MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programmes

BACHELOR of ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME and SYLLABUS

(2022-23 Admitted Batch)

VII AND VIII SEMESTERS (FOURTH YEAR)

Academic Year 2025-26

Vision of the institute

To be an institute of excellence in engineering education and research, Producing socially responsible professionals.

Mission of the institute

1. Create conducive environment for learning and research
2. Establish industry and academia collaborations
3. Ensure professional and ethical values in all institutional endeavors

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,

1. **Engineering knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **Design/Development of solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **Conduct investigations of complex problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. **Engineering tool usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **The engineer and the world**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **Individual and collaborative team work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary settings.
9. **Communication**: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10. **Project management and finance**: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life-long learning**: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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	22ME701	Control Engineering	3	0	0	**3**	3
IPCC	22ME702	Finite Element Method	2	0	2	**3**	4
PCC	22ME703	Financial Management and Engineering Economics	3	0	0	**3**	3
IPCC	22ME704	Fluid Power System	2	0	2	**3**	4
PCC	22ME74X	Professional Elective-III	3	0	0	**3**	3
OEC	22OEME75X	Open Elective -II	3	0	0	**3**	3
PROJ	22ME706	Major Project Work Phase -II	0	0	12	**6**	12
Total			**15**	**00**	**18**	**24**	**32**

Professional Elective-III				
22ME 741	Operations Research		22ME 743	Fundamental of Tribology
22ME 742	Composite Materials		22ME 744	Python for Data Science and Machine Learning

Open Elective – II				
22OEME71	Principles of Manufacturing		22OEME75	Industrial Engineering and Ergonomics
22OEME72	Project Management		22OEME76	Occupational Health and Safety Engineering
22O ME73	Accounting for Engineers		22OEME77	Operations Management
22OEME74	Operations Research			

Course Title	CONTROL ENGINEERING		
Course Code	22ME701	LTPC	3-0-0-3
Exam	03 Hours	Hours / Week	03
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.	analyze control system using root locus and Nyquist plots	2, 3	-
4.	analyze 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, 2024. ISBN – 8131518124, 9788131518120.
2. K. Ogata, Modern Control Engineering, Prentice Hall (India), Pearson Education 2024. ISBN: 0136156738, 9780136156734

REFERENCE BOOKS:

1. FaridGolnaraghi, Benjamin C. Kuo, Automatic Control systems**,** Ninth Edition, Wiley, 2024. ISBN: 0470048964, 9780470048962.
2. F. H. Raven, Automatic Control system, Third Edition, McGraw Hill, 2024. ISBN: 0070512280, 9780070512283.
3. I. J. Nagrath and M. Gopal, Control Systems Engineering, Fifth Edition, Anshan Publishers, 2024. ISBN: 1848290039, 9781848290037.
4. Harrison and Bollinger, Introduction to Automatic Controls, Second Edition, International Text Book. Co 2024. 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	22ME702	LTPC	2-0-2 -3
Exam	03 hours	Hours / Week	04
SEE	50 marks	Total hours	40+12

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 IsoparametricElements: 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, 2024, 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,2022.ISBN -13:978-0-13-21624-6

2. J. N. Reddy, Finite Element Method, Tata McGraw-Hill edition 2022. ISBN: 0071244735.

3. Hutton, Fundamentals of Finite Element Method,McGraw-Hill, 2024.ISBN: 0-07-239536-21

4. Robert Cook, Concepts &applications of FEA,John Wiley & Sons 2022.ISBN:0-471-35605-0

Laboratory component:

1. Bars of uniform cross sectional area, tapered cross sectional area
2. Problems on stepped bar
3. Problems on Trusses
4. Beams–Simply supported beams with point load, UDL and varying load
5. Cantilever beams with point load, UDL and varying load
6. Stress analysis of a rectangular plate with a circular hole
7. Thermal Analysis–1D & 2D problem with conduction and convection boundary conditions
8. Harmonic analysis of a Fixed-Fixed Beam
9. Harmonic analysis of an Axial Bar.
10. Modal analysis of a Fixed-Fixed Beam

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	22ME703	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	-
2	apply basic concepts of accounting and finance and thus can implement while working in an organization at managerial position.	2, 11	-
3	apply the fundamental concepts of economics while solving problems related to economic feasibility of an investment and making decision.	2, 11	-
4	analyse the impact of inflation, taxation and depreciation on an engineering project.	2, 6,11	-

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, 2023, ISBN: 978-0-07-106785-0
2. **Engineering Economics,** James L.Riggs, David D.Bedworth and Sabah U.Randhawa, McGraw Hill Education, Fourth edition, 2024, ISBN: 978-0-07-058670-3

REFERENCE BOOKS

1. Chandra, Prasana: Financial Management; Tata McGraw Hill, New Delhi, 2022.
2. R.L.Gupta, V.K.Gupta : Fundamentals of Accounting : Sultan Chand & Sons : Year of Publication 2022
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	FLUID POWER SYSTEMS		
Course Code	22ME704	LTPC	2-0-2 -3
Exam	03 hours	Hours / Week	04
SEE	50 marks	Total hours	40+12

Course objective: The objective of this course is to make students design, analyze and build pneumatic and hydraulic circuits by applying the principles of fluid power transmission.

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 and PSOs
1.	apply the principals of Pascal's law in fluid power systems and its components	1, 2, 3
2.	select appropriate hydraulic/pneumatic system components and actuators for various applications	1, 2
3.	design, analyze and simulate hydraulic/ pneumatic circuits for an application	1,3, 5, 8, 9, PSO2

Course Contents:

Module –1	07 Hrs.
Pneumatic Control system: Introduction to fluid power**,** Pascal's law and problems on Pascal's Law. Properties of air, gas laws, structure of pneumatic control system. Compressors: Classifications and working principles (Piston, vane and screw compressors). FRL unit,DCV, shuttle valves, two pressure valve, PCV, FCV, quick exhaust valve, pneumatic actuators – functions and applications. **Pneumatic circuit design considerations**: Controlling of single and double acting cylinders. Design and simulation of circuits using double acting cylinders for different applications: Speed control of pneumatic actuators, door opening and closing circuit for public transport vehicle, two handed safety circuit, two step speed control system circuit for stamping operation, continuous cylinder reciprocating circuit, and application circuit for sheet folding device.	
Module – 2	**06 Hrs.**
Introduction to Hydraulic Power: Structure of hydraulic control system. Hydraulic fluids: Properties and types. Filters: Types and locations. Sealing devices: Types and materials used. Accumulators: Types and applications. Source of hydraulic power (Pumps): Classification of pumps and constructional features (gear, lobe, vane and piston pumps). Pump selection parameters. Problems on performance characteristics of pumps.	
Module – 3	**07 Hrs.**
Hydraulic Actuators: Types and constructional features (Hydraulic motors, Hydraulic cylinders), end position cushioning and mounting arrangements of cylinders. Mechanics of cylinder loading. Problems on performance of hydraulic cylinders.	
Module – 4	**06 Hrs.**
Hydraulic Control valves: Directional Control Valves – Classification, actuation methods with symbolic representations. Pressure control valves – Types with symbolic representations. Flow control valves – Types with symbolic representations. **Hydraulic circuit design considerations**: Controlling of single and double acting cylinders. Design and simulation of circuits using double acting cylinders for different applications: speed control of hydraulic actuators, regenerative cylinder circuit, counter balance valve application circuit, cylinder sequencing circuits for bending applications, automatic cylinder reciprocating circuit and hydraulic cylinder & motor synchronizing circuits.	

FLUID POWER SYSTEMS LABORATORY:

(Circuit building and simulation using automation Studio software / Pneumatic trainer kit**)**

1.	Identification and selection of various Pneumatic/Hydraulic components.
2.	Design and simulation of Pneumatic/Hydraulic circuits for different applications with the help of a simulation tool.
3.	Design and build Pneumatic/Hydraulic circuits for different applications with the help of trainer kit.

TEXT BOOK:

1. Anthony Esposito, *Fluid Power with Applications*, Seventh Edition, Pearson Education, Inc. 2024. ISBN: 978-93-325-1854-4.

REFERENCE BOOKS:

1. R. Srinivasan, *Hydraulic and pneumatic controls*, Second edition, McGraw Hill Education pvt. Ltd. 2021, ISBN: 978-81-8209-138-2.
2. S. R. Majumdar, *Pneumatic systems – Principles and Maintenance*, Tata McGraw Hill, 2021, ISBN-13:978-0-07-460231-7.
3. S.R. Majumdar, *Oil Hydraulic Systems - Principles and Maintenance***,** Tata McGraw Hill, 2022, ISBN: 0-07-463748-7.

Laboratory component:

PNEUMATICS: (Circuit building & simulation using trainer kit)

1. Identification of pneumatic circuit components such as air compressors, pneumatic valves and drawing of I.S.O. symbols.

2. Construct and simulate a pneumatic circuit for a clamping device and other applications using a single acting cylinder using trainer kit.

3. Construct and simulate pneumatic circuits for various applications using a double acting cylinder using trainer kit.

4. Construct and simulate an electro-pneumatic circuit for controlling

i) Single acting cylinder

ii) Double acting cylinder using trainer kit

HYDRAULICS: (Circuit building & simulation using Automation Studio software)

1. Identification of hydraulic valves /components / parts of hydraulic power pack and drawing of I.S.O. symbols.
2. Construct and simulate a hydraulic circuit for controlling a single acting cylinder.
3. Construct and simulate a hydraulic circuit for controlling a double acting cylinder.
4. Construct and simulate a hydraulic circuit to control the speed of an actuator (M-in and M-out circuit).
5. Construct and simulate a hydraulic circuit for a multi-cylinder application.
6. Construct and simulate an electro-hydraulic circuit for controlling
   i) Single acting cylinder
   ii) Double acting cylinder

Rubrics for Lab component (20 Marks)

Rubrics for Lab component			
Criteria	**Designing**	**Execution**	**Marks**
Pneumatic circuit building	Students have to build pneumatic circuit for given problem (03)	Execution of built pneumatic circuit using trainer kit (03)	06
Hydraulic circuit building	Students have to build hydraulic circuit for given problem (03)	Execution of built hydraulic circuit using automation studio software (03)	06
Viva-Voce/Quiz	-	Properly justifying the built circuit	03
Record writing	-	Record submission	05

COURSE ARTICULATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	-	3	-	3	-	-	-	2	-	-	3	-	3

Course Title	OPERATIONS RESEARCH		
Course Code	22ME741	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, 2022, ISBN: 9780131889231.
2. Operations Research, S. D. Sharma –KedarnathRamnath& Co, 2022, ISBN: 1234567142552

REFERENCE BOOKS:

1. AM Natarajan, P. Balasubramani and A Tamilaravari, Operation Research, Pearson 2021
2. 9788131700006.
3. Hiller and Liberman, Introduction to operation research, McGraw Hill. 5th edition 2021, ISBN: 978-0077298340.
4. Ravindran, Phillips and Solberg, Operations Research: Principles and practice: Wiley India ltd, 2nd Edition 2022 ISBN: 9788126512560
5. Prem Kumar Gupta, D S Hira, S Chand Publications, Operations Research, New Delhi, 2021, 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	COMPOSITE MATERIALS		
Course Code	22ME742	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives: Equip the students with knowledge of advanced composite materials, their applications and fabrication techniques along with the standard methods to evaluate them.

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.	recognize and explicate the types of composite materials and their distinctive features	**1**	**-**
2.	comprehend and explain different fabrication and testing methods employed in manufacturing of composite materials	**1, 9**	**-**
3.	discern various methods used in scrutinizing various defects in composite materials	**1**	**-**
4.	identify the applications of composites in engineering and commercial applications	**1, 7**	**-**

Course Contents:

Module – 1	**10 Hrs**
Introduction to composite materials: Historical development, Basic concept, Classification, Types and effects of reinforcements and matrices, Characteristics of composites, Selection criteria of composite materials, Fillers, Laminates, Prepegs, Sandwich construction, Nano composites, Composites vs. metals, Weight and volume fraction, Advantages, limitations and applications of composites.	
Module – 2	**10 Hrs**
Fabrication and Testing of Polymer Reinforced Composites: Classification of fibers, Natural and synthetic fibers, Polymers – thermoplastic and thermosets, Hand layup method, vacuum bagging technique, filament winding, pultrusion, injection molding, autoclave molding, cutting of laminates, physical tests – density and void fraction, mechanical tests - tensile test, flexural test, interlaminar shear strength test, impact test, water absorption studies, tribological test.	
Module – 3	**10 Hrs**
Metal matrix composites: Reinforcement materials, types, Characteristics & Selection, base metals - selection, applications. Powder metallurgy technique, liquid metallurgy technique. **Non-Destructive Testing:** Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.	
Module – 4	**10Hrs**
Application developments: Aircraft and military applications, automotive applications, marine applications, sporting goods, infrastructure, building and civil engineering, chemical industries, electrical and electronics applications, machine elements and mechanical engineering applications, medical field – human implants.	

SELF STUDY:

- Extraction techniques employed for different natural fibers and methods used for their characterization (FTIR, XRD, TGA, DSC, SEM etc.,)
- Fabrication of a composite laminate using hand lay-up technique using a natural/synthetic fiber/fabric.
- Carrying out physical (density & void fraction) or mechanical property (tensile, flexural or impact) or water absorption tests on prepared composite laminate using standard formulae and equipments as per standard ASTM methods.

TEXT BOOK:

1. K. K. Chawla, Composite Science and Engineering, Springer Verlag 1998. ISBN: 0387984097.
2. Autar K. Kaw, Mechanics of Composite Materials, CRC Press New York, 2nd edition, 1997. ISBN: 0849396565, 9780849396564.

REFERENCE:

1. Hull and Clyne, Introduction to composite materials, Cambridge University Press, 2nd edition, 1990. ISBN:1-85166-468-8.
2. Ronald F. Gibson, Principles of composite Material Mechanics, McGraw Hill International, 1994. ISBN-13: 9780070234512.
3. Mein Schwartz, Composite Materials Handbook, McGraw Hill Book Company - 1984. ISBN-10: 0070557438, 13: 978-0070557437.
4. Robert M. Jones, Mechanics of Composite Materials, McGraw Hill Kogakusha Ltd. – 2008. ISBN:9780070853478.
5. Fonning Metal hand book, 9th edition, ASM handbook, V15. 1988, P327- 338.
6. V. Srinivasan, Smart Structures analysis and Design, Cambridge University Press, Cambridge Newyork -2001. ISBN: 052165027.

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													
CO4	3						2							

Course Title	FUNDAMENTALS OF TRIBOLOGY		
Course Code	22ME743	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Prerequisites: ME 302, ME603

Course objectives: To impart the knowledge of basic principles of friction, wear and lubrication and its importance in selection 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.	describe basic phenomena related to friction, wear and lubrication	1, 2	-
2.	analyze the effects of friction, wear, and lubrication in metal working process	1,2	-
3.	evaluate possible relationships between tribological response and involved mechanisms.	1,2	-
4.	identify and operate the measuring instruments for tribology	1,9	-

Course Contents:

Module - 1	10 Hrs.
Introduction to Tribology: Definition and History of Tribology**,** industrial significance of tribology, Significance of Micro/Nanotribology. **Friction:** Material properties influencing friction, laws of friction, causes/theories of friction, Types of friction, effects of friction. **Wear:** Causes/sources of wear, types of wear (adhesive, abrasive, and corrosive, erosive, fretting), effects of wear, steps for wear prevention/resistance, Wear measurement.	
Module - 2	**10 Hrs.**
Lubrication: Lubrication principles/types **Hydrodynamic Lubrication:** Pressure development mechanism, converging and diverging film, Petroff's equation, Reynolds 2D and 3D equations, Numerical examples on determining rate of flow and coefficient of friction. **Hydrostatic Lubrication**: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity & oil flow through the hydrostatic step bearing, Numerical examples on determining rate of flow and coefficient of friction. **Elastohydrodynamic lubrication**: Introduction, Generation of Elastohydrodynamic Films, Lubrication Regimes in EHL	

Module - 3	10 Hrs
Tribology in Metal Working Process: Effect of friction in metal working, Wear and lubrication in rolling, Wear and lubrication in extrusion, Wear and lubrication in forging, Wear and Lubrication in Metal cutting. **Future directions of Tribology:** Nanotribology- basic concepts, Applications of nanotribolgy, Principles of Green Tribology, Areas of Green Tribology. Biotribology, Environmental implications of tribology.	

Module - 4	10 Hrs.
Friction and wear measurements: Laboratory experiments/demonstrations: Evaluation of Friction and wear behavior using Pin on Disc Tribometer (ASTM G99), Evaluation of Corrosion properties of Lubricants using Copper Strip Corrosion Method (ASTM D130), Evaluation of Tool wear using Tool Maker's Microscope. Evaluation of Slurry erosion behavior of materials using slurry jet erosion test rig.	
SELF-STUDY: **Scientific Article Review:** An article review is both a summary and an evaluation of another writer's article. This activity is assigned to introduce students to the work of Researchers/Academicians in the field of Tribology.	
TEXTBOOKS: 1. Stachowiak, Gwidon, and Andrew W. Batchelor. Engineering tribology. Butterworth-Heinemann, 2013. ISBN: 7506-7836-4 2. Bharat Bhushan. Principles and Applications of Tribology., John Wiley & Sons, 2013Ltd. ISBN: 9781119944546 3. Sushil Kumar Srivastava. Tribology in Industries: S. Chand & Company Ltd. 2001. ISBN 81-219-2045-0	
REFERENCE BOOKS: 1. B.C. Majumdar, Introduction of Tribology of bearings, Wheelers, and company Pvt. Ltd., 2011-12. ISBN:81-219-29870	

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					

Course Title	Python for Data Science and Machine Learning		
Course Code	22ME744	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course Objective: utilizethe pythonconstructsandlibrariestoperformdataanalysis.

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.	Applythepythonlibrariestoload,pre-process,analysisand visualize the data.	1	-
2.	Analyzethegivendataandinterprettheresultsusingpython libraries	2	-
3.	Developapythonprogramtosolvethegivenproblem	3	-

Course Content:

Module – 1	10 Hrs.
Introduction to NumPy: Understandingdatatypesinpython,basicsofNumPyarrays,NumPy array attributes, arrayindexing, array slicing, reshaping array, array concatenation and splitting, and computations on NumPy Arrays. Introduction to UFuncs, advanced UFancs features, Aggregation: Min, Max and in between, computation on arrays, rules of broadcasting, broadcasting in practice, comparisons, masks and Boolean logics, indexing, sorting arrays, NumPy's structured arrays.	
Module – 2	**10 Hrs.**
Data Manipulation with Pandas: Introduction to pandas objects – Series object, DataFrame object, Index object, Data Indexing and selection for series and DataFrame, Operating on Data in Pandas, Handling missing data, Operating on Null values, hierarchical Indexing, combining datasets using Concat and Append, Merge and Join. Aggregation and Grouping, Pivot tables, Vectorized string operations, working with Time series- Dates and Times in python, indexing by Time, time series data structures, frequencies andoffsets,resampling,shiftingandwindowing,High-performancePandas–eval()andquery()	
Module – 3	**10 Hrs.**
Visualization using Python: Importing matplotlib, setting styles, simple line plots, simple scatter plots, visualizing errors, density and contour plots, visualizing a three-dimensional function, Histograms, binning and density, customizing plot legends, customizing ticks. **Three-Dimensional Plotting:** Three-dimensional points and lines, three-dimensional contour plots, surface triangulation, geographic data with basemap, visualization with Seaborn.	
Module4	**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 interpretability, Evaluating performance of a model.

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, AfshinRostamizadeh, and AmeetTalwalkar. 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	PRINCIPLES OF MANUFACTURING		
Course Code	22OEME71	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	PROJECTMANAGEMENT		
Course Code	22OEME72	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Courseobjectives:Toimpart a comprehensiveunderstandingofhowtoplan,optimizeandefficiently manageprojects (ortasks) to implementproducts,servicesor developments.

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

(POs) Uponsuccessful completionofthiscourse,thestudentshallbeableto

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

CourseContents:

Module–I	10 Hrs.
IntroductiontoProjectManagement: Conceptofprojectandprojectmanagement, characteristic features and classification of projects, phases of Project management,selectionofprojectmanagersandtheirduties. **ProjectPlanningandEstimation:**Projectplanningsteps,objectivesandgoalso theproject,Feasibilityreports, financing arrangements,preparationof cost estimation,and evaluationmethodsforprojectprofitability.	
Module–II	**10 Hrs.**
OrganizingandStaffingtheProjectTeam:Authoritiesofprojectmanager, organizational Organizational structure and types, accountability in project execution, contracts, 3'R'sofcontracting, tenderingprocessandselection of contractors, team building. **ProjectSchedulingToolsandTechniques:**Gantt chart,barchartforcombinedactivities, Critical path method (CPM) and Project evaluation and reviewtechnique(PERT), Numericalproblems	
Module–III	**10 Hrs.**
Project Direction, Coordination and Control: Project direction, communication in a project, PMIS,projectcoordinationcontrol,schedulecontrol& cost control. **Riskmanagement:**Introduction,RiskManagement Process, Monitoring andControlRisks. **PerformanceMeasuresinProjectManagement:**Performanceindicators, performance improvement,TheCM&DMcompaniesforbetterprojectmanagement,projectmanagement environment.	

Module–IV.	10Hrs
Software project management: Introduction, computerized project management,managing software projects, overview of capability maturity model (CMM), projectmanagementandtheCMM.**Casestudiesonprojectmanagement:** CasestudiesonProjectplanning,scheduling,toolsandtechniques,performancemeasurement.	

Self-StudyComponent:

- HistoryandEvolutionofProjectManagement
- Groupofstudentstotakeuponmini-projectandapplyvariousphasesofprojectmanagement.Preparereporton it.
- Makesurveyof various Softwareprojectmanagementtoolsanduseany one tool.

Textbook:

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

ReferenceBooks:

1. SoftwareProject Management inPractice-PankajJalote,Pearsoneducation
2. FundamentalsofProject Management: RoryBurke,2010,Burke-Publishing.
3. Projectplanningscheduling&control,JamesP.Lawis,MeoPublishingCompany,5th edition 2010.
4. AManagementGuidetoPERTandCPM,WEIST&LEVY-EasternEconomyofPHI2002.

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			

ACCOUNTING FOR ENGINEERS

22OEME73 **LTPC: 3-0-0-3**
Exam Hours: **3** Hours / Week: **03**

SEE: **50 Marks** Total hours: **40**

Course objective:

1. Understand the accounting concepts; prepare financial statement as per the standards.
2. Make decisions using accounting tools.
3. Analyze the financial status and identify the avenues in which companies will lead to profitable and undisclosed information.
4. Utilize budgetary techniques for future planning, identify the alternatives and formulate the best decisions.

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.	comprehend the Indian accounting standard and international accounting standard.	2, 11,12
2.	apply basic accounting and finance ideas, which you can then utilize when working in a managerial role in an organization.	2, 11,12
3.	analyze a company's financial position to uncover hidden profit opportunities.	2, 11,12
4.	use budgetary approaches for both long-term and short-term decision making in the organization.	2, 11,12

COURSE CONTENT:

Module -I	**10 Hrs.**
Introduction to Financial Accounting: Definition, Importance, Principles - Concepts & Conventions, Double entry bookkeeping system, Bases of accounting - Cash basis and Accrual basis, Journal, Ledger, and Trial Balance (Simple numerical problems)	
Module -II	**10 Hrs.**
Preparation and Interpretation of Financial Statements: Objective, Importance and Limitations, Trading Account, Profit and Loss Account, Balance Sheet- Grouping of assets and liabilities, Preparation of final accounts without adjustments. Interpretation of financial statements (Simple numerical problems).	
Module -III	**10 Hrs.**
Financial Ratio Analysis: Introduction, Objectives, Classification, Advantages, Limitations and Computation of Liquidity ratios, Profitability ratios, Leverage ratios, Activity ratios (Simple numerical problems).	
Module -IV	**10 Hrs.**
Budgetary Control: Budgetary Control: Meaning of a Budget, Budgetary control, Objectives of budgetary control, Essential features of Budgetary Control& merits, Steps in budgetary Control, Types of Budgets, Flexible Budget, Limitation of Budget Control (Simple numerical problems).	

TEXTBOOKS:

1. KakaniRamachandran, (2021), Financial Accounting for Management, 3rd edition,McGrawHill, India
2. Godwin, Alderman, Sanyal (2016), Financial ACCT - Financial Accounting (2016), Cengage Learning.

REFERENCE BOOKS

1. Anthony A.Atkinson, Robert S.Kaplan, S.Mark Young, Ella Mae Matsumura, G.Arunkumar (2014), Management Accounting: Information for Decision Making and Strategy Execution, 6thedition, Pearson Education, India.
2. R.L.Gupta, V.K.Gupta: Fundamentals of Accounting: Sultan Chand & Sons: Year of Publication 2018
3. Khatri, (2021), Financial Accounting, 1stedition, McGraw Hill, India.
4. Khan M.Y, Jain P.K, (2019), Management Accounting, 5thedition, McGraw Hill, India

Course Articulation 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									3	2		

Course Title	OPERATIONS RESEARCH		
Course Code	22OEME74	LTPC	2-0-2-3
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, 2017, ISBN: 9780131889231. 2. Operations Research, S. D. Sharma –KedarnathRamnath& Co, 2022, ISBN: 1234567142552
REFERENCE BOOKS: 1. AM Natarajan, P. Balasubramani and A Tamilaravari, Operation Research, Pearson 2005 9788131700006. 1. Hiller and Liberman, Introduction to operation research, McGraw Hill. 5th edition 2001, ISBN: 978-0077298340. 2. Ravindran, Phillips and Solberg, Operations Research: Principles and practice: Wiley India ltd, 2nd Edition 2007 ISBN: 9788126512560 3. 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	INDUSTRIAL ENGINEERING AND ERGONOMICS		
Course Code	22OEME75	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 andnew / 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 equipment's, 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	OCCUPATIONAL HEALTH AND SAFETY ENGINEERING		
Course Code	22OEME76	LTPC	3-0-0-3
Exam	03Hours	Hours / Week	03
SEE	50 Marks	Total hours	40

Course objectives:

To apply the basic concept of occupationalhealthand 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 Safetyandriskin 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, ProductSafety and Environmental Management Plan.	**10 Hrs.**
Module – 4	
Occupational Health: Personal Protective Equipment's. Health and Safety Considerations in Construction Industries, Textile Industries, Food Processing Industries, Pharmaceutical Industries andChemical& 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	OPERATIONS MANAGEMENT		
Course Code	22OEME77	LTPC	3-0-0-3
Exam	03 Hours	Hours/Week	03
SEE	50 Marks	Total Hours	40

Course Objective:

To make Students apply the concepts, principles, strategies, and practices to increase the productivity of an organization

Course Outcome

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

#	Course Outcomes	Mapping to Pos	Mapping to PSOs
1	apply knowledge of fundamental concepts of operations management	1	
2	design the system approach and capacity planning and forecast the demand using mathematical tools	2, 5	
3	analyse the relationship of the various planning practices like capacity planning, aggregate planning, project planning and scheduling	2,3	
4	recognize the various production and operations design decisions and analyse the overall strategies of organizations	2, 3	

Course Contents:

MODULE 1	10 Hrs
Operations Management Concepts: Introduction, information for decision making, product verses services, factors affecting productivity, the environment of operations, areas of application. **Operations Decision Making**: Introduction, Frame work for decision making process, model building, decision methodology, decision support systems, economic models, statistical models, decision theory and expected value criteria, decision tree analysis, problems.	
MODULE 2	**10 Hrs**
System Design and Capacity Planning: Introduction, systems concept, manufacturing and service systems, design and system capacity, determination of equipment requirements, facilities location, location planning for goods and services, facilities layout, process layout methods. **Forecasting**: Forecasting objectives and uses, forecasting variables, opinion and judgmental methods, time series methods, exponential smoothing, regression and correlation methods, application and control of forecasts, problems.	
MODULE 3	**10 Hrs**
Aggregate Planning and Master Scheduling: Introduction-planning and scheduling, aggregate planning objectives and strategies, master scheduling objectives and methods, problems. **Inventory Control**: Definition and needs, classification of inventory models, dependent and independent demand, inventory classification, inventory counting methods, problems.	
MODULE 4	**10 Hrs**
MRP and CRP: Overview, MRP terminology, MRP and CRP, essential input and output of MPR system, bill of materials, MRP logic, CRP activities, infinite and finite loading, problems. **Scheduling**: Concepts, measures of performance, SPT rule, weighted SPT rule, EDD rule, minimizing the number of tardy jobs Flow-Shop Scheduling: Introduction, Jonson's rule for 'n' jobs on 2 and 3 machines, CDS heuristics. Job- Shop Scheduling: Types of schedules, scheduling 2 jobs on 'm' machines, problems.	

Text Books

1. **Operations Management,** Monks, J G, McGraw-Hill international Editions, ISBN: 0070427275
2. **Operations Management – Concepts, Models and Behaviors,** R.K. Hegde, Sapna Book House, 2008, ISBN: 10-8128004360.

References

1. **Production and Operations Management,** Panneerselvam. R, PHI, 6th Edition, 2002, ISBN: 81-2031442-5
2. **Operations Management,** William J Stevenson, McGraw-Hill international, **13th Edition, ISBN: 935532264X**

Course Articulation Matrix

Cos		POs											
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2
1	2												
2		2			1								
3		2	1										
4		2	1										

Course Title	Major Project Work Phase-II		
Course Code	22ME706	LTPC	0-0-12-6
Exam	03Hours	Hours / Week	12 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 needs improvement.	Well-organized, clear, and effective presentation.	5
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
B.E. in Mechanical Engineering
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(academic year 2025-26)

VIII Semester B.E. Mechanical Engineering

Sl. No.	Course Category	Course Code	Course Title	Teaching Hours/Week				
				Theory Lecture	Tutorial	Practical/ Drawing	SDA	Credits
				L	T	P	S	C
1	PEC	22ME801X	Professional Elective-IV	3	0	0		3
2	OEC	22ME802X	Open Elective -III	3	0	0		3
3	INT	22ME803	Internship (Industry/Research) (14 - 16 weeks)	0	0	12		10
Total				**6**	**0**	**12**		**16**

Professional Elective-IV Course			
22ME8011	Quality Design & Control (Available in NPTEL)	22ME8013	Modelling& Analytics for Supply Chain Management (Available in NPTEL)
22ME8012	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL)	22ME8014	Strategies for Sustainable Design (Available in NPTEL)
Open Elective-III Course			
22OEME8021	Fundamentals of Automotive systems (Available in NPTEL)	22OEME 8023	Computer Integrated Manufacturing (Available in NPTEL
22OEME 8022	Product Design and Manufacturing (Available in NPTEL)	22OEME8024	Business Planning & Project Management (Available in Swayam Portal)