MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programmes

BACHELOR of ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS

VII AND VIII SEMESTERS

(FOURTH YEAR)

21 Admitted Batch

Academic Year 2024-25

Vision of The Department:

To emerge as department of high repute in Mechanical Engineering and allied fields through effective teaching, learning process and research activities, operating with a sense of professional and social responsibility.

Mission of The Department:

1. Empower students to scale high in their professional career through upskilling.
2. Effective association with higher institutes of learning, industry and research laboratories with emphasis on multi-disciplinary approach.
3. Encourage students to participate in sustainable projects.
4. Inculcate professional and ethical norms in all activities.

Program Educational Objectives:

PEO 1: Graduates will be able to apply engineering principles to develop products, processes or knowledge to solve mechanical and associated engineering problems for successful careers in mechanical engineering/higher education/research.

PEO 2: Graduates will acquire leadership qualities with strong communication skills along with professional and ethical values.

PEO 3: Graduates will be able to become entrepreneur / innovators to design and develop manufacturing systems and services to address social, technical and business challenges.

PEO 4: Graduates will be lifelong learners.

PROGRAM OUTCOMES [POs]:

Mechanical Engineering students shall be able to,

PO1:	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2:	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3:	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4:	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5:	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6:	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7:	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8:	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9:	**Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10:	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11:	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12:	**Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES [PSOs]

PSO1:	Apply the knowledge of design engineering skills to manufacture an engineering mechanical system.
PSO2:	Model, simulate, analyze and optimize mechanical systems / processes through application of software.

Scheme of Evaluation (Theory Courses)

	Portions for CIE	Mode of Evaluation	Weightage in Marks
CIE - 1	Syllabus to be decided by the course coordinators such that all the COs shall be covered.	Descriptive Test	**10**
CIE - 2		Descriptive Test	**10**
CIE - 3		Descriptive Test	**10**
Activity	Minimum of two activities to be conducted	Assignment / Case study/Practical/ Working model /Quiz	**20**
		Total	**50**

Examination		**Maximum marks**	**Minimum marks to be scored**	**Minimum Average marks to qualify**
CIE	**Tests**	**30**	**12 (> = 40%)**	**40 (> = 40%)**
	Activity	**20**	**08 (> = 40%)**	
SEE		**50**	**17.5 (> = 35%)**	

Scheme of Evaluation (Laboratory Courses)

Evaluation Type	**Evaluation modules**	**Marks**
Continuous internal Evaluation (CIE) in every lab session by the Course coordinator	Conduction of experiments	10
	Observation and tabulation of results	10
	Record writing	20
	Viva voce/Quiz	10
CIE		**50**
SEE		**50**

Note: The marks distribution to be made based on the rubrics for a particular laboratory course.

MALNAD COLLEGE OF ENGINEERING, HASSAN
B.E. in Mechanical Engineering
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2024-25)

Course Type	Course Code	Course Title	Credits			Total Credits	Contact Hours
			L	T	P		
PCC	21ME701	Control Engineering	3	0	0	**3**	3
PCC	21ME702	Finite Element Method	3	1	0	**3**	4
HSMC	21ME703	Financial Management and Engineering Economics	3	0	0	**3**	3
PEC	21ME74X	Program Elective – 3	3	0	0	**3**	3
PEC	21ME75X	Program Elective – 4	3	0	0	**3**	3
PCC	21ME706	Design Laboratory	0	0	1	**1**	2
PCC	21ME707	Modelling and Simulation Laboratory	0	0	1	**1**	2
PCC	21ME708	Automation Lab	0	0	1	**1**	2
OEC	21OEXXX	Open Elective -2	3	0	0	**3**	3
AEC	21RMIP	Research Methodology and Intellectual Property rights (Mandatory course)	2	0	0	**0**	2
PI	21PROJ1	Main Project Work Phase-1	0	0	4	**2**	4
Total			**18**	**02**	**07**	**23**	**32**

Program Elective – 3			**Program Elective – 4**	
21ME 741	Non-Destructive Testing		21ME 751	Lean Manufacturing
21ME 742	Engineering System Design		21ME 752	Machine Learning with Python
21ME 743	Fundamentals of Industry 4.0and Industrial IoT		21ME 753	Refrigeration and HVAC systems
21ME 744	Concurrent Engineering		21ME 754	Occupational Health and Safety Engineering
21ME 745	Operations Research		21ME 755	Foundations of Robotics

Open Electives –2	
21OEME 71	Principles of Manufacturing
21OEME 72	Industrial Engineering and Ergonomics
21OEME 73	Project Management
21OEME 74	Occupational Health and Safety Engineering

Course Title	CONTROL ENGINEERING		
Course Code	21ME701	LTPC	3-0-0-3
Exam	03 Hours	Hours / Week	04
SEE	50 Marks	Total hours	40

Course objectives: To build and regulate mechanical systems through mathematical modeling and analysis to obtain desired output.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	mathematically model and analyze block diagrams and signal flow graphs for physical systems	1,2,3	-
2.	determine the response of first & second order systems to applied inputs and understand the concept of control action and types of controllers	2,3	-
3.	analyse control system using root locus and Nyquist plots	2, 3	-
4.	analyse control system using Bode plots and apply basics of state space techniques for control systems	2,3	-

Course Contents:

Module – 1	10 Hrs.
System Dynamics: System transfer function, Mathematical modelling of mechanical, electrical, thermal, hydraulic and pneumatic systems. **Feedback control systems:** Physical modelling, Areas of vital role, classification of control system, requirements of automatic control system, Block diagram algebra, Signal flow graphs	
Module – 2	**10 Hrs.**
Transient Response and Stability: First order and second order system response to step, ramp and sinusoidal inputs, system types, steady state error, Routh - Hurwitz criterion. **Controllers:** Controllers, Concept of proportional control, Integral control, Proportional plus integral (P-I) control, Proportional plus derivative (P-D), Proportional- integral- differential control.	
Module – 3	**10 Hrs.**
Root Locus Method: introduction, Root locus plots. Illustrations, General rules for Constructing root loci, Root locus analysis of control system **Nyquist (polar) plots:** Theory, Nyquist stability criterion, System analysis using Nyquist diagrams.	
Module - 4	**10 Hrs**
Bode Plot: Frequency Response, Basic factors, Construction of Bode attenuation diagrams, Stability using Bode plots. **Introduction to State Variable Techniques:** Introduction to state concepts, state equation of linear continuous data system, Matrix representation of state equations, Observability and Controllability	

SELF STUDY:

To prepare and present a report on the following topics:

1. Concept of system compensation,
2. Lead, Lag, Lag-Lead compensation.

TEXT BOOKS:

1. Dhanesh. N. Manik, Control Systems, Seventh Edition, Thomson Press (India) Limited, 2012. ISBN – 8131518124, 9788131518120.

2. K. Ogata, Modern Control Engineering, Prentice Hall (India), Pearson Education 2010. ISBN: 0136156738, 9780136156734

REFERENCE BOOKS:

1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control systems**,** Ninth Edition, Wiley, 2009. ISBN: 0470048964, 9780470048962.
2. F. H. Raven, Automatic Control system, Third Edition, McGraw Hill,2010. ISBN: 0070512280, 9780070512283.
3. I. J. Nagrath and M. Gopal, Control Systems Engineering, Fifth Edition, Anshan Publishers, 2008. ISBN: 1848290039, 9781848290037.
4. Harrison and Bollinger, Introduction to Automatic Controls, Second Edition, International Text Book. Co 2007. ISBN: 13-978-0-9676897.

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	1											
CO2		3	1											
CO3		3	1											
CO4		3	1											

Course Title	FINITE ELEMENT METHOD		
Course Code	21ME702	LTPC	3-1 -0 -3
Exam	03 hours	Hours / Week	04
SEE	50 marks	Total hours	40

Course objectives: To make students familiar with the application of Finite Element Method enabling them to formulate and find solutions for structural, thermal and fluid flow problems.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	enumerate the procedure, importance of matrix algebra in finite element method and its applications.	1,2	-
2	formulate one dimensional element in structural, thermal & fluid flow engineering using direct/variational/Galerkine's approaches.	1,2	-
3	apply appropriate procedure in discretization and handle various boundary conditions for solving structural, thermal & fluid flow problems.	2,5	2
4	create shape functions for various elements in local, natural coordinate systems and explain their role and significance in Finite element formulation.	1,2	-

Course Contents:

Module – 1	10 Hrs.
Introduction: Need for use of FEM, General steps for FEM, Applications of FEM, Matrix algebra, Eigen values and Eigen vectors, Gaussian Quadrature. **Potential Energy Approach:** To derive Spring Element equations, numerical on spring assemblage using PE approach. **Stiffness (Displacement) Method**: Definition of Stiffness Matrix, Derivation of Stiffness Matrix for Spring element, Spring assemblage, Assembling Total Stiffness Matrix, Boundary conditions. Approaches used for handling specified displacement boundary conditions, numerical on spring assemblage using stiffness method.	
Module – 2	**10 Hrs.**
Discretization of domain: Basic element shapes-one, two, three and axis symmetric elements, discretization process. Interpolation polynomials **Shape functions**: For one dimensional linear, quadratic and cubic element, shape functions in natural coordinates, Convergence criteria, selection of the order of the interpolation polynomial, Pascal triangle and Pascal tetrahedron, nodal degrees of freedom, aspect ratio. **Development of Truss Equations:** Derivation of Stiffness Matrix for a Bar Element in local coordinates, Approximate functions for Displacements, Transformation of vectors in Two dimensions, Global Stiffness Matrix, Computation of Stress, and Solution of a Plane Truss, numerical on bars and trusses using stiffness method.	
Module – 3	**10 Hrs.**
Development of Beam Equations: Beam Stiffness, Assemblage of Beam Stiffness Matrices, Beam Analysis using the Direct Stiffness Method, Distributed Loading, Potential Energy approach, Galerikin's Method for Deriving Beam element equations, numerical on beams with different kinds of supports and loading**.** Finite Element Method applied to Heat Transfer problems: Basic Differential Equations of Heat Transfer, Heat transfer with convection, One Dimensional steady state heat conduction. Finite Element Formulation using variational Method and Galerkin's formulation. Heat transfer by conduction and convection – The one-dimensional fin, the composite wall.	

Module – 4	10 Hrs.

Finite Element method applied to Fluid flow problems: Basic differential equations – fluid flow in pipes and around solid bodies- One dimensional finite element formulation. Simple problems.

Higher order and Isoparametric Elements: Lagrangian interpolation, Higher order one dimensional elements- quadratic, cubic elements and their shape functions, properties of shape functions, shape functions for 2D quadratic triangular element in natural coordinates, 2D quadrilateral element shape functions- linear, quadratic, shape function of beam element. Hermitshape functions of beam element.

SELF STUDY:

1. Practice and submit analytical solution for structural/thermal/fluid flow problem using any one of the analysis software available.
2. Derive shape functions for higher order 1D and 2D elements.
3. Derive Galerikin's Method for deriving beam element equations.

TEXT BOOK:

1. Daryl L. Logan, A First Course in Finite Element Method, 5th Edition, 2012, Cengage Learning ISBN-13: 978-0-495-66825-1/ISBN-10: 0-495-66825-7

REFERENCE BOOKS:

1. Chandrupatala and Belegunda, Introduction to Finite Elements in Engineering, Pearson education,2002.ISBN -13:978-0-13-21624-6

2. J. N. Reddy, Finite Element Method, Tata McGraw-Hill edition 2002. ISBN: 0071244735.

3. Hutton, Fundamentals of Finite Element Method, McGraw-Hill, 2004.ISBN: 0-07-239536-21

4. Robert Cook, Concepts &applications of FEA, John Wiley & Sons 2002.ISBN:0-471-35605-0

Tutorials:

1. Problems on matrix algebra
2. Numerical on spring assembly using potential approach
3. Numerical on spring assembly using direct stiffness method
4. Derivation of shape function for cubic element in both local and natural coordinates
5. Problems on stepped bar elements using direct stiffness method
6. Numerical on truss element
7. Derivation of Hermite shape function
8. Numerical on beam element subjected to different types of loading
9. Finite element formulation of heat transfer element using Galerkin's approach
10. Numerical on heat transfer using finite element approach
11. Numerical on fluid flow through pipes and solid bodies
12. Derivation of shape function for higher order element using Lagrangian shape function

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	-	-	-	-	-	-	-	-	-	-	-	-
CO2	**3**	**3**	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	**3**	-	-	**2**	-	-	-	-	-	-	-	-	**2**
CO4	**3**	**3**	-	-	-	-	-	-	-	-	-	-	-	-

Course Title	FINANCIAL MANAGEMENT & ENGINEERING ECONOMICS		
Course Code	21ME703	LTPC	3-0-0-3
Exam	03 Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objective:

To apply the fundamental concepts of financial management and engineering economics to carry out a comparative study based on costs and revenues of engineering operations.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	apply the concepts of financial management to solve engineering problems.	2, 11,12	-
2	apply basic concepts of accounting and finance and thus can implement while working in an organization at managerial position.	2, 11,12	-
3	apply the fundamental concepts of economics while solving problems related to economic feasibility of an investment and making decision.	2, 11,12	-
4	analyse the impact of inflation, taxation and depreciation on an engineering project.	2, 6,11,12	-

COURSE CONTENT:

Module -1	
Financial Management: Finance and Related Disciplines, Scope & Objectives of Financial Management. **Volume-Cost-Profit Analysis:** Introduction, Break-even Analysis, Simple Numerical. **Budgeting and Profit Planning:** Introduction, Profit planning, Objectives & essentials of profit planning, Budget planning process, Budget administration, type of budgets, preparation of budgets, advantages, dangers of budgeting, Simple Numerical.	**10 Hrs.**
Module -2	
Book-keeping and Accounting: Bookkeeping – systems of bookkeeping, Definition of Accounting, Accounting equation, Important accounting terminology- Assets, Liabilities, Drawings, Debit, Credit, Debtors, Creditors, Capital, Investment, loans, shares, debentures and bonds, Journal and Ledger posting, Simple Numerical. **Statements of Financial Information**: Source of financial information, financial statements, Preparation of Trial balance, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account, Simple Numerical.	**10 Hrs.**
Module -3	
Financial Ratio Analysis: Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Comparative statements analysis, Simple Numerical. **Present-Worth Comparisons:** Cash flow diagram**,** Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Numerical problems.	**10 Hrs.**

Module -4	
Equivalent Annual-Worth Comparisons and Rate-Of-Return Calculations: Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Rate of return, Minimum acceptable rate of return, IRR, Numerical problems. **Depreciation and Taxation:** Depreciation meaning, Causes of Depreciation, Basic methods of computing depreciation charges, Tax concepts, Inflation: Causes, Consequences and Control of Inflation, Inflation in Economic Analysis.	**10 Hrs.**

SELF-STUDY:

1. Refer published financial statement of public sector manufacturing company and to interpret company's financial position.
2. Select any one product and estimate cost of manufacturing per unit.

TEXT BOOKS:

1. **Financial Management: Text, Problems & Cases,** M. Y. Khan &P. K. Jain, Sixth Edition, Tata McGraw Hill Education, 2011, ISBN: 978-0-07-106785-0
2. **Engineering Economics,** James L.Riggs, David D.Bedworth and Sabah U.Randhawa, McGraw Hill Education, Fourth edition, 2015, ISBN: 978-0-07-058670-3

REFERENCE BOOKS

1. Chandra, Prasana: Financial Management; Tata McGraw Hill, New Delhi, 2008.
2. R.L.Gupta, V.K.Gupta : Fundamentals of Accounting : Sultan Chand & Sons : Year of Publication 1993
3. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
4. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3									3	2		
CO2		3									3	2		
CO3		3									3	2		
CO4		3				2					3	2		

Course Title	NON-DESTRUCTIVE TESTING		
Course Code	21ME741	LTPC	3-0-0-3
Exam	03 Hours	Hours / Week	3
SEE	50 Marks	Total hours	40

Course objectives:

To provide a comprehensive understanding of different Non-Destructive Testing (NDT) methods, enabling participants to proficiently apply these techniques for defect detection and material characterization in industrial contexts.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

COs	Statement	POs	PSOs
1.	demonstrate a thorough understanding of NDT methods, distinguishing them from mechanical testing and grasping the overarching principles, advantages, and limitations within the field	1, 6, 7, 8	-
2.	apply NDT methods to detect defects and characterize materials, demonstrating practical proficiency in executing testing procedures and interpreting results across various techniques	1, 6, 7	-
3.	analyze and compare NDT methods, evaluate material characteristics, and make informed decisions for quality control and assurance in diverse applications	1, 6, 7, 8	-

COURSE CONTENTS:

Module - 1	10 Hrs.
Overview of NDT: NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection - Unaided and aided. **Surface NDE Methods:** Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results.	
Module - 2	**10 Hrs.**
Surface NDE Methods (Continued): Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism. **Ultrasonic Testing (UT):** Ultrasonic Testing- Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction.	
Module - 3	**10 Hrs.**
Thermography and Eddy Current Testing (ET): Thermography- Principles, Contact and noncontact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing- Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.	

Module - 4	10Hrs.
Acoustic Emission (AE): Acoustic Emission Technique –Principle, AE parameters, Applications **Radiography (RT):** Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radio graphic equivalence. Fluoroscopy- Xeroradiography, Computed Radiography, Computed Tomography.	

Activity Components

- Conduct visual inspection sessions with unaided and aided methods, allowing students to identify and document defects on sample materials.
- Engage students in a workshop where they perform some NDT tests and interpret and report results.
- Facilitate a simulation exercise for some NDT tests, enabling students to practice magnetization methods, evaluate test indications, and implement demagnetization techniques.
- Present real-world case studies of NDT applications, encouraging students to analyze advantages, limitations, and interpretation/evaluation aspects for different scenarios.

TEXTBOOK:

1. Practical Non-Destructive Testing Baldev Raj, T.Jayakumar, M.ThavasimuthuNarosa Publishing House 2009.
2. Non-Destructive Testing Techniques Ravi Prakash New Age International Publishers 1st revised edition2010

REFERENCE:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", Volume-17 American Society of Metals, Metals Park, Ohio, USA, 2000
2. Introduction to Nondestructive testing: A Training Guide Paul E Mix, Wiley 2nd Edition New Jersey, 2005.
3. Handbook of Nondestructive evaluation Charles, J. Hellier McGraw Hill, New York 2001.

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					2	2	2						
CO2	3					2	2							
CO3	3					2	2	2						

Course Title	ENGINEERING SYSTEM DESIGN		
Course Code	21ME742	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objective: To make students apply the concepts such as designing at system level, reliability, man-machine interaction, and engineering economics while evaluating various design concepts.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	apply knowledge of system design to generate innovative ideas for solving engineering problems	2,3	-
2.	develop design morphology, identify and analyze the need, and evaluate alternatives.	2,3	-
3.	apply reliability concepts in system design	2,6	-
4.	apply appropriate combinations of advanced concepts of engineering economics and man machine interaction	2, 3,6	-

COURSE CONTENTS:

Module- 1	10 Hrs.
Introduction: What is designing, Man as a designer, Design by evolution, inadequacies of traditional design method, System approach of engineering problems, Need models: design history of large-scale existing system. **Morphology of Design:** The three phases of design projects, the structure of design process, decision making and iteration. **Identification and Analysis of Need:** Preliminary need statement, analysis of need, specifications, standards of performance and constraints.	
Module - 2	**10 Hrs.**
Origination of Design Concept: Process of idealization, mental fixity, and some design methods like morphological analysis, AIDA, brainstorming. **Preliminary Design:** Mathematical modelling for functional design: concept of sensitivity, compatibility and stability analysis.	
Module– 3	**10 Hrs.**
Evaluation of Alternatives and Design Decisions: Physical realizability, Design Tree: Quality of design, Concept of utility, multi criteria decisions, decisions under uncertainty and risk (Numerical). **Reliability Considerations in Design:** Bathtub curve, exponential reliability function, system reliability concept (Numerical).	
Module– 4	**10 Hrs.**
Economics and Optimization in Engineering Design: Economics in Engineering Design, Fixed and variable costs, break-even analysis (Numerical) **Man-Machine Interaction:** Man-machine cycle, Design of displays and controls. Factors influencing displays and controls.	
SELF STUDY: Sustainability, Planning and Design for Sustainability, Environmental Considerations, Environmental Assessment Programs and Techniques, Social Impact, Social Assessment Tools and Methods	

TEXT BOOKS:

1. V. Gupta and P. Murthy, An Introduction to engineering design method, Tata McGraw Hill, 2000. ISBN-0070964416.
2. Graeme Dandy, Trevor Daniell, Bernadette Foley and Robert Warner, Planning & Design of Engineering Systems, Third Edition, CRC Press, 2018. ISBN: 978-1-1380-3189-0

REFERENCE BOOKS:

1. D.D. Meredith, K.W. Wong, R.W. Woodhead and K.K. Worthman, Design &Planning of engineering systems. 2000
2. M.A. Asimov, Introduction to Design, Prentice Hall. 1996
3. J. C. Jones, Design Methods, John Wiley & Sons Inc., 1992. ISBN: 0-471-28496-3.
4. T. Woodson, Introduction to Engineering Design, McGraw Hil1, 2001.

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	2											
CO2		3	2											
CO3		3				2								
CO4		3	2			1								

Course Title	Fundamentals of Industry 4.0 and Industrial IoT		
Course Code	21ME743	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course Objective:

The course is designed to offer fundamentals of Industry 4.0, IoT and their applications in the business world. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done to overcome some of the challenges, especially in the field of Mechanical Engineering.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

COs	Statement	POs
1.	Knowing fundamentals of Industry 4.0, Industrial revolution and challenges being faced	1, 6
2.	Information on sensors and actuators used in Industry 4.0, Smart Manufacturing and other cyber-physical related attributes.	1, 5
3.	Studying various aspects of IoT, IIoT, current technologies that are driving industries in manufacturing and management.	1, 5, 6,11
4.	Applications and Case Studies of IoT and IIoT in various streams	1, 4, 11, 12

Module – 1	10 Hrs.
Industry 4.0: Introduction, Various Industrial Revolutions, Fourth Revolution, Drivers, Enablers and Challenges for Industry 4.0.Lean Production System, Smart Factories, Smart and Connected Business Perspectives, Collaboration Platform and Product Life-Cycle Management.	
Module - 2	**10 Hrs.**
Cyber-Physical Systems (CPS) and Next Generation Sensors, Industrial Sensing and Actuation, Smart Manufacturing, Smart Devices and Products, Smart Logistics. Automation and Robotics in Industry, Artificial Intelligence, Support system for Industry 4.0, Opportunities in future and strategies for competing in Industry 4.0 era.	
Module - 3	**10 Hrs.**
Industrial IoT: Introduction, Internet of Things (IoT), Industrial IoT, Industrial Processes, Advanced technologies: Software Defined Networking and Security in IIoT.Key Enablers of IIoT: Sensing, Connectivity, Processing & Process control, IIoT Analytics and Data Management: Machine Learning and Cloud computing (Brief description only)	
Module - 4	**10 Hrs.**
Applications of IIoT: Inventory Management & Quality Control, Plant Security and Safety, Facility Management, Oil-Chemical & Pharmaceutical Industry, UAVs in Industries, Factories and Assembly Line, Food Industry, Case Studies for Industry 4.0 and IIoT: Milk Processing & Packaging Industries, Manufacturing Industries, Virtual Reality Lab, Steel Technology Lab.	

Self-study component:

1. Advanced robotic applications in various industries.
2. Programming of Raspberry Pi and other similar microcontrollers

Activity:

1. Developing simple working models using IoT platform.

Textbooks:

1. Oliver Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key Applications and Protocols", Wiley Publications, 2011. ISBN: 1119966701.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 1st Edition, 2017. ISBN: 1484220463.
3. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, "Internet of Things", Wiley Publications, 2019. ISBN: 8126578378.

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1								
CO2	3				2									
CO3	3				2	1					1			
CO4	3			1							1	1		

Course Title	CONCURRENT ENGINEERING		
Course Code	21ME744	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course Objective: The objective is to introduce the students with a systematic approach to the integrated, concurrent design of products and their related processes including manufacture and support and to learn principles of Concurrent Engineering and its applications to reduce product development time.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	discuss the new paradigm areas of concurrent engineering for process and Methodologies to meet manufacturing competitiveness and sustainability with financial management.	1, 11	-
2.	analyze the effect of technological changes by concurrent activities to reduce product development time and life cycle management of a product.	1, 12	-
3.	identify and apply the appropriate C.E principles considering cultural, societal, and environmental factors to arrive at reduction of cost.	1	-
4.	model the information to simulate and communicate the various options to make informed decisions early in the process.	1,10	-

Course Contents:

Module - 1	10 Hrs.
Introduction: Review of Historical Events. Push and pull for New Paradigms. Areas of Manufacturing Competitiveness. Product and Services. **Process and Methodologies:** Performance Indicators, Manufacturing competitiveness.	
Module - 2	**10 Hrs.**
Life-Cycle Management: Shrinking Life Cycle. Life-Cycle Management, New Product Introduction, Strategic Technology Insertions, Managing Continuity, Managing Revision Changes. **Life-Cycle Cost:** Drivers, Life-Cycle Management Tools, Sequential Versus Concurrent Engineering, Life-Cycle Management	
Module - 3	**10 Hrs.**
Concurrent Engineering Definitions: Introduction, CE Definitions. Basic Principles of CE. Components Of CE. **Concurrency and Simultaneity:** Modes of Concurrency. Modes of Cooperation. Benefits of Concurrent Engineering.	
Module - 4	**10Hrs.**
Information Modeling: Information Modeling. Modeling Methodology. Foundation of Information Modeling. Concurrent Engineering Process Invariant. **Enterprise Model:** Class, Specification Model-Class, Product Model-Class, Process Model- Class Cognitive Models, Merits and Demerits.	

SELF-STUDY:

1. Survey of CE Success: key to Japanese success.
2. Future concurrent engineering.
3. Case studies of Quality Function Deployment.
4. Case studies of successful C.E Applications**.**

TEXT BOOK:

1. Prasad. B, Concurrent Engineering Fundamentals-Integrated product and process organization- Vol. I, PHI, 1996. ISBN: 0131474634, 9780131474635.

REFERENCE BOOKS:

1. Johan.R. Hartely, Concurrent Engineering-Shortening lead times, Raising Quality and Lowering Costs, Taylor and Francis, 1998. ISBN: 1563271893, 9781563271892.
2. Carter DE and Baker BS, Concurrent Engineering-The Product Development Environment for the 1990's, Addison Wesley Publishing Company.
3. I mad Moustapha, Concurrent Engineering in Product Design and Development, 2006, New Age International Publishers, ISBN:81-224-1309-9.

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3										2			
CO2	3											1		
CO3	3													
CO4	3									1				

Course Title	OPERATIONS RESEARCH		
Course Code	21ME745	LTPC	3-0-0-3
Exam	3Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives: To apply the fundamental techniques of Operations Research to formulate and solve problems involving Linear Programming and heuristic approaches.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	formulate real-world problems as a linear programming problem and obtain the optimal solutions using graphical and analytical methods.	1,2,3	-
2.	formulate and solve transportation and assignment problems using appropriate method.	2, 4,6	-
3.	design and solve simple models of CPM, PERT, and queuing to improve decision making and develop critical thinking and objective analysis of decision problems.	3,5,6,11	-
4.	select the best course of action out of several alternative courses for the purpose of achieving objectives by applying game theory and sequencing models.	3,5,6,11	-

Course Contents:

Module - 1	10 Hrs.
Introduction: Linear programming, Definition, scope of Operations Research (O.R) approach and limitations of OR Models, Characteristics, and phases of OR, Mathematical formulation of L.P. Problems, Graphical solution methods. **Linear Programming Problems:** The simplex method - slack, surplus and artificial variables. Concept of duality, two phase method, dual simplex method.	
Module - 2	**10 Hrs.**
Transportation Problem: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems **Assignment Problem:** Formulation of Assignment Problem, unbalanced assignment problem, Applications of Assignment Problem, Traveling salesman problem and its applications.	
Module - 3	**10 Hrs.**
PERT-CPM Techniques: Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion. **Queuing Theory:** Queuing system and their characteristics. The M/M/1 Queuing system, Steady state performance analysing of M/M/ 1 and M/M/C queuing models.	
Module - 4	**10 Hrs.**
Game Theory: Formulation of games, Two Person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property. **Sequencing:** Johnson's algorithm, n - jobs to 2 machines, n jobs 3machines, n jobs m machines without passing sequence, 2 jobs n machines with passing, Graphical solutions priority rules.	

TEXTBOOKS:

1. Taha H. A, Operations Research and Introduction**,** Pearson Education edition, 8th edition, 2007, ISBN: 9780131889231.
2. Operations Research, S. D. Sharma –Kedarnath Ramnath & Co, 2002, ISBN: 1234567142552

REFERENCE BOOKS:

1. AM Natarajan, P. Balasubramani and A Tamilaravari, Operation Research, Pearson 2005
2. 9788131700006.
3. Hiller and Liberman, Introduction to operation research, McGraw Hill. 5th edition 2001, ISBN: 978-0077298340.
4. Ravindran, Phillips and Solberg, Operations Research: Principles and practice: Wiley India ltd, 2nd Edition 2007 ISBN: 9788126512560
5. Prem Kumar Gupta, D S Hira, S Chand Publications, Operations Research, New Delhi, 2007, ISBN: 9788121941006

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2											
CO2		3		2		2								
CO3		3			2	2					2			
CO4		3			2	2					2			

Course Title	LEAN MANUFACTURING		
Course Code	21ME751	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objective: To impart the knowledge of lean manufacturing to maximize the product value and minimize losses in the form of waste in manufacturing.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	explain the basic concepts of lean manufacturing	1	-
2.	apply tools of lean manufacturing to reduce waste	1,2	-
3.	explain how lean manufacturing can be implemented	1, 2	-

Course Content:

Module - 1	10 Hrs.
The Origins of Lean Production: The rise and fall of mass production- Craft Production, Mass Production, Characteristics& Limits of Mass Production, Diffusion of Mass Production. The Rise of Lean Production: Supply Chain, Changing Consumer Demand, Dealing with the Customer, Traditional Versus lean Manufacturing. **Lean Manufacturing:** Introduction, Value, Top Seven Wastes, Elements of Lean Manufacturing: Customer Value, Value Stream, Value Flow, Customer Pull, Continuous Improvement.	
Module - 2	**10 Hrs.**
Primary Tools of Lean Manufacturing: Total Productive Maintenance: Basic Conditions Applicable for its Success, Implementation Process. Process Mapping: Advantages, Types & Preparation of Process Map. Value Stream Mapping: Steps to be followed to prepare VSM	
Module - 3	**10 Hrs.**
Secondary Tools of Lean Manufacturing: Kanban, Jidoka, Andon, Just in Time. **Lean Manufacturing Rules:** Stability- Employees, Machine, Process, Materials. Management, Standardized Work, Pull System, Level Production.	
Module - 4	**10 Hrs.**
Implementation of Lean Manufacturing: Areas needed to improve to achieve higher productivity: Operator, Process, Machinery and equipment, Workplace. Types of Inventories, 5S in Inventory Management: Sort the suppliers, Set in order the suppliers, Clean the purchase system, Standardize the process, Sustain the standards.	
SELF-STUDY: 1. Identify the waste in manufacturing industry through route cause analysis. 2. Selection of lean tools requirement 3. Implementation of Lean tools to improve the manufacturing efficiency	

TEXT BOOK:

1. **Simplified Lean Manufacture,** Gopalakrishnan N, PHI Learning Pvt Ltd, 2010
2. **The Machine that changed the World,** James P. Womack, Daniel T. Jones and Daniel Roos, Simon and Schuster.

REFERENCE BOOKS:

1. **Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System,** Pascal Dennis, (Second edition), Productivity Press, New York.
2. **Toyoto production system –An integrated approach to just in time,** Yasuhiro Modern – Engineering and Management press – Institute of Industrial Engineers
3. **Total Quality Management,** Dale H. Bester field et al., Revised Third Edition, Pearson, ISBN: 9788131764961

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3	2												

Course Title	MACHINE LEARNING WITH PYTHON		
Course Code	21ME752	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course Objective: to provide students with basic skills of python programming an in-depth introduction to two main- areas of machine learning: supervised and unsupervised**.**

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	interpret the basic constructs and OOPS concepts of python language	1,2,5	-
2.	describe variety of machine learning concepts and applications, data modeling & evaluation techniques,	2, 5	-
3.	demonstrate the supervised and unsupervised machine learning algorithms	2, 5	-

Course Content:

Module – 1	10 Hrs.
Python Basics: The way of Programming, Variables, Expression and Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program, **Flow control**: Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules.	
Module – 2	**10 Hrs.**
Lists: The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, List-like Types: Strings and Tuples, **Tuples and Dictionaries and Structuring Data**: The Dictionary Data Type, Pretty Printing. **Introduction to NumPy, Pandas and Matplotlib:** Create arrays using NumPy, perform various operations on arrays and manipulate them, Read & write data from text/CSV files into arrays and vice-versa, Create Series and Data Frames in Pandas, Data structures & index operations in pandas, Importing and exporting data, Reading and Writing data from Excel/CSV formats into Pandas, Create simple plots in matplotlib.	
Module – 3	**10 Hrs.**
Introduction to Machine learning: Human learning and its types, Machine learning and its types, Applications, tools and issues in machine learning, Activities in machine learning, Exploring structure of data, Data quality and Preprocessing. **Modeling and Evaluation:** Introduction, selecting a model, training a model, model representation and interpret ability, Evaluating performance of a model.	

Module – 4	10Hrs.
Supervised Learning: SVM, Regression-Simple linear regression, Multiple linear regression, Assumptions in Regression analysis. **Unsupervised Learning**: Supervised Vs Unsupervised, Application, clustering, finding pattern using Association rule.	

Programming Exercises:

1. Develop a program to read the student details like Name, USN, and Marks in three subjects. Display the student details, total marks and percentage with suitable messages.
2. Develop a program to generate Fibonacci sequence of length (N). Read N from the console.
3. Write a function to calculate factorial of a number. Develop a program to compute binomial coefficient (Given N and R).
4. Read N numbers from the console and create a list. Develop a program to print mean, variance and standard deviation with suitable messages.
5. Write a program to search an element using linear search.

TEXTBOOKS:

1. Al Sweigart," Automate the Boring Stuff with Python",1st Edition, No Starch Press,2015. (Available under CC-BY-NC-SA license at https://automateheboringstuff.com/)for lambda functions use this link: https://www.learnbyexample.org/python-lambda- function/
2. Flach, Peter. Machine learning: the art and science of algorithms that make sense of data. Cambridge University Press, 2012.

REFERENCE BOOKS:

1. Mohri, Mehryar, Afshin Rostamizadeh, and Ameet Talwalkar. Foundations of machine learning. MIT press, 2018.
2. Richert, Willi. Building machine learning systems with Python. Packt Publishing Ltd, 2013.
3. Rogers, Simon, and Mark Girolami. A first course in machine learning. CRC Press, 2016.
4. Bowles, Michael. Machine learning in Python: essential techniques for predictive analysis. John Wiley & Sons, 2015.

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2			3									
CO2		2			3									
CO3		2			3									

Course Title	REFRIGERATION AND HVAC SYSTEMS		
Course Code	21ME753	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives:

To give exposure to the students apply thermodynamic principles to carry out simple calculations, design and analysis of refrigeration and air-conditioning systems.

Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)}

Upon completion of the course, students shall be able to:

COs	Statement	Pos
1	apply the fundamental principles to analyze vapour compression & vapour absorption refrigeration systems.	2,3
2	Analyze multi pressure, multi evaporator and cascade vapour compression refrigeration systems.	2,3
3	perform preliminary design and analyze air-conditioning systems by cooling load calculations	2,3,7
	enumerate equipments used and their control in both refrigeration and air conditioning systems.	2,3,7

COURSE CONTENTS:

Module –1	
Brief review of various methods of Refrigeration. Vapour Compression Cycle &Vapour Absorption System. Analysis of Vapour Compression cycle using P-h and T-s diagrams, Standard rating of operating conditions, Actual vapour compression cycle. Solar energy-based refrigeration systems. (No numerical). Refrigerants: Survey of Refrigerants, Comparative study of Ethane and Methane derivatives. Selection of Refrigerants, Requirements of Refrigerants, Effect of lubricants in Refrigerants. Mixture Refrigerants-azeotropic mixtures.	**10 Hrs.**
Module – 2	
Multi Pressure Vapour Compression systems: Multi evaporator systems, Cascade systems, Calculations, Production of Solid Carbon dioxide. Equipments used in vapor compression Refrigeration system: Compressors: Principle, types of compressors, Capacity Control. Condensers: Types and construction, Expansion devices: Types-automatic expansion valve, Thermostatic expansion valves, Capillary tube.	**10 Hrs.**
Module – 3	
Psychrometry of Air conditioning Process- Review: Summer Air conditioning, Apparatus Dew point, and Winter Air conditioning. Design Conditions: Outside design conditions, Choice of Inside conditions, Comfort chart. Load Calculations and Applied Psychometrics; Internal heat gains, System heat gains, Break up of Ventilation Load and Effective Sensible Heat Factor, Cooling Load Estimate. Psychrometric calculations for cooling. Selection of Air conditioning Apparatus for Cooling and Dehumidification.	**10Hrs**
Module – 4	
Transmission and Distribution of Air: Room Air Distribution, Friction loss in ducts, dynamic losses in ducts, Air flow through simple Duct system, Duct design. Controls in Refrigeration and Air conditioning equipment: High pressure and Low pressure cut out, Thermostats, Pilot operated solenoid valve, Motor controls, Bypass control -Damper motor.	**10Hrs**

TEXT BOOKS:

1. C.P. Arora, *Refrigeration and Air-conditioning,* TMH, 2nd edition, 2001, ISBN: 0074630105, 9780074630105.

REFERENCE BOOKS:

1. Dossat, *Principles of Refrigeration,* TMH, 1st edition, 2000 ISBN: 0132333716, 9780132333719
2. Jordon & Priester, *Refrigeration & Air conditioning,* PHI, 1st edition, 1995. ISBN: 9780750618588.

DATA HAND BOOKS:

1. *Carrier, Air conditioning System Design Hand Book,* McGraw Hill 2000. ISBN: 10: 007010090X.
2. Nijaguna & Samaga, *Thermodynamics Data Hand Book,* 2002, ISBN: 13: 978007010909.

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	2											
CO2		3	2											
CO3		3	2				1							
CO4		3	2				1							

Course Title	OCCUPATIONAL HEALTH AND SAFETY ENGINEERING		
Course Code	21ME754	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives:

To apply the basic concept of occupational health and safety standards in workplace scenario.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

COs	Statement	POs
1.	interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces.	6, 11
2.	apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological, and psychosocial hazards.	6, 7, 11
3.	identify fire and electrical safety hazards, Product Safety and risk in the workplace.	6, 7, 11

COURSE CONTENTS:

Module – 1	
Introduction: Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws. Indian Acts – Labour Act, Factories Act, OSHA.	**10 Hrs.**
Module – 2	
Occupational Hazard and Control: Hazard Analysis, Human Error and Fault Tree Analysis, Emergency Response. Hazards and their control in different manufacturing and processing industries.	**10 Hrs.**
Module – 3	
Fire Prevention and Protection: Types of Fire, Fire Development and its Severity, Effect, Extinguishing Fire, Electrical Safety, Product Safety and Environmental Management Plan.	**10 Hrs.**
Module – 4	
Occupational Health: Personal Protective Equipments. Health and Safety Considerations in Construction Industries, Textile Industries, Food Processing Industries, Pharmaceutical Industries and Chemical & petroleum Industries. Occupational Health and Safety considerations in Wastewater Treatment Plants.	**10 Hrs.**

SELF STUDY:

Workplace ergonomics, fire safety, workplace violence prevention, employee health resources, and environmental safety.

TEXTBOOK:

Goetsch D.L., "Occupational Safety and Health for Technologists", Engineers and Managers", Prentice Hall.

REFERENCE:

1. Heinrich H.W., "Industrial Accident Prevention", McGraw Hill Publication, Network.

2. Colling D.A., "Industrial Safety Management and Technology", Prentice Hall, New Jersey.

3. Della D.E., and Giustina, "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc.

4. CPHEEO, Manual on Sewerage and Sewage Treatment, M/s.Jain Book Agency, c-9, Connaught place, New Delhi.

5. National Safety Council and Associate (Data) Publishers Pvt. Ltd., "Industrial Safety and Pollution Control Handbook"

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3					2			
CO2						3	2				1			
CO3						3	2				1			

Course Title	FOUNDATIONS OF ROBOTICS		
Course Code	21ME755	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course Objective:

To impart concepts of structure of industrial robots, kinematics, actuators, sensors, intelligent robot, robot applications and programming

Upon successful completion of this course, the student shall be able to:

COs	Statement	POs
1.	apply the basic concepts to analyze the structure of industrial robot	1,2
2.	compare, recommend and justify usage of robotic systems with relevant sensors and vision systems	2,3
3.	incorporate the concepts of robot programming and work-cell design for a variety of industrial applications	1,2
4.	apply basic principles of robotic design, analytical techniques and D.H method to solve kinematics problems	1,4

Module – 1	10 Hrs.
Basic concepts in robotics: Introduction, Historical development, Automation and Robotics, Robot Anatomy, classification, Basic Configurations of robots, Robot links and joints, Robot specifications: resolution, accuracy & repeatability, compliance, speed of response an stability, work volume, simple numerical problems, Joint notation schemes, PTP and continuous path system, wrist/Gripper/End Effectors Motions, Robot drive systems: hydraulic, pneumatic and electric drive systems, types of grippers, vacuum cups, magnetic grippers, adhesive grippers, hooks, scoops and other gripper devices, tool as end effectors	
Module - 2	**10 Hrs.**
Sensors and Robot vision System: Desirable characteristics and classification of sensors, Use of Sensors and Sensor Based System in Robotics, Machine vision system: functions of machine vision system, sensing and digitizing, imaging devices, analog to digital signal conversion, quantization and encoding, image storage, image processing and analysis, image data reduction, segmentation, feature extraction, Object recognition, robotic machine vision applications, inspection, identification, visual surveying and navigation	
Module - 3	**10 Hrs.**
Robot Programming and Work cell Design: A Robot Program as a Path in Space, Motion Interpolation, Robot Language Structure, Methods of robot programming, online lead through teaching, offline programming languages: syntax, structure and statements, Typical Programming Examples such as Palletizing, Loading a Machine. Robot Work cell design: Robot cell layouts, work cell control and interlocks, Error detection and Recovery, Industrial robot's applications	
Module - 4	**10 Hrs.**
Robot Kinematics: Direct kinematics and inverse kinematics, 3D homogeneous transformations, rotation, translation and displacement matrix, composite rotation matrix, rotation matrix about an arbitrary axis, links, joints and their parameters **Denavit-Hertenberg (D-H) Representation**: application of D-H matrices: D.H Convention 3-Axis arm, 3-axis wrist, 6-axis manipulator for PUMA & SCARA Configurations only	

Self-study component:

Students must perform the following exercises in Robotics laboratory

1. Teaching robots for palletizing application.
2. Online training of Robot for pick and place application.
3. Robot teaching for component stacking application.
4. Identifying degrees of freedom and their configuration based on observing the structure of the given Robot.

5. Robot teaching for point-to-point application for a spot-welding task.
6. Robot teaching for material handling applications

Activity:

2. Developing simple working models using IoT platform.

Textbooks:

4. Fu, Lee and Gonzalez, Robotics Control Vision, and Intelligence, McGraw Hill International. ISBN: 0070226253.
5. Mikell P. Groover, Industrial Robotics, Weiss, Nagel, McGraw Hill International ISBN: 9780071004428

Reference Books:

1. YoramKoren, Robotics for Engineers, McGraw Hill International. ISBN: 9780070353992,
2. Rafael C. González, C. S and George Lee, Robotics control, sensing, vision and intelligence, McGraw-Hill, 1987. ISBN: 0070226253, 9780070226258
3. Schilling R. J., Prentice-Hall, Fundamentals of Robotics, Analysis and Control, Publications, Eastern Economy edition, ISBN:978-8120310476.

COURSE ATRICULATION MATRIX

Course Out comes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2		2	1											
CO3	3	2												
CO4	3			1										

Course Title	DESIGN LABORATORY		
Course Code	22ME706	LTPC	0 – 0 – 2 - 1
Exam	03 hours	Hours / Week	02
SEE	50 marks	Total hours	26

Course objectives: To provide students with the necessary skills to conduct experiments, collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures to evaluate kinematic and dynamic characteristics of machine elements.

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}
Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	determine the behavior of undamped & damped system for longitudinal, torsional and forced vibrations in a single degree freedom system.	**1,2,9,10**	**-**
2	conduct experiments on governors, gyroscope, balancing of rotating masses and pressure distribution around journal bearing.	**1,2,9,10**	**-**
3	determine the stresses & strains in a member subjected to combined Loading using rosettes and photo elasticity.	**1,2,9,10**	**-**

Course Contents:

1. Determination of equilibrium speed, sensitiveness, power and effort of centrifugal governors.
2. Conduct experiments on gyroscope.
3. Experiment on Balancing of rotating masses.
4. Determination of pressure distribution in journal bearing
5. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree freedom system.
6. Experiments on longitudinal, Torsional and forced vibrations.
7. Determination of critical speed of a rotating shaft.
8. Determination of principal stresses and strains in a member subjected to combined loading using rosettes.
9. Demonstration of stress concentration using photo elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2 D crane hook.
10. Determination of fringe constant of photo elastic material using
    a) Circular disc subjected to diametral compression.
    b) Pure bending specimen (four-point bending).

Scheme of Evaluation

Evaluation Type	Evaluation modules	Marks
Continuous internal Evaluation (CIE) in every lab session by the Course coordinator	Conduction of experiments from 1 to 10	30
	Demonstration Experiments	10
	Record writing	10
	CIE	**50**
Semester End Examination		
1. Experiment-1		20
2. Experiment-2		20
3. Viva-Voce		10
	SEE	**50**

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3							2	2				
CO2	3	3							2	2				
CO3	3	3							2	2				
CO4	3	3							2	2				

Course Title	MODELLING AND SIMULATION LABORATORY		
Course Code	21ME707	LTPC	0-0-2-1
Exam	3Hours	Hours / Week	03
SEE	50 Marks	Total hours	26

Course objectives: To provide the students with knowledge of computer aided engineering analysis tools enabling them to acquire skills to carry out simulation and analysis of structural, thermal and dynamic problems.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}
Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Construct FE model of the given problem using basic aspects of FEM, apply BC's and obtain solution for structural problems using CAE software	2, 3, 5,9,10	2
2	conduct structural analyses, normal modes/natural frequency analysis, steady-state heat conduction analysis problems using CAE software	2, 3, 5,9,10	2

Course Contents:

Part-A
Bars of constant cross section area, tapered cross section area and stepped bar
Trusses – (**Minimum 2 exercises of different types)**
Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. **(Minimum 6 exercises different nature)**
Stress analysis of a rectangular plate with a circular hole
Part-B
Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions **(Minimum 4 exercises of different types)**
Harmonic analysis of a Fixed-Fixed Beam and Axial Bar.
Modal analysis of a Fixed- Fixed Beam

Scheme of Evaluation

Evaluation Type	Evaluation modules	Marks
Continuous internal Evaluation (CIE) in every lab session by the Course coordinator	Conduction of experiments from Part A & B	30
	Demonstration Experiments	10
	Record writing	10
	CIE	**50**
Semester End Examination		
1. Experiment-1 from Part-A		20
2. Experiment-2 from Part-A		20
3. Viva-Voce		10
	SEE	**50**

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	2		2				2	2				2
CO2		3	2		2				2	2				2
CO3		3	2		2				2	2				2
CO4		3	2		2				2	2				2

Course Title	AUTOMATION LABORATORY		
Course Code	21ME708	LTPC	0-0-2-1
Exam	3Hours	Hours / Week	03
SEE	50 Marks	Total hours	26

Course Objectives: Students will be able to gain Knowledge of basics of Mechatronics system, transducers, actuators, signal conditioning, sensors and understanding the working of Mechatronics components, signal conditioning & sensors.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes(POs)}**

On completion of the course the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	program a six-axis articulated Robot for different application.	2, 3, 5,9,10	2
2.	apply RPT techniques to prepare models of machine components	2, 3, 5,9,10	2
3.	describe the purpose, construction and operation of Hydraulic systems and its components.	2, 3, 5,9,10	2

Course Contents:

I. Robotics.

1. Identification of robot components and study of physical configuration and specifications.
2. Programming of six axis articulated Robot for pick and place operation.
    a. Single component.
    b. Alignment of two components.
3. Programming the Robot to generate Arcs, Spline and Circle.
4. ROBOT cell and Palletization applications and study of performance

II. Rapid Prototyping

5. Study of process parameters and Printing of simple machine components using Rapid Prototyping set up. Involving the following steps.
    i. Preparation of solid model.
    ii. Converting to STL format.
    iii. Exporting to RPT machine software environment.
    iv. Selection of parameters to print the model according to the required size.
6. Printing of Simple Machine components on 3D Printer

III. Hydraulics

7. Identification of Hydraulics circuit components and study of ISO symbol to represent them.
    i. Single- rod cylinder intensification.
    ii. Building of meter-in circuits
    iii. Building of meter-out circuits.
    iv. Application of 4/3 directional valve

Scheme of Evaluation

Evaluation Type	Evaluation modules	Marks
Continuous internal Evaluation (CIE) in every lab session by the Course coordinator	Conduction of experiments from Robotics, Rapid Prototyping & Hydraulics	30
	Demonstration Experiments	10
	Record writing	10
	CIE	**50**
Semester End Examination		
1. Experiment-1		20
2. Experiment-2		20
3. Viva-Voce		10
	SEE	**50**

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	2						2	2				2
CO2		3	2						2	2				2
CO3		3	2						2	2				2
CO4		3	2						2	2				2

Course Title	PRINCIPLES OF MANUFACTURING		
Course Code	21OEME71	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives: To equip students of other engineering disciplines with the fundamental aspects of manufacturing processes and their applications

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	realize the role of manufacturing processes in other engineering branches and learn principles of different metal forming processes	1	-
2	comprehend the basic principles and recent developments of modern manufacturing processes	1, 5	-
3	realize the significance of various joining and assembly techniques	1	-
4	infer the basic concepts and applications of rapid prototyping	1, 5	-

Course Contents:

Module – 1	10 Hrs.
Introduction and overview of manufacturing: History and concepts of manufacturing, Materials in manufacturing, Classification of manufacturing processes. **Fundamentals of metal forming:** Overview of metal forming, working principle, advantages, limitations and applications of rolling, forging, extrusion, wire and bar drawing, sheet metal operations – shearing, blanking and punching, bending operations – V and Edge bending, drawing, bending of tube stock.	
Module – 2	**10 Hrs.**
Fundamentals of material removal: Traditional vs. Non-traditional machining process, working principle, advantages, limitations and applications of ultrasonic machining, abrasive jet machining, electrochemical machining - deburring, grinding and honing, chemical machining, laser beam machining, electron beam machining.	
Module – 3	**10 Hrs.**
Fundamentals of joining and assembly processes: Working principle, advantages, limitations and applications of electron beam welding, laser beam welding and ultrasonic welding. **Adhesive bonding:** Materials and their properties, advantages, limitations and applications. **Coatings:** Painting, paint application methods, chemical conversion coatings, electroplating, anodizing, electro less plating, mechanical plating, porcelain enameling, clad materials.	
Module – 4	**10 Hrs.**
Rapid Prototyping: Fundamentals of rapid prototyping, rapid prototyping technologies, application issues in rapid prototyping. **Applications of rapid prototyping:** Processing of integrated circuits, electronics assembly, and packaging, micro fabrication technologies, and nanofabrication technologies.	

SELF-STUDY:

1. Simulation of manufacturing processes through online virtual labs.
   - https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html
   - http://msvs-dei.vlabs.ac.in/upsetting_simulation.php
   - http://mm-coep.vlabs.ac.in/
   - http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/#
   - http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpMM/
2. Preparation of reports on the simulation and presentations to be made in a group.

TEXT BOOK:

1. Mikell, P. Groover. Fundamentals of modern manufacturing: materials, processes and systems. JOHN WILEY, 2019.

REFERENCE BOOKS:

1. Black, J. Temple, and Ronald A. Kohser. DeGarmo's materials and processes in manufacturing. John Wiley & Sons, 2017.
2. Pham, Duc, and Stefan S. Dimov. Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling. Springer Science & Business Media, 2012.
3. Production Technology, HMT TATA McGraw Hill 2001 ISBN-0070764432.
4. Adityan, Modern Machining Process, 2002. ISBN-85143774 -11.

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3				1									
CO3	3													
CO4	3				1									

Course Title	INDUSTRIAL ENGINEERING AND ERGONOMICS		
Course Code	21OEME72	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives: To provide basic knowledge of productivity and method study, work measurement and ergonomics in various sectors and its effectiveness in improvement of productivity.

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	explain the fundamental concepts of productivity and work study	1, 6,11	-
2.	compare and prepare the charts for the existing method and new / proposed method to identify the unnecessary movements.	2, 6,11	-
3.	apply the concepts of work measurement to solve problems related to work measurement and performance of workers	2, 6	-
4.	apply the ergonomic concepts in design of new systems, displays and controls	3, 6	-

COURSE CONTENTS:

Module – 1	10 Hrs.
Productivity and work study: Definition of productivity, Production and productivity, expectations from productivity, benefits from productivity, productivity measures, advantages and limitations of productivity measures, Factors affecting the productivity, Productivity improvement programmes (Simple Problems). Basic work content. Definition, objective and scope of work-study. Human factors in work study. Work study and management, work study and supervision, work study and worker.	
Module – 2	**10 Hrs.**
Method Study and Tools for Method study: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts (Problems). Charts to record moment at workplace – principles of motion economy, classification of moments, two handed process chart, SIMO chart, (Problems)	
Module – 3	**10 Hrs.**
Work Measurement: Definition, objectives, preparing to measure process work, techniques of work measurement, types of elements, time study equipments, performance rating, allowances, computation of standard time, comparison of various techniques, work sampling, synthetic data, predetermined motion time analysis (PMTS)	

Module – 4	10 Hrs.

Ergonomics and Design of Man-Machine System: Introduction, areas of study under ergonomics, System approach to ergonomics model, Man-machine system. Components of man-machine system and their functions Quantitative, qualitative representation and alphanumeric displays. Controls and their design criteria, Control types, Relation between controls and displays. Design of workplace.

SELF STUDY:

1. Study of occupational loads
2. Study in detail about working space and working environment.
3. Working environment factors
4. Anthropometry and its importance
5. Risk factors for musculoskeletal disorders in the workplace
6. Predetermined motion time system techniques and development of PMT system

TEXT BOOKS:

1. Industrial Engineering and Production Management, Martand T Telsang, 3rd edition, 2018. ISBN 978-93-525-3379-4
2. Work Study & Ergonomics, Suresh Dalela& Saurabh, standard publishers & distributors. ISBN 9780850660085

REFERENCE BOOKS:

1. Introduction to Ergonomics, R. C. Bridger, McGraw Hill Publications. ISBN 978-0-8493-7309-0
2. Industrial Design for Engineers, Mayall W. H. London Hiffee Books Ltd., 1988. ISBN -10-0592042057
3. Human Factor Engineering: Sanders & McCormick McGraw Hill Publications. ISBN 08403 16240

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					2					2			
CO2		2				2					2			
CO3		2				2								
CO4			2			2								

Course Title	PROJECT MANAGEMENT		
Course Code	21OEME73	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives: To impart a comprehensive understanding of how to plan, optimize and efficiently manage projects (or tasks) to implement products, services or developments.

Course Outcomes (COs) {with mapping shown against the Program Outcomes

(POs) Upon successful completion of this course, the student shall be able to

CO's	Statement 's	PO's
1	describe project management, the project lifecycle, planning, estimating, and the project manager's roles.	1, 9, 11
2	demonstrate project organization structures, tendering and contracting processes, scheduling, and CPM and PERT.	1, 2, 9, 11
3	comprehend, how organizations enhance project management through directing, coordinating, and controlling.	1, 9, 10, 11
4	explain the importance of software efforts and techniques in project management and conduct project case studies.	1, 9, 10, 11

Course Contents:

Module–I	10 Hrs.
Introduction to Project Management: Concept of project and project management, characteristic features and classification of projects, phases of Project management, selection of project managers and their duties. **Project Planning and Estimation:** Project planning steps, objectives and goals of the project, Feasibility reports, financing arrangements, preparation of cost estimation, evaluation methods for project profitability.	
Module–II	**10 Hrs.**
Organizing and Staffing the Project Team: Authorities of project manager, organizational organizational structure and types, accountability in project execution, contracts, 3'R'sofcontracting, tendering process and selection of contractors, team building. **Project Scheduling Tools and Techniques:** Gantt chart, bar chart for combined activities, Critical path method (CPM) and Project evaluation and review technique (PERT), Numerical problems	
Module–III	**10 Hrs.**
Project Direction, Coordination and Control: Project direction, communication in a project, PMIS, project coordination control, schedule control& cost control. **Risk management:** Introduction, Risk Management Process, Monitoring and Control Risks. **Performance Measures in Project Management:** Performance indicators, performance improvement, The CM & DM companies for better project management, project management environment.	

Module–IV.	10Hrs
Software project management: Introduction, computerized project management, managing software projects, overview of capability maturity model (CMM), project management and the CMM. **Case studies on project management:** Case studies on Project planning, scheduling, tools and techniques, performance measurement.	

Self-Study Component:

- History and Evolution of Project Management
- Group of students to take upon mini project and apply various phases of project management. Prepare a report on it.
- Make survey of various Software project management tools and use any one tool.

Textbook:

1. ProjectManagementaSystemapproachtoplanningScheduling&Controlling-HaroldKerzner, 10th edition 2009, John Wiley &sons.
2. Chaudhry S, ProjectExecutionPlan-PlanforprojectExecutioninteraction,2001

Reference Books:

1. Software Project Management in Practice-Pankaj Jalote, Pearson education
2. Fundamentals of Project Management: RoryBurke,2010, Burke Publishing.
3. Project planning scheduling & control, James P. Lawis, Meo Publishing Company, 5th edition 2010.
4. A Management Guide to PERT and CPM, WEIST & LEVY-Eastern Economy of PHI2002.

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2								3		3			
CO2	2	2							3		3			
CO3	2								3	2	3			
CO4	2								3	2	3			

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

Course Title	OCCUPATIONAL HEALTH AND SAFETY ENGINEERING		
Course Code	21OEME74	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives:

To apply the basic concept of occupational health and safety standards in workplace scenario.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon completion of the course, students shall be able to:

COs	Statement	POs
1.	interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces.	6, 11
2.	apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological, and psychosocial hazards.	6, 7, 11
3.	identify fire and electrical safety hazards, Product Safety and risk in the workplace.	6, 7, 11

COURSE CONTENTS:

Module – 1	
Introduction: Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws. Indian Acts – Labour Act, Factories Act, OSHA.	**10 Hrs.**
Module – 2	
Occupational Hazard and Control: Hazard Analysis, Human Error and Fault Tree Analysis, Emergency Response. Hazards and their control in different manufacturing and processing industries.	**10 Hrs.**
Module – 3	
Fire Prevention and Protection: Types of Fire, Fire Development and its Severity, Effect, Extinguishing Fire, Electrical Safety, Product Safety and Environmental Management Plan.	**10 Hrs.**
Module – 4	
Occupational Health: Personal Protective Equipments. Health and Safety Considerations in Construction Industries, Textile Industries, Food Processing Industries, Pharmaceutical Industries and Chemical & petroleum Industries. Occupational Health and Safety considerations in Wastewater Treatment Plants.	**10 Hrs.**

SELF STUDY:

Workplace ergonomics, fire safety, workplace violence prevention, employee health resources, and environmental safety.

TEXTBOOK:

Goetsch D.L., "Occupational Safety and Health for Technologists", Engineers and Managers", Prentice Hall.

REFERENCE:

1. Heinrich H.W., "Industrial Accident Prevention", McGraw Hill Publication, Network.

2. Colling D.A., "Industrial Safety Management and Technology", Prentice Hall, New Jersey.

3. Della D.E., and Giustina, "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc.

4. CPHEEO, Manual on Sewerage and Sewage Treatment, M/s.Jain Book Agency, c-9, Connaught place, New Delhi.

5. National Safety Council and Associate (Data) Publishers Pvt. Ltd., "Industrial Safety and Pollution Control Handbook"

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3					2			
CO2						3	2				1			
CO3						3	2				1			

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

Course Title	**RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS**		
Course Code	**21RMIP**	**LTPC**	**(2-0-0) Audit**
CIE	**100 marks**	**Hours / Week**	**4**
SEE	**--**	**Total hours**	**28**

Course objective: Understand research methodology, design, data collection, and analysis techniques and gain knowledge of Intellectual Property Rights (IPR) with a focus on patents, designs, trademarks, and copyrights, including their registration and protection procedures.

Course Outcomes (COs)Upon completion of the course, students shall be able to:

COs	Statement	POs	PSOs
4.	acquire research skills and conduct comprehensive literature reviews	8,10, 12	-
5.	apply research design knowledge to create prototype	3,4, 8, 10, 12	-
6.	evaluate methods for data collection, analysis, and sampling design	4, 8, 10, 12	-
7.	understand global and Indian patent scenarios, as well as registration requirements, infringements and protections related to trademarks, copyrights, and designs	6,8, 10, 12	-

COURSE CONTENTS:

Module - I	**7 Hrs.**
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct. Literature Review and Technical Reading. **Citations:** Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments.	
Module - II	**7 Hrs.**
Research Design: Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis. **Experimental Designs:** Introduction to Randomized Block Design, Complete Randomized Design, Latin Square Design, and Factorial Design.	
Module - III	**7 Hrs.**
Method of Data Collection: Primary and Secondary Data Collection. **Sampling Design:** Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design. **Data Analysis:** Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors. Procedure for Hypothesis Testing: Mean, Variance, and Chi-square Test.	
Module - IV	**7 Hrs.**
Introduction to IPR: Different forms of IPR, Role of IPR in Research and Development. **Patents:** Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. **Design:** What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design. **Trademarks:** Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements. **Copyrights:** Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights.	

Activity Components
➢ Students select a research topic and perform a literature review, identifying existing knowledge, synthesizing prior art, and compiling relevant citations leading to publishing a survey paper.

- Students develop research proposals, including the formulation of research hypotheses.
- Students collect primary or secondary data, design a sampling procedure, and perform data analysis using statistical techniques.
- Students analyze real-world case study/studies for legal issues and propose solution/s to infringement cases.

The rubrics for evaluation will be set suitably as decided by the BOS and will be announced to the students at the beginning of the semester.

Text Book

3. Kothari C R. Research methodology: Methods and techniques. New Age International; 2004.
4. Pandey N, Dharni K. Intellectual property rights. PHI Learning Pvt. Ltd.; 2014 Jul 30.
5. Deb D, Dey R, Balas V E. Engineering research methodology. A Practical Insight for Researchers. 2019;153.

Reference Book:

Thiel D V. Research methods for engineers. Cambridge University Press; 2014 Sep 11.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	3	-	2	-	3	-	-
CO2	-	-	3	3	-	-	-	3	-	2	-	3	-	-
CO3	-	-	-	3	-	-	-	3	-	2	-	3	-	-
CO4	-	-	-	-	-	3	-	3	-	2	-	3	-	-

MALNAD COLLEGE OF ENGINEERING, HASSAN
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Course Title	**Project Work Phase-1**		
Course Code	**21PROJ1**	**LTPC**	**0-0-4-2**
Exam	**03Hours**	**Hours / Week**	**04 Hrs.**
SEE	**50 Marks**	**Total hours**	**-**

Course Objectives: To be able to identify a relevant problem that requires technical solution and conduct survey for the same.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**} Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	identify a problem, through Extensive literature Survey leading to publication of a survey paper in a Conference/Journal.	1,2	-
2.	plan & design the solution to the chosen problem	3	
3.	make oral presentation and documentation of the work carried out	9,10	

Course Contents

During VII semester, candidates in consultation with the guides shall carry out literature survey to finalize the topic of the project. The same project will be continued in Eighth semester. Students are expected to present the project synopsis, system analysis, requirements specification and should publish a technical paper on Literature Survey. The evaluation will be carried out in three stages

- Project Stage 1 – Team Formation, Topic Selection & Guide allotment (No marks)
- Project Stage 2 – Extensive Literature Survey, Problem Definition
- Project Stage 3 – Preliminary Design, Report Preparation and Publication

The evaluation of the project phases shall be carried out by the evaluation committee comprising of project guide & other faculty members. The committee will be constituted by the project coordinator in consultation with the Head of the department. For Multidisciplinary projects guides will be allotted from each concerned branch.

Performance Indicators	**Low**	**Medium**	**High**
Literature Survey and Problem Definition (20 Marks)	Literature Survey not pertaining to the title of the project (8)	Incomplete literature survey and improper problem definition (14)	Extensive literature survey with clear state of the art problem definition (20)
Preliminary Design (10 Marks)	Has no coherent strategies for problem Solving (4)	Has some strategies for problem – solving, but does not apply them consistently (7)	Formulates strategies for solving problems (10)

Presentation (10 marks)	Disorganized and ineffective presentation (4)	Organized, but ineffective presentation (7)	Effective organized presentation (10)
Report Preparation (30 Marks)	Disorganized and contents are not sufficient	Organized but not good content wise	Effectively organized and well framed contents
Paper Publication (20 Marks)	Paper submitted & awaiting results (8)	National conference International Conference (14)	Journal (20)
Punctuality (Project Dairy Maintenance) (10 marks)	Not meeting the guide regularly (4)	Meeting regularly but doesn't document details of every session (7)	Up to date dairy maintenance (10)

COURSE ATRICULATION MATRIX

Course Outcomes	Program Outcomes [POs]													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3												
CO2			3											
CO3									3	3				

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

VIII Semester B.E. Mechanical Engineering							
Course Type	**Course Code**	**Course Title**	**Credits**			**Total Credits**	**Contact Hours**
			L	T	P		
PI	21PROJ2	Project Work Phase-2	0	0	4	**4**	08
PI	21INT3	Research/Industry Internship III	0	0	24	**12**	24
Total			**0**	**0**	**16**	**16**	**32**

Course Title	**Project Work Phase-2**		
Course Code	**21PROJ2**	**LTPC**	**0-0-4-8**
Exam	**03Hours**	**Hours / Week**	**08 Hrs.**
SEE	**50 Marks**	**Total hours**	**-**

Course Objectives: To take part in a group to demonstrate the acquired skill & knowledge gained to identify, formulate, analyze, evaluate and to provide meaningful engineering solutions to Industrial/societal needs.

Course Outcomes (COs) {with mapping shown against the **Program Outcomes (POs)**}

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Implement the design with appropriate techniques, resources and contemporary tools	3,5	-
2.	Communicate effectively with team members and mentors, make presentations and prepare technical document	9,10,11,12	-
3.	Use ethical practices in all endeavors	8	-
4.	Share the responsibilities for carrying out the project & playing individual roles appropriately	9	-

The project teams will implement the project started in their seventh semester

Stage I – First Internal Evaluation (30 Marks)

Criteria: Fine-tuning of SRS and Design Presentation.

Criteria	Low (1-2)	Medium (3-4)	High (5)	Max Marks
Understanding of Problem Domain	Incomplete or unclear understanding.	Somewhat clear but missing key details.	Clear understanding of scope and problem.	5
SRS Documentation	Missing or incomplete sections, unclear.	Some parts are well defined but lack clarity.	Complete, clear, and well-defined requirements.	5
Design Quality	Poor system architecture lacks coherence.	Adequate design but lacks technical depth.	Strong, coherent design with appropriate methods.	5
Presentation Skills	Unorganized, difficult to follow.	Somewhat organized but	Well-organized, clear, and effective presentation.	5

		needs improvement.		
Teamwork and Collaboration	Unbalanced contribution, lack of collaboration.	Partial collaboration, some unbalanced efforts.	Effective teamwork with clear roles.	5
Response to Questions	Unable to answer most questions.	Adequate responses with minor gaps.	Clear, confident, and accurate answers.	5

Stage II – Mid Phase Evaluation (20 Marks)

Criteria: Presentation, Intermediate Demonstration, and Draft Copy of the Paper.

Criteria	Low (1-2)	Medium (3-4)	High (5-6)	Max Marks
Progress and Functionality	Minimal progress, many core functions missing.	Some progress, but key functions incomplete.	Significant progress, key functionalities work.	6
Intermediate Project Demonstration	Unclear or ineffective demonstration.	Some aspects demonstrated, minor issues.	Clear and effective demonstration.	6
Draft Paper Submission	Incomplete, lacks major sections or clarity.	Adequate, but missing details or structure.	Well-structured and clear draft paper.	6
Presentation Skills	Unorganized or unclear communication.	Somewhat organized, needs more clarity.	Clear and well-organized presentation.	6
Teamwork and Roles	Unbalanced contributions or lack of clarity.	Some collaboration, but roles unclear at times.	Clear roles, effective collaboration.	6

Stage III – Final Evaluation (50 Marks)

Criteria: Final Project Demonstration, Report Submission, and Technical Paper Publication.

Criteria	Low (1-4)	Medium (5-7)	High (8-10)	Max Marks
Project Implementation	Incomplete or major issues in implementation.	Partially complete with some issues.	Fully implemented with expected functionality.	10
Technical Innovation	Lacks innovation or creative approaches.	Somewhat innovative but lacks originality.	Highly innovative with creative problem-solving.	10

Final Report Quality	Incomplete, lacks structure or clarity.	Adequate report but needs improvement.	Well-written, clear, and technically sound.	10
Technical Paper Publication	Poorly written, lacks readiness for publication.	Adequate, but needs more technical depth.	High-quality paper, ready for submission.	10
Presentation and Demonstration. Teamwork and Leadership. Response to Queries.	Unclear or unorganized presentation. Poor collaboration or unbalanced effort. Unable to respond or unclear answers.	Adequate presentation but needs more clarity. Some collaboration, but uneven contributions. Adequate responses with minor gaps.	Clear, organized, and well-executed presentation. Effective collaboration and clear leadership. Clear, confident, and knowledgeable responses.	10

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	3	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	3	3	2	2	-	-
CO3	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	3	-	-	-	-	-

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belgaum)

Course Title	**Research/Industry Internship III**		
Course Code	**21INT3**	**(L-T-P) C**	(0-0-24) 12
Exam	**3 Hrs.**	**Weeks**	**16 weeks**
CIE	**100 Marks**	**Total Hours**	**---**

Course Objective: It involves a short theoretical or experimental research project supervised by a researcher/ To bridge the gap between the theoretical knowledge obtained in the classrooms and the practical skills required in the actual workplace

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's
1	Get exposure to real world job environment and gain practical experience	1,2,3,4,5,10,12
2	Generating technical paper/s and publish in refereed journal/s and conferences	1,2,8,9,10,12

Guidelines for Research Internship III	
Purpose	It involves a theoretical or experimental research project supervised by a researcher.
Skills acquired	• Planning and scheduling. • Documentation. • Critical thinking. • Data collection. • Data analysis. • Appreciating and practicing the ethical values.
Expected Outcomes	• Generating technical paper/s and publish in refereed journal/s. • Possibility of acquiring intellectual ownership and patent. • Build a prototype for an idea on which the research was carried out. • File patent/s.
Selection	• In consultation with a researcher/ researcher working in MCE research Centre • A research institute • Company's R and D department.
Team Size	Can be carried out either individually or in a team (**Up to 5 students**)
Venue	Laboratory of college A research institute Company's R and D department.
Supervision	Internship shall be carried out under the supervision of a faculty mentor* at the department level. For all students attending in-house internship, the attendance should be maintained by the faculty mentor
Parameters for Assessment	Diary Report presentation skill Technical Paper Recommendation Letter from the guide
Evaluation	**CIE (100 Marks)–**The CIE marks shall be awarded by a committee* consisting of the faculty mentor and two faculty members of the Department, one of whom shall

	be the Guide (applicable for in-house interns). The schedule for evaluation will be announced by chairman BOE at the end of the semester. The Evaluation can be done in ***phases as decided by the internal BOS*** of the department. The contents of the report and the evaluation Rubrics will be set by the Department based on the assessment parameters **SEE (100 Marks)–** Contribution to the internship and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department. Marks shall be awarded based on the evaluation of the diary, report, presentation skill and viva voce
*For interdisciplinary internship its necessary to involve an expert from each discipline	
Guidelines for Industry Internship III	
Purpose	To bridge the gap between the theoretical knowledge obtained in the classrooms and the practical skills required in the actual workplace
Skills acquired	• Applying the theoretical knowledge in a practical scenario • Build confidence in applying the skills learnt • Documentation • Communication • Appreciating and practicing the ethical values
Expected Outcomes	• Get exposure to a real-world job environment and gain practical experience • Build confidence in applying the skills learnt. • Enhances Placement Opportunity
Selection	• Can select individually • Can seek the help from the department
Team Size	Can be carried out either individually or in a team (**not exceeding 5 students**).
Venue	In a domain specific organization
Supervision	Internship shall be carried out under the supervision of a faculty mentor* at the department level. One faculty mentor can supervise a maximum of 20 students.
Parameters for Assessment	Diary Report presentation skill Recommendation Letter from the guide
Evaluation	**CIE (100 Marks) -**The CIE marks shall be awarded by a committee* consisting of the faculty mentor and two faculty members of the Department, one of whom shall be the Guide (applicable for in-house interns). The schedule for evaluation will be announced by chairman BOE at the end of the semester. The Evaluation can be done in ***phases as decided by the internal BOS*** of the department. The contents of the report and the evaluation Rubrics will be set by the Department based on the assessment parameters **SEE (100 Marks)-** Contribution to the internship and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department. Marks shall be awarded based on the evaluation of the diary, report, presentation skill and viva voce
*For interdisciplinary internship its necessary to involve an expert from each discipline	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	3	-	3		
CO2	3	3	-	-	-	-	-	3	2	2	-	3		