2	2

Final Year. B. Tech.
Pattern 2022 Semester: VI (B.Tech Mechancial)
MEC223014C : Computational Fluid Dyanamics

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks InSem Exam: 20Marks EndSem Exam: 60Marks**

Prerequisite Courses, if any: -Mathematics, Physics, Systems in Mechanical Engineering, Engineering Thermodynamics, Applied Thermodynamics, Fluid Mechanics, Numerical & Statistical Methods, Heat & Mass Transfer,Computer Aided Engineering

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

	Course Outcomes	**Bloom's Level**
CO1	Recognize the fundamental principles of mass conservation	2-Understand
CO2	Comprehend the fundamental properties and behaviors of PDEs	2-Understand

CO3	Apply error minimization techniques to assess the accuracy of numerical solutions	3-Apply
CO4	Apply the Finite Difference Method (FDM) to discretize differential equations	3-Apply
CO5	Pertaining to the conceptual basics of steady-state diffusion problems	3-Apply

COURSE CONTENTS

Unit I	**Introduction to computational fluid dynamics and principles of conservation**	**(08 hrs)**	**COs Mapped - CO1**

Continuity Equation, Navier Stokes Equation, Energy Equation and Conservation Equations.

Unit II	**Classification of partial differential equations and physical behaviour**	**(07 hrs)**	**COs Mapped - CO1, CO2**

Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations.

Unit III	Approximate solutions of differential equations	**(07 hrs)**	**COs Mapped - CO1, CO2, CO3**

Error Minimization Principles, Functional involving higher order derivatives, Approximate solution of differential equations through variation formulation, Boundary conditions in the variation form: Primary and secondary variables, Essential and natural boundary conditions, Approximate solutions of differential equations,

Unit IV	**Fundamentals of discretization-**	**(07 hrs)**	**COs Mapped - CO1, ,CO3,CO4**

Discretization principles: Pre-processing, Solution, Post-processing, Finite Element Method, 3 Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term.

Unit V	**Finite volume method**	**(07 hrs)**	**COs Mapped - CO1, CO2, CO5**

Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a 1-D steady state diffusion type problem, Composite material with position dependent thermal conductivity, Four basic rules for FV Discretization of 1-D steady state diffusion type problem, Source term linearization, Implementation of boundary conditions

Text Books

1. Chung, T. J., “Computational Fluid Dynamics”, 2nd Ed., 2014, Cambridge University Press.
2. Anderson J. D. (Jr)., “Computational Fluid Dynamics: The basic with applications”, 2017, McGraw Hill Education

Reference Books

1. Patankar, S. V., “Numerical Heat Transfer and Fluid Flow”, 2017, CRC Press.
2. Versteeg, H. K., Malalasekera, W., “An Introduction to Computational Fluid Dynamics”, 2nd Ed., 2007, PHI. 3. Ferziger, J. H. and Peric, M., “Computational Methods for Fluid Dynamics”, 3rd Ed., 2002, Springer.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on unit-1, Unit-2, Unit-3 , Unit-4, Unit-5	15
2	LearniCo Test on Each Unit	05
	Total	20

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T. Y. B. Tech.
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223014D : Operation Research

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: - Engineering Mathematics, Theory of probability, Statistics

Course Objectives:
To familiarize the students with the use of practice oriented mathematical applications for optimization functions in an organization.

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

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

	Course Outcomes	**Bloom’s Level**
CO1	Apply LPP and Decision Theory to solve the problems	3-Apply

CO2	Apply the concept of transportation models to optimize available resources	3-Apply
CO3	Apply the concept of Inventory control and replacement analysis	3-Apply
CO4	Evaluate the process parameters for queuing theory and sequencing models	3-Apply
CO5	Analyze the project management techniques.	4-Analyze

COURSE CONTENTS

Unit I	**Introduction: Operation Research**	**(08 hrs)**	**COs Mapped - CO1**

Introduction: Definition, Evolution and Classification of Quantitative Methods and Operations Research Techniques, Methodology, Advantages and Limitations. Linear Programming Problem: Introduction, Formulation of LPP, Solution of LPP by Two Phase Method only. Decision Theory: Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, under Risk, under Uncertainty, Decision Trees

Unit II	**Transportation & Assignment Model**	**(07hrs)**	**COs Mapped - CO1, CO2**

Introduction, Formulation, Basic Method of Solving Transportation Problem, Optimization Methods like UV and Stepping Stone Method, Assignment Problem- Hungarian Method to solve Assignment Problem.

Unit III	**Inventory Control and Replacement Analysis**	**(07hrs)**	**COs Mapped - CO1, CO3**

Inventory Control - Deterministic Models- Shortage, without shortage; Probabilistic Inventory Models, Introduction to Concept of Service level. Replacement Analysis - Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly

Unit IV	**Queuing Theory and Sequencing Models**	**(07hrs)**	**COs Mapped - CO1, CO4**

Queuing Theory: Introduction, Basis Structure, Terminology (Kendal‘s Notations) and Applications.
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

Unit V	**Project Management**	**(07hrs)**	**COs Mapped - CO1, CO5**

Network Models: Fulkerson‘s rule, concept and types of floats, CPM and PERT, Crashing Analysis Unit 5: Queuing Theory and Sequencing Models and Resource Scheduling. Simulation: Introduction, Monte-Carlo Simulation method, Simulation of Inventory and Queuing Problems.

Text Books

1. Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
2. J. K. Sharma, Operations Research: Theory and Application, Laxmi pub. India, 2010.
3. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut, 2015.
4. L.C.Jhamb, Quantative Techniques Vol. I &II, Everest Publication, 2007.
5. Manohar Mahajan, Operation Research, Dhanpatrai Publication, 2006.
6. V. K. Kapoor, Operations Research: Quantitative Techniques for Management, Sultan Chand Publications, 2013.

Reference Books

1. Hillier F.S., and Lieberman G.J., Operations Research, Eight Edition, Mc. Tata McGraw Hill, India, 2011.
2. Ravindran, ―Engineering optimization Methods and Applications‖, 2nd edition, Wiley, India
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey,
4. Operations Research - An introduction, Hamdy A Taha, Pearson Education, 2010

Strength of CO-PO Mapping												
	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	2	-	-	1	-	-	-	-	-	1	2
CO2	2	2	-	-	1	-	-	-	-	-	1	2
CO3	2	2	-	-	1	-	-	-	-	-	1	2
CO4	2	2	-	-	1	-	-	-	-	-	1	2
CO5	2	2	-	-	1	-	-	-	-	-	1	2
Average	2	2	-	-	1	-	-	-	-	-	1	2

Components for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on Unit-1, Unit-2, Unit-3, Unit 4 & Unit 5	10
2	LMS Test	10
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik

(Autonomous from Academic Year 2022-23)

T. Y. B. Tech. **Pattern 2022 Semester: VI (Mechanical Engineering)** **MEC223015A : Computer Integrated Manufacturing**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
3 hrs/week	**03**	**Insem – 20 Marks** **End Sem – 60 Marks** **Continuous Comprehensive Evaluation: 20Marks**
Prerequisite Courses, if any: -Geometric Modeling and Production Drawing,Industrial Psychology and organizational Behavior		
Course Objectives		
Understand **the importance of CIM and factory automation.** Learn **to integrate hardware, software, and generate CNC programs for CIM.** Explore **advanced manufacturing concepts, including flexible manufacturing, cellular manufacturing, group technology,** Explore Theoretical concepts **of IoT, Industry 4.0, and cloud-based manufacturing.**		
Course Outcomes: On completion of the course, students will be able to–		
	Course Outcomes	**Bloom's Level**

CO1	Understand the Principles of CIM	2-Understand
CO2	Apply Data Integration Techniques in CIM	3-Apply
CO3	Demonstrate Proficiency in CAM and CNC Programming	4-Analyze
CO4	Analyze Computer-Aided Process Planning (CAPP) methodologies	4-Analyze
CO5	Analyze Theoretical Concepts of Future Manufacturing Technologies	4 - Synthesize

COURSE CONTENTS

Unit I	**Unit 1: Foundations of CIM**	**(08 hrs)**	**COs Mapped - CO1**
	Need and Evolution of CIM, CIM Hardware and Software, Role of CIM System, Definition of CIM and Types of Automation, Functions in Manufacturing, CIM Wheel and Computerized Elements, Advantages of CIM		
Unit II	**Data Integration in CIM**	**(07 hrs)**	**COs Mapped - CO1, CO2**
	CAD-CAM Integration, Product Development through CIM, Design Activities in a Networked Environment, Networking in Manufacturing, CIM Database and Database Management, EDM, PDM, PLM in CIM		
Unit III	**CAM in CIM**	**(07 hrs)**	**COs Mapped - CO3**
	Introduction to CAM, Coordinate System and CNC Principles, CNC Lathe, Turning Centers, Milling Machines, CNC Part Programming, Tool and Geometric Compensations, Canned Cycles, Subroutines, Do Loops, CIM Integral Machines		
Unit IV	**Process Planning, Quality Control, and MRP**	**(07 hrs)**	**COs Mapped – CO4**
	CAPP and Benefits, Logical Steps in CAPP, MRP, Capacity Planning, MRP-II, ERP Concepts and its Applications, Computer-Aided Production Scheduling, Control Systems: Shop Floor, Inventory, Inspection, MES		
Unit V	**FMS, Cellular Manufacturing, and Future Smart Factories**	**(07 hrs)**	**COs Mapped – CO5**
	Flexible Manufacturing Systems (FMS), FMS Components, Layouts, and Applications Group Technology (GT) and Part Families, Industry 4.0 and Functions, IoT Applications in Manufacturing, Digital Manufacturing in Industry 4.0, Scheduling, Lean Manufacturing		

Text Books

5. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person India, 2007 2nd edition.
6. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India
7. Harrington J, Computer Integrated Manufacturing Krieger Publications 1979.

Reference Books

1 Weatherall, A., 2013. Computer integrated manufacturing: from fundamentals to implementation. Butterworth-Heinemann.

2. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley Publications.
3. Jha, N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.

Strength of CO-PO/PSO Mapping		
Strength	PO	PSO

of COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	3	-	-	-	-	3	-	-	-	2	2	-	2
CO 2	3	3	-	-	-	-	3	-	-	-	2	2	-	2
CO 3	3	3	3	3	3	-	-	-	2	-	2	2	2	2
CO 4	3	3	-	-	3	-	-	-	2	-	2	2	2	2
CO 5	3	3	3	3	-	-	**2**	-	2	-	**2**	2	2	**2**
Avg	**3**	**3**	**3**	**3**	**3**	-	**3**	-	**2**	-	**2**	**2**	**2**	**2**

Guidelines for Continuous Comprehensive Evaluationof Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	One Assignments on Unit-1, Unit-2, Unit-3,Unit-4,Unit-5	10
2	Pre insem test and pre end em test	5
3	LMS Test	5
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik

(Autonomous from Academic Year 2022-23)

T. Y. B. Tech. **Pattern 2022 Semester: VI (Mechanical Engineering)** **MEC223015B : Automobile Engineering**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
3 hrs/week	**03**	**Insem – 20 Marks** **End Sem – 60 Marks** **Continuous Comprehensive Evaluation: 20Marks**
Prerequisite Courses, if any: - Fundamentals of Mechanical Engineering, Mechanism and Machines, Energy Systems for Mobility.		
Course Objectives		
To develop a comprehensive understanding of automobile systems and their fundamental principles. **To comprehend Chassis, Powertrain, and Mobility Components.** **To analyze Suspension, Brake Systems, and Vehicle Performance.** **To explore Automotive Safety Standards and Emerging Technologies.** **To make students conservant about Electrical Systems and Vehicle Maintenance.**		

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

	Course Outcomes	Bloom's Level
CO1	Explain and Compare automotive system for the vehicle.	2-Understand
CO2	Describe different types of mobility components and their respective functionalities.	2-Understand
CO3	Classify vehicle safety systems and comprehend their roles in risk mitigation and occupant protection.	2-Understand
CO4	Apply knowledge of suspension and brake systems in automobiles for maintenance tasks.	3-Apply
CO5	Analyze factors impacting vehicle performance and evaluate testing methodologies.	4-Analyze

COURSE CONTENTS

Unit I	**Introduction**	**(08hrs)**	**COs Mapped - CO1**

Introduction: History and evolution of automobiles, Current trends and challenges in the automotive industry.
Chassis and Frames: Types, layout and constructional features of chassis and frames, components and materials.
Vehicle Powertrain Systems: Necessity and selection of clutch, Necessity of gear box and different types of transmission systems- MT, AT, AMT, CVT, DCT, Hybrid Transmission. Overdrive, final drive and differential.

Unit II	**Mobility Components**	**(07hrs)**	**COs Mapped – CO1,CO2**

Axles: Types of axles: solid, live, dead, semi-floating, and full-floating
Wheels and tyres: Wheel design and construction, Wheel alignment and balancing procedures, type of tyres, construction, materials. Factors influencing tyre performance: tread design, compound, inflation pressure.
Steering system : Types of steering systems, Steering kinematics, Active and adaptive steering systems Steer-by-wire technology and drive-by-wire systems, electronic stability control (ESC)

Unit III	**Suspension and Brake System**	**(07hrs)**	**COs Mapped – CO1,CO4**

Suspension: Types of Suspension Systems- Independent, Dependent, types of suspension springs, self levelling suspension (active suspension), shock absorbers (hydraulic and air).
Brake systems: Drum, disc, mechanical, hydraulic, air brakes, vacuum, power assisted brakes, handbrake, ABS, EBD, Electronic stability control (ESC) and traction control systems (TCS)

Unit VI	**Automotive Performance & Safety**	**(07 hrs)**	**COs Mapped – CO1,CO5**

Automotive performance: Performance testing methodologies and standards, Basic principles of vehicle dynamics: traction, stability, and control. Road performance curves, Factors Affecting Vehicle Performance.
Automotive safety: Types of active and passive safety, Emerging Technologies in Vehicle Performance and Safety.

Unit V	**Electrical System and Vehicle Maintenance**	**(07 hrs)**	**COs Mapped – CO1,CO3**

Batteries : Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods, introduction to lithium batteries. Introduction to Electrical system and accessories.

Maintenance: Types of vehicle maintenance, servicing/overhauling of clutch, gear box, propeller shaft, differential, axles, steering system, suspension system, break system, electrical system.

Text Books

8. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering", SAE Publications.
9. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
10. SAE Manuals and Standards.
11. N. K. Giri, Automobile Mechanics
12. P. S. Kohali, Automobile Electrical Equipment, Tata McGraw Hill Publishing House.
13. Narang G. B. S, "Automobile Engineering", S. Chand and Company Ltd.

Reference Books

1. Dr. Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.
2. Automobile Mechanics, "Crouse/Anglin", TATA Mcgraw-Hill.
3. R. B. Gupta, Automobile Engineering, Satya Prakashan. Faculty of Science and Technology Mechanical Engineering Page 25 of 62
4. Chris Mi, M .Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, ,Willey.
5. Electric and Hybrid Vehicles, Tom Denton, Routledge.
6. Hybrid Electric Vehicle Technology, Automotive Research and Design, American Technical.

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	1	-	-	-	-	-	-	-	-	-	-	-	2
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 3	3	2	2	-	-	2	-	-	2	-	-	-	2	2
CO 4	3	2	2	-	-	2	2	-	2	-	-	-	2	2
CO 5	3	2	2	2	-	-	**2**	-	2	-	-	-	2	**2**
Avg	**3**	**2**	**2**	**2**	-	**2**	**2**	-	**2**	-	-	-	**2**	**2**

Guidelines for Continuous Comprehensive Evaluationof Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	One LMS Test on each Unit (10 marks) Total 50 marks will be converted into 10 marks	10
2	Pre Insem test (30 marks) and Pre Endsem test (60 marks) Total marks will be converted into 10 marks	10
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik
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T. Y. B. Tech.
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223015C : Product Design, Innovation, and Entrepreneurship

Teaching Scheme: 3 hrs/week	**Credit Scheme: 03**	**Examination Scheme:**
		Insem – 20 Marks **End Sem – 60 Marks** **Continuous Comprehensive Evaluation: 20Marks**

Prerequisite Courses, if any: - Engineering Design Fundamentals , Mechanics of Materials, Thermodynamics, Manufacturing Processes, Engineering Economics, Materials Science and Engineering

Course Objectives

Understand **the principles of design thinking and creativity techniques to foster innovative problem-solving skills.**
Learn **principles of design thinking and creativity techniques to generate innovative solutions to engineering challenges.**
Explore market **trends, consumer needs, and competitor offerings to identify opportunities for product innovation and entrepreneurship.**
Survey **the feasibility and viability of product designs through prototyping, testing, and iterative refinement processes.**

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

	Course Outcomes	**Bloom's Level**
CO1	**Describe** design thinking and creativity principles to foster innovative problem-solving skills.	2-Understand
CO2	**Apply** design thinking techniques to engineer innovative solutions.	3-Apply
CO3	**Analyze** market trends for product innovation and entrepreneurship opportunities.	4-Analyze
CO4	**Evaluate** product designs through prototyping for feasibility and viability.	5-Analyze

COURSE CONTENTS

Unit I	**Unit 1: Introduction to Product Design, Innovation, and Entrepreneurship**	**(07 hrs)**	**COs Mapped - CO1**

Overview of Product Design, Innovation, and Entrepreneurship
Importance and Role in Mechanical Engineering
Understanding Design Thinking Process
Market Analysis and Identifying Opportunities
Introduction to Intellectual Property Rights (IPR)
Design for Manufacturing and Assembly (DFMA) Principles
Prototyping Techniques and Rapid Prototyping

Unit II	**Design Fundamentals and Concept Development**	**(07 hrs)**	**COs Mapped - CO1, CO2**

Fundamentals of Engineering Design
Concept Generation and Selection

Design Optimization Techniques Ergonomics and Human Factors in Design Material Selection for Product Design Design Validation and Testing Sustainability in Product Design			
Unit III	Innovation Strategies and Creativity Techniques	**(07 hrs)**	**COs Mapped – CO3**
Understanding Innovation and its Types Innovation Strategies in Mechanical Engineering Creativity Techniques and Brainstorming Design Thinking in Practice: Ideation Phase Value Proposition and Business Model Canvas Lean Startup Methodology			
Unit VI	Entrepreneurship in Engineering	**(07 hrs)**	**COs Mapped – CO4**
Introduction to Entrepreneurship in Engineering Business Plan Development Financial Management for Startups Marketing Strategies for Engineering Ventures Sales and Distribution Channels Intellectual Property Strategy for Startups			
Unit V	Product Development Lifecycle and Project Management	**(07 hrs)**	**COs Mapped – CO5**
Overview of Product Development Lifecycle (PDLC) Project Management Techniques for Product Development Risk Management in Product Development Quality Control and Assurance in Product Design Agile Methodology in Product Development Scaling Up Production and Manufacturing Post-Launch Evaluation and Continuous Improvement			

Text Books

14. Idris Mootee, 2013, Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Publisher: Wiley

15. Tom Kelley, 2001, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Publisher: Crown Business

16. Eric Ries, 2011, Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Publisher: Currency

Reference Books

1. Jeanne Liedtka, 2011, Designing for Growth: A Design Thinking Tool Kit for Managers, Publisher: Columbia University Press
2. Dan Olsen, 2015, The Lean Product Playbook: How to Innovate with Minimum Viable Products and Rapid Customer Feedback, Publisher: Wiley
3. Heidi M. Neck, Christopher P. Neck, Emma L. Murray, 2017, Entrepreneurship: The Practice and Mindset, Publisher: SAGE Publications, Inc

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	3	3	-	2	2	-	2	-	-	2	2	2	2
CO 2	3	3	3	-	3	2	-	-	-	3	-	2	2	2
CO 3	3	3	3	-	2	2	-	-	-	-	-	2	2	2
CO 4	3	3	3	-	3	2	-	-	-	-	-	2	2	2
Avg	**3**	**3**	**3**	**-**	**3**	**2**	**-**	**2**	**-**	**3**	**2**	**2**	**2**	**2**

Guidelines for Continuous Comprehensive Evaluationof Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	One Assignments on Unit-1, Unit-2, Unit-3,Unit-4,Unit-5	5
2	Pre insem test and pre end em test	10
3	Use of LMS	5
	Total	**20**

K.K.Wagh Institute of Engineering Education and Research, Nashik
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T. Y. B. Tech.
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223016A : Finite Element Analysis

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical :02 hrs/week	01	Term Work : 25 Marks OR/ Practical : 25 Marks

Prerequisite Courses, if any: - Mechanics of materials, Thermodynamics, Machine Design

Course Objectives:

20. To understand fundamentals of FEA for finite element formulation
21. To understand the 1D structural member for displacement, stress
22. To understand 2D structural member for displacement, stress
23. To understand the heat transfer problems for temperature, thermal stress, heat flux
24. To understand the mechanical component for dynamic conditions

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

	Course Outcomes On completion of the course the learner will be able to;	Bloom's Level
CO1	Apply fundamentals of FEA for finite element formulation	3 (Apply)
CO2	Analyze the 1D structural member for displacement, stress	4 (Analyze)
CO3	Analyze the 2D structural member for displacement, stress	4 (Analyze)
CO4	Analyze the heat transfer problems for temperature, thermal stress, heat flux	4 (Analyze)
CO5	Analyze the mechanical component for dynamic conditions	4 (Analyze)

List of Practical

The term work shall consist of record of any eight from following topic using any suitable analysis software

1. 1D Bar Element – Structural Linear Analysis
2. Spring - Structural Linear Analysis
3. Truss Analysis using 1D Element
4. Plate/Shell Element – Structural Linear Analysis
5. Thermal Analysis – Steady state Analysis
6. Coupled Analysis- (Structural + Thermal)
7. Modal Analysis – Spring -Mass system, simply supported/Cantilever beam, etc.
8. Analysis of Machine Component using 3D Elements
9. Eigen Value Buckling Analysis of Beam

Text Books

1. A First Course in the Finite Element Method, Daryl L. Logan
2. Concepts and Applications of Finite Element Analysis, R. D. Cook, et al. Wiley, India

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. Bathe K. J., ―Finite Element Procedures‖, Prentice-Hall of India (P) Ltd., New Delhi.
4. Fagan M. J., ―Finite Element Analysis, Theory and Practice‖, Pearson Education Limited
5. Kwon Y. W., Bang H., ―Finite Element Method using MATLAB‖, CRC Press, 1997
6. S. Moaveni, ―Finite element analysis, theory and application with Ansys‖,
7. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
8. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., ―Practical Finite Element Analysis‖,
17. Finite to Infinite, Pune

Strength of CO-PO Mapping														
	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	-	-	3	2	-	-	2	-	-	3	2	2
CO2	3	3	3	-	3	2	-	-	2	-	-	3	2	2
CO3	3	3	3	-	3	2	-	-	2	-	-	3	2	2
CO4	3	3	3	-	3	2	-	-	2	-	-	3	2	2
CO5	3	3	3	-	3	2	-	-	2	-	-	3	2	2
Average	3	3	3	-	3	2	-	-	2	-	-	3	2	2

K. K. Wagh Institute of Engineering Education and Research, Nashik
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T. Y. B. Tech. Pattern 2022 Semester: VI (Mechanical Engineering) MEC223016B: Renewable Energy lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical :02 hrs/week	**01**	**Term work : 25 marks Oral : 25 marks**
Prerequisite Courses, if any: - Engineering Thermodynamics, Fluid Mechanics , Heat Transfer		

Course Objectives:

11. To understand the basics of Solar PV system.
12. To design the solar thermal conversion systems and solar photovoltaic systems for different applications.
13. To understand wind energy sources and technologies
14. To analyse the liquid bio-fuel and gasifier system

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

	Course Outcomes	**Bloom's Level**
CO1	Apply the knowledge of solar thermal and solar PV systems	2-Understand
CO2	Understand the wind energy conversion systems and wind energy resources	1- Knowledge
CO3	Analyse the liquid bio-fuels and gasifier systems	3-apply
CO4	Understand the working of Fuel Cell	2-Understand

List of Laboratory Experiments (Any Five)

Sr. No.	**Laboratory Experiments / Assignments**	**CO Mapped**
1	Visit to Solar thermal System and it's technical and economic analysis.	CO1
2	Study and plotting I-V characteristics of PV solar cell.	CO1
3	Visit to solar PV grid connected system and it's technical and economic analysis.	CO1
4	Design of solar PV roof top standalone and grid connected system.	CO1
5	Study of wind energy conversion systems and study of it's case studies.	CO2
6	Analysis of liquid bio-fuels: biodiesel and ethanol.	CO3
7	Analysis of gasifier systems.	CO3
8	Performance characteristics study of fuel cell.	CO4

Guidelines for Laboratory Conduction

6. Teacher will brief the given experiment to students its procedure, observations, calculation, and outcome of this experiment.
7. Apparatus and equipment's required for the allotted experiment will be provided by the lab assistants.

8. Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant.
9. After performing the experiment students will check their readings, analysis, visit report from the teacher.
10. After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, setup diagram/layout, working principle, procedure, observations, graphs, calculations-technical and economics and conclusion.

Guidelines for Term work Assessment

5. Each experiment from lab journal is assessed for thirty marks based on three rubrics.
6. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.

T. Y. B. Tech.
Pattern 2022 Semester: VI (B.Tech Mechancial)
MEC223016C : Computational Fluid Dynamics Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical : 02 hrs/week	**01**	**Termwork:25Marks** **Oral : 25 Marks**

Prerequisite Courses, if any: -

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

	Course Outcomes	**Bloom's Level**
CO1	Recognize the importance of CFD in Heat and Fluid flow	1-Knowledge
CO2	Recognize forced convection heat transfer coefficient over regular bodies like sphere, cylinder.	2-Understand
CO3	Assessment of drag coefficient in circular pipe under turbulent flow and bent pipe.	3-Apply
CO4	Pertain how to handling moving boundaries and wall effects in motion of fluid	3-Apply
CO5	Analyze how to handle power law fluids in CFD.	4-Analyze

List of Laboratory Experiments / Assignments

Sr. No.	**Laboratory Experiments / Assignments**	**CO Mapped**
1	Turbulent flow in a circular pipe: generating the friction coefficient versus Reynolds number	**CO1,CO3**
2	Flow of a power law non Newtonian fluid over an elliptic cylinder	**CO1,CO5**
3	Natural convection over a sphere.	**CO1**
4	Mixed convection over a sphere.	**CO1,CO2**
5	Forced convection over a sphere.	**CO1,CO2**
6	Forced convection over two cylinders in tandem arrangement.	**CO1,CO2**
7	Calculation of flow and heat transfer in a lid driven cavity.	**CO1,**
8	Wall effect on a sphere in a cylindrical tube.	**CO1,CO4**

Guidelines for Laboratory Conduction

Student should also submit a detailed report for all the above laboratory practicals.

All simulation results should be validated with correlations available.

The student is expected to attach the simulation predictions and the literature results when he presents the record.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

5. Each experiment from lab journal is assessed for thirty marks based on three rubrics.
6. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journalwriting where each rubric carries ten marks.

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech.
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223016D : Operation Research

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical : 02 hrs/week	**01**	**Termwork: 25Marks** **Oral: 25Marks**

Prerequisite Courses, if any: - Engineering Mathematics, Theory of probability, Statistics

Course Objectives:
To familiarize the students with the use of practice oriented mathematical applications for optimization functions in an organization.

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

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

	Course Outcomes	**Bloom's Level**
CO1	Apply LPP and Decision Theory to solve the problems	3-Apply
CO2	Apply the concept of transportation models to optimize available resources	3-Apply
CO3	Apply the concept of Inventory control and replacement analysis	3-Apply
CO4	Evaluate the process parameters for queuing theory and sequencing models	3-Apply
CO5	Analyze the project management techniques.	4-Analyze

List of Laboratory Experiments / Assignments

Sr. No.	**Laboratory Experiments / Assignments** **Practical/Lab to be performed on a computer using OR/Statistical packages**	**CO Mapped**
1	To solve Linear Programming Problem using Graphical Method with (i) Unbounded solution (ii) Infeasible solution (iii) Alternative or multiple solutions.	**CO1**
2	Solution of LPP with simplex method and Big – M method.	**CO1**
3	Solution of Transportation Problem	**CO2**
4	Solution of Assignment Problem.	**CO2**
5	Problems based on selective inventory classification (ABC analysis).	**CO3**
6	To determine the performance measures for M/M/1 queuing model	**CO4**
7	To perform Project scheduling of a given project (Deterministic case-CPM).	**CO5**
8	To perform Project scheduling of a given project (Probabilistic case-PERT).	**CO5**

Guidelines for Laboratory Conduction

11. Teacher will brief the given experiment/assignment to students its procedure, observations calculation, and outcome of this experiment/assignment.
12. Apparatus and equipment's required for the allotted experiment/assignment will be provided by the lab assistants using SOP.
13. Students will perform the allotted experiment/assignment in a group (two students in each group) under the supervision of faculty and lab assistant.
14. After performing the experiment/assignment students will check their readings, calculations from the teacher.
15. After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Term work Assessment

7. Each experiment from lab journal is assessed for thirty marks based on three rubrics.
8. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.

Text Books

. 1. Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
. 2. J. K. Sharma, Operations Research: Theory and Application, Laxmi pub. India, 2010.
. 3. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut, 2015.
. 4. L.C.Jhamb, Quantative Techniques Vol. I &II, Everest Publication, 2007.
. 5. Manohar Mahajan, Operation Research, Dhanpatrai Publication, 2006.
. 6. V. K. Kapoor, Operations Research: Quantitative Techniques for Management, Sultan Chand Publications, 2013.

Reference Books

. 1. Hillier F.S., and Lieberman G.J., Operations Research, Eight Edition, Mc. Tata McGraw Hill, India, 2011.
. 2. Ravindran, ―Engineering optimization Methods and Applications‖, 2nd edition, Wiley, India
. 3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey,
. 4. Operations Research - An introduction, Hamdy A Taha, Pearson Education, 2010

Strength of CO-PO Mapping												
	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	2	-	-	1	-	-	-	-	-	1	2
CO2	2	2	-	-	1	-	-	-	-	-	1	2
CO3	2	2	-	-	1	-	-	-	-	-	1	2
CO4	2	2	-	-	1	-	-	-	-	-	1	2
CO5	2	2	-	-	1	-	-	-	-	-	1	2
Average	2	2	-	-	1	-	-	-	-	-	1	2

T. Y. B. Tech.
Pattern 2022
MEC223017 : Machine Intelligence

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03hrs/week	**03**	**Continuous Comprehensive Evaluation:** 20Marks **In Sem Exam:** 20 Marks **End Sem Exam:** 60 Marks

Prerequisite Courses: -Engineering Mathematics, Linear Algebra, Probability, Basic Statistics

Course Objectives:

1. UNDERSTAND the fundamentals of Artificial Intelligence and Machine Learning.
2. APPLY Feature Extraction and Selection techniques to process datasets.
3. APPLY fundamental of classification and regression algorithms.
4. DEMONSTRATE the ability to develop machine learning models by outlining and executing essential steps, emphasizing practical application in mechanical engineering contexts.
5. EXPLORE the concepts of reinforced and deep learning, digital twin and Transfer learning.

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

	Course Outcomes	**Bloom's Level**
CO1	APPLY fundamental principles of Artificial Intelligence and Machine Learning.	2-Understanding
CO2	EXPLORE emerging technologies in solving engineering problems using Machine Learning.	2-Understanding
CO3	APPLY feature extraction and selection techniques to preprocess the given dataset	3- Apply
CO4	DEMONSTRATE classification and regression Algorithms in the context of mechanical engineering, enabling them to choose and implement suitable solutions	3- Apply
CO5	DEVELOP machine learning models, to address complex problems in mechanical engineering by following systematic and well-defined steps.	4 -Analyze

COURSE CONTENTS

Unit I	**Introduction to AI & ML**	**(08 hrs)**	**COs Mapped -CO1**

Introduction to AI- Definition and history of AI, Comparison of AI with Data Science and Machine learning Basics of AI: Reasoning, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Ethical considerations in AI, Societal Impact and Responsible AI **Introduction to Machine Learning.**

Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning.

Unit II	**Feature Engineering**	**(07 hrs)**	**COs Mapped –CO3**

Feature selection: Filter Method, Wrapper Method, Embedded Methods, Greedy forward & backward methods, feature Ranking techniques, Decision tree

Feature extraction: Statistical features, Principal Component Analysis. (Numerical based on Statistical features and PCA)

Unit III	Machine Learning Algorithms	(07 hrs)	COs Mapped –CO4
Classification: Decision tree- Entropy reduction and information gain, Random Forest, Naive Bayes, Support vector machine. (Numerical based on Decision tree using IG and Bays theorem only) **Regression:** Logistic Regression, K-Means, K-Nearest Neighbor (KNN), Time series forecasting Algorithms (ARIMA, SARIMA, LSTM)			
Unit IV	**Development of Machine Learning Model**	**(07 hrs)**	**COs Mapped – CO4, CO5**
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), parameters for Model evaluation of classification and regression algorithms (confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning. Introduction to Artificial Neural Network, Convolution Neural Network.			
Unit V	**Introduction to Emerging Technologies**	**(07 hrs)**	**COs Mapped –CO2**
Characteristics of reinforced learning Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning Models, Markov Decision Process, Deep Learning, Introduction to digital twin (Definition, Components, Characteristics, Applications) and basics of Transfer Learning. Application of Artificial Intelligence and Machine Learning			

Text Books

1. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
2. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015

Reference Books

1. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.
2. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
3. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
4. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

Strength of CO-PO Mapping												
	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	1	2	2	2	-	1	2	2	-	2
CO2	3	3	1	2	2	2	-	1	2	2	-	2
CO3	3	3	1	2	2	2	-	1	2	2	-	2
CO4	3	3	1	2	2	2	-	1	2	2	-	2
CO5	3	3	1	2	2	2	-	1	2	2	-	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments- Total 5 Assignment Assignment on each unit for 10 Marks (These 50 marks will be converted to 10 Marks)	10
2	Tests on each unit using LMS \ Learni-Co (Each test for 10 M and total 50 marks will be converted to 10 M)	10

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech. **Pattern 2022 Semester: VI (Mechanical Engineering)** **MEC223018 : Financial Management**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 2 Hrs /week	**02**	**Continuous Comprehensive Evaluation: 50 Marks**

Prerequisite Courses, if any: - Fundamentals of Statistics, Basics of finance

Course Objectives

5. To introduce the concepts of economics & finance in industry.
6. To understand cost analysis and pricing
7. To acquire knowledge on basic financial management aspects and develop the skills to analyze financial statements
8. To understand the budgetary process and control.
9. To introduce the entrepreneurial financial aspects.

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

	Course Outcomes	**Bloom's Level**
CO1	UNDERSTAND the business environment, concepts of economics and demand-supply scenario.	2-Understand
CO2	UNDERSTAND accounting systems and analyze financial statements using ratio analysis	2-Understand
CO3	APPLY the concepts of costing and pricing to evaluate the pricing of mechanical components.	3-Apply
CO4	SELECT and PREPARE the appropriate type of budget and understand the controlling aspects of budget	3-Apply
CO5	DEMONSTRATE understanding of financing decisions of new ventures and performance	4-Analyze

COURSE CONTENTS

Unit I	**Introduction to Economics**	**(04hrs)**	**Cos Mapped – CO1**

Economics: Significance of Economics, Micro and Macro Economic Concepts, Various terms and Concepts, Importance of National Income, Inflation, Money Supply in Inflation, Factors of Production, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics

Demand and Supply: Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting

Unit II	**Costs and Cost Accounting**	**(05hrs)**	**Cos Mapped – CO1,CO3**

Costs: Standard cost, estimated cost, First cost, Fixed cost, Variable cost, Incremental cost, Differential cost, Sunk and marginal cost, Cost curves, Breakeven point and breakeven chart, Limitations of breakeven chart, Interpretation of breakeven chart, margin of safety, Angle of incidence and multi product break even analysis, Cost Output Decision and Estimation of Cost, Zero Based Costing and numerical

Cost Accounting: Objectives of cost accounting, elements of cost: material cost, labor cost, and expenses, allocation of overheads by different methods, Costing based on direct and indirect costs, Overheads apportionment and absorption, Different Models of Depreciation. Numerical on costing

Unit III	**Financial Accounting**	**(5hrs)**	**Cos Mapped – CO1,CO2**

Accounting, Cost accounting & Management accounting, Various types of business entities, Accounting principles, postulates & meaning of accounting standards, Accounting cycle, Capital and revenue, Revenue, Expenses, Gains & Losses, Types of accounts & their rules, Journal Entries Create ledger, Preparation of Trial Balance, Finalizations, Preparation of Trading & Profit & Loss account, Understanding of Assets & Liabilities Balance sheet and related concepts – Profit & Loss Statement and related concepts, Financial Ratio Analysis, Cash flow analysis, Funds flow analysis, Comparative financial statements, Analysis & Interpretation of financial statements, Concept of Ratio Analysis, Preparation of Balance sheet (numerical)

Unit VI	**Budget and Budgetary Control**	**(05hrs)**	**Cos Mapped – CO1,CO4**

Budgeting and Budgetary Control: Concept of budget, Types and classification of budgets, Advantages and limitations, Methods of budgeting

Budgetary Control: objectives, merits and limitations, Budget administration. Functional budgets. Fixed and flexible budgets, Installation of Budgetary Control System, Zero base budgeting, Taxes and Financial Planning, Impact of Taxation and Inflation on Financial Management

Unit V	**Entrepreneurial Finance**	**(05 hrs)**	**Cos Mapped – CO1,CO5**

Sources of Funds for Entrepreneurs and Start Ups: Entrepreneurial Finance Vs. Corporate Finance; Traditional Sources of Funds, Early-Stage Sources of Funds- Incubators, Accelerators, Crowd Funding, Business Angels, Mezzanine Funds, Venture Capitals, Private Equity, LBO, Funding Process – Deal Sourcing, Deal Negotiation, Deal Agreement, Term Sheet

Investment Decisions for Start Ups: Time Value of Money, Types of Investment Decisions, Capital Budgeting Process – Investment Evaluation, Risk Analysis in Capital Budgeting – Risk Adjusted Discount Rate, Certainty Equivalent, Decision Tree, Sensitivity Analysis, Scenario Analysis

Valuation and Measurement of Financial Performance: Pre Money and Post Money Valuation, Factors Influencing Valuation, Valuation Methods, Dilution and Valuation of Equity, Metrics used for Performance Evaluation, Harvesting-Exit Strategies

Text Books

17. Hay, Donald A. and Derek J. Morris. Industrial Economics and Organization: Theory and Evidence, 2nd Edition (Oxford: Oxford University Press), 1991.
18. Lall, Sanjaya. Competitiveness, Technology and Skills (Cheltenham: Edward Elgar), 2001.
19. Scherer, F. M. and D. Ross. Industrial Market Structure and Economic Performance, 3rd Edition (Houghton: Mifflin), 1990
20. Financial Accounting", Dr. Kaustubh Sontakke [Himalaya Publishing House] 4.Chandra, Prasanna (2004). Financial Management: Theory and Practice. New Delhi: TATA McGraw Hill.

Reference Books

1. Accounting Theory & Practice Prof Jawahar Lal [Himalaya Publishing House].
2. Brearley, Richard A. and Myers, Stewart C. (1988). "Principles of Corporate Finance", New Delhi: McGraw-Hil
3. Engineering Economics, Tara Chand, Nem Chand and Brothers, Roorkee
4. Engineering Economy, Thuesen, G. J. and Fabrycky, W. J., Prentice Hall of India Pvt. Ltd.
5. Mechanical Estimating and Costing, T. R. Banga and S. C. Sharma, Khanna Publishers, Delhi

Strength of CO-PO/PSO Mapping														
Strength of Cos	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	1	-	1	-	-	-	-	-	-	-	-	-	-
CO 4	1	1	-	-	-	-	2	-	-	-	-	-	-	-
CO 5	1	1	-	2	-	-	**2**	-	-	-	-	-	-	-
Avg	**1**	**1**	-	**2**	-	-	**2**	-	-	-	-	-	-	-

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	One LMS Test on each Unit (10 marks) Total 50 marks will be converted into 25 marks	25
2	Test- I (25 marks) and Test-II (25 marks) Total marks will be converted into 20 marks	20
3	Certification course using any Mooc's platform	05
	Total	**50**

K.K.Wagh Institute of Engineering Education and Research, Nashik
(Autonomous from Academic Year 2022-23)

T. Y. B. Tech
Pattern 2022 Semester: VI (Mechanical Engineering)
MEC223019 : Measurement and Automation Laboratory

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Tutorial: 01 hrs / week Practical: 02 hrs / week	01 01	Termwork: 25 Marks Oral: 25 Marks

Prerequisite Courses: - Basics of linear measurement, Physics, Fundamentals of Mechanical Engineering.

Course Objectives:

- To develop essential skills for calibrating and testing instruments.
- To apply basics of measurement methods through the gathering of data, analysis, and interpretation and expertise in designing limiting gauges.
- To demonstrate various robotic configurations using industrial robot
- To select appropriate hydraulic and pneumatic components by considering specified system requirements, performance criteria, and compatibility with existing infrastructure.
- To summarize troubleshooting techniques essential for identifying and resolving common issues encountered in fluid power systems

	Course Outcomes	**Bloom's Level**
CO1	**Selection** of measurement methods and standards, carryout data collection and its analysis.	2-Understanding
CO2	**Determine** limits, fits, tolerances, geometric tolerances and Design of Gauges.	3- Apply
CO3	**Demonstrate** of various robotic configurations using industrial robot	3- Apply
CO4	**Construct** Industrial circuits using suitable hydraulic and pneumatic components	3- Apply
CO5	**Design** an industrial fluid power system	5 - Evaluate

COURSE CONTENTS

The student shall complete the following activity as a Term Work,

1. Demonstrate and compute linear and angular measurements employing tools such as Vernier Caliper, Screw Gauge, Dial Gauge, Height Gauge, Bevel Protector, etc. Analyze measurement errors using OER software, Minitab, or Excel sheets.
2. Determine Parameters of screw thread using floating carriage micrometer.
3. Determine the geometry and dimensions of a given composite object or a single-point tool using an

Optical Projector or Tool Maker's Microscope. Evaluate and distinguish its practical utility in real-life applications.

4. Measurement of the any one characteristics from the following using any suitable measurement system,
   a. Surface roughness
   b. Gear tooth Parameter
   c. Verification of composite geometry.
5. Limit Gauges: Concepts, uses and applications of Go –No Go Gauges, Taylor's principle and Design of gauges (Numerical and student activity)
6. Demonstration of various robotic configurations using industrial robot
7. Demonstrate industrial circuits on Hydraulic trainers
8. Demonstrate industrial circuits on Pneumatic trainers
9. Design an industrial fluid power system to address a specified problem by selecting components from manufacturer catalogs.
10. Exploring Industrial Automation Systems: Site Visit.

Important Note:
Industry visit for advanced in measurement and automation to provide exposure to students.

Text Books

1. Jain R.K., Engineering Metrology, Khanna Publication.
2. I.C.Gupta, Engineering Metrology, Dhanpath Rai.
3. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, McGraw hill Publication.
4. Esposito A, Fluid Power with application, Prentice Hall
5. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
6. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
7. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference Books

1. Narayana K.L., Engineering Metrology.
2. Galyer J.F &Shotbolt C.R., Metrology for engineers
3. Judge A.W., Engineering Precision Measurements, Chapman and Hall
4. ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
5. Connie Dotson, Fundamentals of Dimensional Metrology, Thamson Publn. 4th Edition.
6. Pipenger J.J, Industrial Hydraulics, McGraw Hill
7. Pinches, Industrial Fluid Power, Prentice Hall
8. ISO - 1219, Fluid Systems and components, Graphic Symbols

9. Fundamentals of Pneumatics, Vol I, II and III. FESTO
10. Fundamentals of fluid power control, John Watton Cambridge University press
11. Introduction to Fluid power, Thomson Prentcie Hall
12. Hydraulic Control Systems Herbert E. Merritt John Wiley and Sons, Inc

Codes / Handbooks

Francis T. Farago, Mark A. Curtis, Handbook of dimensional measurement

E- resources

1. nptel.ac.in/courses/112106179
2. www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html
3. https://nptel.ac.in/courses/112/107/112107242/
4. freevideolectures.com › Mechanical › IIT Madras
5. https://nptel.ac.in/courses/112/106/112106139/
6. https://archive.nptel.ac.in/courses/112/106/112106175/#
7. https://archive.nptel.ac.in/courses/112/106/112106300/

	Strength of CO-PO/PSO Mapping													
	PO												PSO	
Strength of CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	-	3	-	-	-	-	2	2	1	2	2	1
CO 2	3	2	-	3	3	-	-	-	2	2	1	2	2	1
CO 3	3	2	-	3	2	-	-	-	2	2	1	2	2	2
CO 4	3	2	-	3	2	-	-	2	2	2	1	2	2	2
CO 5	3	2	3	3	2	-	-	3	2	2	1	2	2	2

Guidelines for Teamwork Assessment

Continuous Assessment Policy
(Term work marks of 25 will be awarded based on the following policy)

Each laboratory assignment will be assessed for 30 Marks according to the following rubrics:
R1- Timely completion of assignments (10 Marks)
R2- Understanding of assignment (10 Marks)
R3 – Presentation/Clarity of journal writing (10 Marks)
For all 10 Experiments, total marks of 300 will be converted into 25 Marks.

Description	**Weightage**	**Evaluation criteria**
R1-Timely completion of assignments	10 Marks	Each experiment/assignment will get 10 marks for timely submission. Late submission will be valued as 5 in totality. Fail to submit will be valued as 0 in totality
R2- Understanding of assignment.	10 Marks	Understanding of assignments is based on oral questions based on assignment.
R3 – Presentation/Clarity of Drawing Sheets	10 Marks	Completed sheet with proper dimensioning, line work carries 10 marks.

Third Year. B. Tech.Pattern 2024 MEC223020 : Seminar		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical : 2 hrs./week	**1**	**Term Work:** 50 Marks
Prerequisite Courses: --		
Course Objectives: • Apply problem-solving skills to real-world scenarios related to their specialization. • Analyze the technical and practical challenges within their course specialization. • Evaluate the implications of these challenges on industry practices and innovations. • Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting		
Course Outcomes: With this seminar report and presentation, the student is expected to learn/achieve the following:		

	Course Outcomes
1	***Applying*** problem-solving techniques to real-world scenarios, demonstrating adaptability and creativity in finding effective solutions.
2	***Illustrate*** technical and practical issues relevant to their specialization.
3	***Comparing*** the potential impact of these challenges on various sectors or segments within the industry.
4	***Demonstrate*** enhanced soft skills and effective presentation.

Course Overview:

This course is designed to enhance the intellectual and professional development of third-year mechanical engineering students by providing them with an opportunity to explore and present on advanced topics relevant to the field. This seminar aims to foster critical thinking, research skills, and effective communication abilities among the students.

Selection of Seminar Topic: (Week 1)

Choose topics that align with current trends, emerging technologies, and challenges in the field of mechanical engineering.

Encourage diversity in topic selection to cover a broad spectrum of sub-disciplines within mechanical engineering, such as thermodynamics, materials science, manufacturing, robotics, fluid mechanics, and sustainable design.

Literature Survey: (Week 2 to Week 4)

Allocate sufficient time for students to conduct in-depth research on their chosen seminar topic.

Encourage the use of reputable academic sources, journals, and research papers for information gathering.

Emphasize the importance of critical analysis and synthesis of information to form well-supported arguments.

Guidance for the Presentation: (Week 5)

Provide guidance on effective presentation techniques, including clear slides, proper use of visual aids, and engaging delivery.

Encourage students to practice their presentations to ensure they adhere to time limits and effectively convey their message.

Highlight the importance of maintaining eye contact, using confident body language, and responding to audience questions with clarity.

Stage I Presentation: (Week 6)

Follow the guidelines for the presentation

Stage I presentation slides should include introduction, literature review and concept.

Stage I presentation to be delivered to the seminar guide.

Report Preparation: (Week 7 to 9)

The students should get draft copy of the report checked from the allotted seminar guide.

Students are expected to maintain a high standard of originality, with a permissible similarity threshold limited to 10%.

Stage II Presentation: (Week 10)

Stage II presentation slides should be as per format and structure provided.

Stage II presentation to be delivered in front of the internal panel.

Report & PPT Editing: (Week 11 to 12)

Report and PPT should be modified as per the suggestions/corrections given by the internal panel.

Final Presentation:

The final presentation/viva will be assessed by a committee including an expert (preferably from industry with minimum 5 years' experience) and an internal panel. The internal panel will consist of the seminar guide and two subject experts, approved by the HOD and the principal of the institute.

Format and Structure for Seminar Report Writing:

Introduction: Provide a clear and concise introduction to the chosen topic, highlighting its relevance and significance in the field of mechanical engineering.

Literature Review: Summarize key findings from relevant literature and discuss the existing knowledge base on the selected topic.

Methodology (if applicable): Outline any experimental methods, simulations, or data analysis techniques employed in the research.

Results and Discussion: Present and analyze the findings, addressing any challenges or limitations encountered during the research process.

Conclusions: Summarize the key takeaways and contributions of the seminar, along with potential avenues for future research.

Q&A Session: Allow time for questions and discussions, promoting interaction and engagement with the audience.