Ref: MITM/ME/CBS/2023-24/113

MAHARAJA INSTITUTE OF TECHNOLOGY MYSORE

Autonomous Institution Affiliated to VTU

Competency Based Syllabus (CBS)

for

Mechanical Engineering

(Under Outcome Based Education (OBE) and

Choice-Based Credit System (CBCS))

Offered from 7th to 8th Semesters of Study

in

Partial Fulfillment for the Award of Bachelor's Degree in

Mechanical Engineering

2023 Scheme

Scheme Effective from the academic year 2023-24

Dean Academics
MIT Mysore

APPROVED
Dean Academics

Principal
MIT Mysore

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7th Semester

7th Semester	Management science (MS) Industrial Management and Entrepreneurship	M23BME701

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Communication Skills	Proficiency in written and verbal communication for effective participation in discussions and presentations
2	Computer skills	The ability to navigate basic computer programs such as word processors and spreadsheets will be beneficial for completing assignments and accessing online resources. Familiarity with presentation software could also be advantageous
3	Basic Problem-Solving Skills	The ability to analyze situations, identify potential solutions, and make well-informed decisions is a valuable asset in both management and entrepreneurship.
4	Interest in Business	A genuine curiosity about how businesses function and a desire to learn more about management and entrepreneurship will significantly enhance the learning experience
5	Time Management Skills	This course will involve reading, assignments, and potentially group projects. Effective time management skills will ensure you can meet deadlines and stay on top of your workload.
6	Analytical Skills	Ability to analyze and interpret data related to business operations and management practices

2. Competencies

S/L	Competency	KSA Description
1	Management Principles	**Knowledge**: Understanding of management concept, roles, levels, and the evolution of management thought. **Skills**: Ability to apply management principles in practical scenarios. **Attitudes**: Open-mindedness towards diverse management practice
2	Planning	**Knowledge**: Knowledge of planning processes, objectives, and types of plans **Skills**: Competence in creating strategic and operational plans **Attitudes**: Proactive approach to future planning and decision-making
3	Organizing & Staffing	**Knowledge**: Understanding organizational structures, principles, and departmentation. Insight into staffing processes, including selection and recruitment. **Skills**: Skills in designing and implementing effective organizational structures, Ability to conduct effective recruitment and selection processes. **Attitudes:** Appreciation for organized and systematic approaches to management.Value the importance of having the right people in the right role
4	Directing &Controlling	**Knowledge**: Knowledge of leadership styles, motivation theories, and communication strategies, Understanding control processes and techniques, including coordination. **Skills**: Skills in leading teams, motivating employees, and communicating effectively, Ability to implement and manage control systems in organizations **Attitudes**: Positive attitude towards leadership and motivation in the workplace. Commitment to maintaining high standards of performance and accountability.
5	Entrepreneurship	**Knowledge**: Knowledge of the entrepreneurial process, types of entrepreneurs, and their role in economic development **Skills**: Skills in identifying business opportunities and developing entrepreneurial ventures **Attitudes**: Entrepreneurial mindset with a focus on innovation and risk-taking
6	Small Scale Industries (SSI)	**Knowledge:** Understanding of the characteristics, role, and government support for small scale industries **Skills**: Skills in managing and developing small scale business enterprises. **Attitudes:** Appreciation for the importance of small scale industries in economic development

3. Syllabus

Industrial Management and Entrepreneurship **SEMESTER – VII**			
Course Code	**M23BME701**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

The objectives of this course is to

1. Explain fundamentals management functions of a manager. Also explain planning and decision making processes.
2. Explain the organizational structure, staffing and leadership process.
3. Describe the understanding of motivation and different control systems in management.
4. Explain understanding of Entrepreneurships and Entrepreneurship development process.
5. Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur.

Module -1

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches – Modern management approaches.

Module -2

Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises.

Organizing: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees Centralization Vs Decentralization of authority and responsibility - Span of Control.

Module -3

Staffing: Nature and importance of staffing--Process of Selection & Recruitment (in brief).

Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Coordination. Meaning and steps in controlling - Essentials of a sound control system.

Module -4

Entrepreneur: Meaning of Entrepreneur; Evolution of .the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.

Module -5

Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI, Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help.

Text Books:

1. Principles of Management – P. C. Tripathi, P.N. Reddy – Tata McGraw Hill.
2. Dynamics of Entrepreneurial Development & Management-Vasant Desai,Himalaya PublishingHouse.
3. Entrepreneurship Development – Poornima. M. Charantimath, Small Business Enterprises – PearsonEducation - 2006 (2 & 4).

Reference Books:

1. Management Fundamentals - Concepts, Application, Skill Development – RobersLusier, Thomson.
2. Entrepreneurship Development - S. S. Khanka, S. Chand & Co. New Delhi.
3. Management - Stephen Robbins, Pearson Education/PHI - 17thEdition, 2003.

Web/Digital resources:

1. https://www.springer.com/journal/11365
2. https://onlinecourses.swayam2.ac.in/cec20_mg19/preview
3. https://onlinecourses.nptel.ac.in/noc23_ge16/preview

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Management Fundamentals	Introduction to Management, Meaning, Nature, Characteristics Scope and Functional Areas of Management , Management as a Science, Art, and Profession; Management vs. Administration
2	Week 3-4: Management as a Discipline & planning	Roles and Levels of Management; Development of Management Thought **Planning**: Nature, Importance, and Purpose; Types of Plans Decision Making; Steps in Planning and Planning Premises
3	Week 5-6: Organizing & Staffing	**Organizing**: Nature, Purpose, Principles; Types of Organization Departmentation, Committees; Centralization vs. Decentralization; Span of Control **Staffing**: Nature, Importance, Selection and Recruitment Process
4	Week 7-8: Directing, and Controlling	**Directing:** Meaning, Leadership Styles, Motivation Theories; Communication and Coordination **Controlling**: Meaning, Steps, and Essentials of a Sound Control System
5	Week 9-10: Entrepreneurship	**Entrepreneurshi**p: Definition, Evolution, Functions, Types; Role in Economic Development
6	Week 11-12: Small Scale Industries	**Small Scale Industries**: Definition, Role, Policies, and Impact of Economic Changes

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Case Studies	Analyze historical and modern management approaches through case studies. This allows students to grapple with real-world scenarios and understand the practical application of theoretical frameworks.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Field Trips	Organize a field trip to a successful local small-scale industry to allow students to observe real-world operations and entrepreneurship in action.
5	Problem-Solving Activities	Regularly incorporate problem-solving exercises through case studies, business simulations, and real-world problem analysis to hone critical thinking and practical application skills.
6	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand Management Fundamentals	Grasp the meaning, nature, scope, and evolution of management, distinguishing it from administration.
2	Develop Planning and Organizational Competencies:	Learn the importance of planning, types of plans, planning steps, organizational principles, and structures
3	Master Staffing, Directing, and Controlling	Recognize the importance of staffing, recruitment processes, leadership styles, motivation theories, communication, coordination, and control systems.
4	Comprehend Entrepreneurship	Define entrepreneurship, understand its evolution, functions, types, barriers, and the entrepreneurial process in economic development, particularly in India
5	Small Scale Industries (SSI)	Define SSI, understand its role, objectives, government policies, support systems, and the impact of liberalization, privatization, and globalization on SSI.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME701.1	**Apply** the concepts of management and its function , management principles to solve business problems
M23BME701.2	**Interpret** the effective planning at different levels in an organization and process of organizing for the development of an organization
M23BME701.3	**Assess** various staffing methods, leadership styles, motivation theories, and control systems for their effectiveness.
M23BME701.4	**Apply** the concepts of entrepreneurial and Implement the stages of the entrepreneurial process in real-world scenarios
M23BME701.5	**Illustrate** the role and impact of small scale industries in economic development, including the effects of liberalization, privatization, and globalization.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME701.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME701.2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME701.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME701.4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BME701.5	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BME701	3	3	-	-	-	-	-	-	-	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

A background in Industrial Management and Entrepreneurship equips you with a valuable skillset that positions you well for a future in various sectors. Here's a glimpse into some potential opportunities:

Industrial Management:

- **Diverse Career Options:** You can pursue careers in operations management, supply chain management, project management, human resource management, and more, depending on your specific interests.
- **Leadership Roles:** As you gain experience, you can progress towards leadership positions within organizations, overseeing teams and making strategic decisions.

Entrepreneurship:

- **Rise of Innovation:** The global entrepreneurial ecosystem is thriving, with a growing focus on innovation and technology-driven startups.
- **Problem-Solving Focus:** Your ability to identify opportunities, develop solutions, and manage resources effectively will be crucial for success as an entrepreneur.
- **Self-Employment and Flexibility:** Starting your own business allows you to be your own boss, set your own goals, and work on projects you're passionate about.

Additional Considerations:

- **Technology Integration:** Digital transformation is impacting all industries. Familiarity with relevant technologies like data analytics and automation will enhance your skillset.
- **Globalized Business Environment:** Developing intercultural awareness and understanding global business practices will be beneficial, especially if you're interested in international opportunities.
- **Lifelong Learning:** The business landscape is constantly evolving. Maintaining a commitment to continuous learning will ensure your skills remain relevant.

Overall, a background in Industrial Management and Entrepreneurship provides a strong foundation for a future filled with possibilities. With the right blend of knowledge, adaptability, and a growth mindset, you can thrive in a dynamic and ever-changing world.

7th Semester	Integrated Professional Course (IPC) Finite Element Methods	M23BME702

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Mathematics**	• Understanding of linear algebra, calculus, and differential equations, which are essential for solving elasticity and FEM problems.
2	**Mechanics of Materials**	• Familiarity with fundamental concepts like stress, strain, and material properties to comprehend stress-strain relations and equilibrium equations.
3	**Engineering Mechanics**	• Knowledge of statics and dynamics, including force analysis and basic structural analysis, to grasp the concepts of equilibrium and load conditions.
4	**Heat Transfer Basics**	• A basic understanding of heat conduction, convection, and radiation to effectively model and solve heat transfer problems using FEM.
5	**Introductory Computer Programming**	• Experience with basic programming or computational tools, which is useful for implementing FEM algorithms and solving numerical problems.

2. Competencies

S/L	Competency	KSA Description
1	**Introduction to FEM**	**Knowledge**: Understanding of elasticity, stress-strain relations, and FEM basics. **Skills**: Proficient in applying FEM concepts, matrix formulation, and element classification. **Attitude**: Analytical precision, critical evaluation, and systematic problem-solving approach
2	**Interpolation Models**	**Knowledge**: Understanding interpolation polynomials, element types, and shape functions. **Skills**: Proficient in solving bar problems using FEM techniques like penalty and elimination approaches. **Attitude**: Precise modeling and analytical problem-solving.
3	**Beams and Torsion**	**Knowledge**: Understanding beam theory, boundary conditions, and shaft torsion. **Skills**: Ability to apply FEM to analyze beams and shafts under various loading conditions. **Attitude**: Commitment to accurate analysis and problem-solving in structural engineering.
4	**Trusses and Heat Transfer**	**Knowledge**: Understanding truss stiffness matrices and fundamental heat transfer equations. **Skills**: Proficient in applying FEM to truss analysis and heat transfer problems. **Attitude**: Focused on detailed, accurate modeling and solution techniques.
5	**Dynamic Considerations**	**Knowledge**: Understanding dynamic mass formulations and eigenvalue analysis for structural elements. **Skills**: Proficient in applying FEM for dynamic analysis of bars, trusses, and beams. **Attitude**: Emphasis on precise and thorough dynamic modeling and analysis.

3. Syllabus

FINITE ELEMENT METHODS SEMESTER – VII			
Course Code	**M23BME702**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:2:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**50 hours Theory**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course Objectives: Students will be able

1. To introduce the fundamental concepts of the Finite Element Method (FEM) and its applications in engineering analysis.
2. To develop the ability to formulate and solve engineering problems using FEM.
3. To provide hands-on experience with FEM software for structural, thermal, and dynamic analysis.
4. To prepare students for advanced studies and research in computational mechanics and design.

Module -1

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width.

Basic Procedure: Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method.

Module -2

Interpolation Models: Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements. 2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element.

Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach.

Module -3

Beams: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.

Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts. Numerical Problems

Module -4

Trusses: Stiffness matrix of Truss element. Numerical problems

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins. Numerical problems

Module -5

Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams. Numerical Problems

Practical Component

Sl. No.	Experiments
1	Introduction to FEA software , Pre-processing tools, Solver tools and Post-processing tools
2	Analysis of Bars of constant cross section area, tapered cross section area and stepped bar subjected to Point forces, Surface forces and Body forces (Minimum 2 exercises of different types)
3	Analysis of trusses (Minimum 2 exercises of different types)
4	Analysis of Beams – Simply supported, cantilever, beams with point load , UDL, beams with varying load etc.
5	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)

6	Stress analysis of a rectangular plate with a circular hole.
7	Dynamic Analysis to find: Natural frequency of beam with fixed – fixed end condition, Response of beam with fixed – fixed end conditions subjected to forcing function
8	Dynamic Analysis to find: Natural frequency of bar, Response of Bar subjected to forcing functions

TEXTBOOKS:

1. Finite Elements in Engineering, T.R.Chandrupatla, A.D Belegunde, 3 rd Ed PHI.
2. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.

REFERENCE BOOKS:

1. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
2. Finite Element Method, J.N.Reddy, McGraw -Hill International Edition.

VIDEO LINKS:

1. https://archive.nptel.ac.in/courses/112/105/112105308/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to FEM and its Basic Procedure	**Introduction:** Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width. **Basic Procedure:** Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method.
2	Week 4-6: Interpolation Models and Numerical Problems on Bars	**Interpolation Models:** Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements. 2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element. **Solutions of bars** and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach.
3	Week 7-10: Finite element formulation of Beams and Shafts	**Beams:** Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load. **Torsion of Shafts:** Finite element formulation of shafts, determination of stress and twists in circular shafts. Numerical Problems
4	Week 11-13: FEM applied to Trusses and Heat Transfer Problems	**Trusses:** Stiffness matrix of Truss element. Numerical problems **Heat Transfer:** Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using variation method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins. Numerical problems
5	Week 14-16: Finite element methods applied to Dynamic Problems	**Dynamic Considerations:** Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams. Numerical Problems

5. Teaching-Learning Process Strategies

S/L	TLP Strategies	Description
1	**Lectures and Theoretical Instruction**	Deliver fundamental concepts through structured lectures, covering topics such as equilibrium equations, FEM principles, and interpolation models.
2	**Hands-On Tutorials**	Conduct practical sessions where students apply FEM techniques to solve real-world problems, including numerical problems related to beams, shafts, and

		heat transfer.
3	**Interactive Simulations**	Utilize software tools and simulations to visualize and analyze FEM models, enhancing understanding of complex concepts like stress distribution and dynamic behavior.
4	**Problem-Based Learning**	Engage students in solving case studies and numerical problems that require application of FEM methods to reinforce theoretical knowledge and develop problem-solving skills.
5	**Group Projects and Collaboration**	Facilitate group projects where students collaboratively work on FEM analyses and simulations, promoting teamwork and deeper learning of course material.
6	**Assessment and Feedback**	Implement regular quizzes, assignments, and exams to assess understanding, coupled with feedback sessions to address questions and guide students in improving their skills.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Theory (A)	Internal Assessment-Tests (A)	2	**60%**	**15**	**06**
	Assignments/Quiz/Activity (B)	2	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**
Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Laboratory(B)	Record Writing	Continuous	**60%**	**15**	**06**
	Test at the end of the semester	1	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**

Final CIE=A+B

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	**Learning Objectives**	**Description**
1	Understanding Elasticity and Stress-Strain Relations	Develop a solid foundation in the principles of elasticity, including the formulation of equilibrium equations, and explore the stress-strain relations in plane stress and plane strain conditions.
2	Introduction to Finite Element Method (FEM)	Gain a comprehensive understanding of the Finite Element Method, including its applications, limitations, and the basic procedure for formulating stiffness matrices using various approaches.
3	Interpolation Models and Element Analysis	Learn to apply interpolation models for different types of elements, including simplex, complex, and multiplex elements. Understand shape functions, nodal load vectors, strain-displacement matrices, and Jacobians for triangular and rectangular elements.
4	Analysis of Structural Components	Apply FEM to solve for displacements, reactions, and stresses in bars, beams, shafts, and trusses using direct stiffness, penalty, and elimination methods. Explore boundary conditions, load vectors, and stiffness matrices for these components.
5	Heat Transfer	Understand the basic equations governing heat transfer, and learn to formulate 1D

	Analysis	finite element models for heat conduction, convection, and radiation problems. Solve numerical problems involving temperature gradients, heat fluxes, and composite sections.
6	Dynamic Analysis of Structures	Formulate mass matrices for various elements and evaluate eigenvalues and eigenvectors for dynamic systems, applying these techniques to bars, beams, and trusses to solve numerical problems involving dynamic considerations.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME702.1	**Apply** the basic theory behind FEM, including the discretization process and the derivation of element equations.
M23BME702.2	**Apply** interpolation models and **formulate** finite element solutions for displacements and stresses in bar structures.
M23BME702.3	**Analyze** beam and shaft problems using FEM, including boundary conditions, load vectors, and torsion, using Euler-Bernoulli theory and numerical techniques.
M23BME702.4	**Evaluate** truss stiffness matrices and heat transfer problems, including conduction, convection, and radiation, using finite element methods and numerical problem-solving techniques.
M23BME702.5	**Analyze** consistent and lumped mass matrices for bar, truss, and beam elements; evaluate eigenvalues and eigenvectors; and solve dynamic problems involving point and distributed masses using numerical methods.
M23BME702.6	Use FEM software for modeling and analyzing complex engineering systems.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME702.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME702.2	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME702.3	-	-	3	-	-	-	-	-	-	-	-	-	3	3
M23BME702.4	-	-	-	3	-	-	-	-	-	-	-	-	3	3
M23BME702.5	-	-	-	-	3	-	-	-	-	-	-	-	3	3
M23BME702.6	-	-	-	-	-	3	-	-	-	-	-	-	3	3
M23BME702	**3**	**3**	**3**	**3**	**3**	**3**	-	-	-	-	-	-	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	CO6	Total
Module 1	**5**	-	-	-	-	-	**5**
Module 2	-	**5**	-	-	-	-	**5**
Module 3	-	-	**5**	-	-	-	**5**
Module 4	-	-	-	**5**	-	-	**5**
Module 5	-	-	-	-	**5**	-	**5**
Practical Component	-	-	-	-	-	**25**	**25**
Total	**5**	**5**	**5**	**5**	**5**	**25**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	CO6	Total
Module 1	**20**	-	-	-	-	-	**20**
Module 2	-	**20**	-	-	-	-	**20**
Module 3	-	-	**20**	-	-	-	**20**
Module 4	-	-	-	**20**	-	-	**20**
Module 5	-	-	-	-	**20**	-	**20**
Total	**20**	**20**	**20**	**20**	**20**	-	**100**

10. Future with this Subject:

1. **Advanced FEM Techniques**: Integration of more sophisticated FEM methods and tools to tackle increasingly complex engineering problems.
2. **Multidisciplinary Applications**: Expanding FEM applications to new fields such as biomechanics, aerospace, and advanced materials.
3. **Computational Advancements**: Leveraging high-performance computing (HPC) and machine learning to enhance FEM accuracy and efficiency.
4. **Sustainability and Optimization**: Focusing on environmentally sustainable design solutions and optimization techniques within FEM.
5. **Industry Collaboration**: Strengthening partnerships with industry to ensure the course content remains relevant to current engineering challenges.
6. **Interactive Learning**: Incorporating virtual labs, simulations, and other interactive tools to enhance the learning experience and practical application of FEM concepts.

7thSemester	Professional Course (PC) CONTROL ENGINEERING	M23BME703

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic knowledge of systems	Understanding of System Mechanical System, Electrical system, Thermal system, Hydraulic system, Pneumatic system
2	Mathematics and Complex Algebra	Solving Simultaneous equations, Roots of polynomial equations, Differential equations, Laplace transforms,
3	Electrical Engineering Knowledge	Applying Kirchhoff's current and voltage law, Loop circuits, Ohm's law
4	Applied mechanics	Applying Newton's laws of Motion, drawing free body diagrams,
5	Thermo-dynamics and Fluid mechanics	Applying law of conservation of energy, momentum. Analyzing thermal systems with its principles, viscosity principles, Tank levels and its potential heads.
6	Theory of Machines	Knowledge of multi degree freedom systems, Concepts of forced vibrations and free vibrations, Damping and its types.

2. Competencies

S/L	Competency	KSA Description
1	**Transfer Function Simplification**	**Knowledge:** Proficiency knowledge of Complex algebra, Differential equations, Laplace Transforms **Skills:** Ability to apply Laplace transforms techniques for governing differential equation simplification. Proficiency in utilizing Laplace & inverse Laplace transforms techniques. **Attitudes:** Appreciation for the importance of relationship between output and input in modeling the physical system
2	**Electrical systems knowledge**	**Knowledge:** Understanding of Kirchhoff's law and ohms law **Skills:** Obtaining mathematical model by applying basic electrical laws. **Attitudes:** Appreciation for the importance of relationship between output and input in modeling the Electrical and electro-mechanical system
3	**Thermo-dynamics and Fluid Mechanics Knowledge**	**Knowledge:** Understanding of Law of conservation of energy/ momentum **Skills:** Apply the laws for a given thermal / fluid system **Attitudes:** Appreciation for the importance of mathematical model for physical system
4	**Theory of Machines**	**Knowledge:** Understanding the Degrees of freedoms in the system Knowledge of Free and forced Vibrations for damped systems **Skills:** Draw Free body diagram and analyze degrees of freedom

		Transient analysis of 2nd order system **Attitudes:** Implementing the models of mechanical systems and analysis in time and frequency domain.

3. Syllabus

CONTROL ENGINEERING SEMESTER – VII			
Course Code	M23BME703	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:2:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**52 hours**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course objectives: This course will enable students to:

1. To develop comprehensive knowledge and understanding of modern control theory, industrial automation, and systems analysis.
2. To model mechanical, hydraulic, pneumatic and electrical systems.
3. To represent system elements by blocks and its reduction techniques.
4. To understand transient and steady state response analysis of a system.
5. To carry out frequency response analysis using polar plot, Bode plot.
6. To analyze a system using root locus plots.
7. To study state space characteristics of linear systems.

Module -1

Introduction to Control System: Definition of control system, Open loop and closed loop systems, Examples, Classification of closed loop control system, Requirements, Advantages, limitations, Block diagram representation of Closed loop control system.

Modeling of Physical Systems: Mathematical Models of Mechanical (Translation & Rotational) Systems, DC Motors, Electrical, Thermal, Liquid level system, Pneumatic actuator, Analogous system (FV & FI analogy). Numerical problems

Pedagogy	Chalk and talk, Power point presentation, Real time examples	10 Hours

Module -2

Block diagram Algebra: General representation of a feedback control system, Summing junctions, transfer functions, rules of block diagram algebra, Reduction of block dia. to obtain closed loop transfer function. Numerical Problems

Signal flow graphs: Mason's gain formula, Numerical Problems

Control action and Controllers: Control actions, Proportional, Integral, derivative, Proportional-Integral, Proportional- Derivative and Proportional- Integral- Derivative controllers.

Pedagogy	Chalk and talk, Power point presentation, Real time examples	10 Hours

Module -3

Time domain performance of control systems: Introduction, Types of input signals,

Steady State Error Analysis: Steady state error, Steady state analysis for general block dia. for a control system, Numerical Problems.

Transient Analysis: Time Response for first order system response to step, ramp and parabolic inputs, Time response for second order system response to unit step input with Overdamped, underdamped and critically damped systems. Numerical problems

Time domain specifications (No derivations), Numerical problems

System stability: Routh's-Hurwitz Criterion. Numerical problems

Pedagogy	Chalk and talk, Power point presentation, Real time examples	10 Hours

Module -4

Frequency Domain Analysis: Introduction to frequency Response, Frequency response function, Frequency domain specifications. **Polar and Nyquist Plots :**Polar plot, Nyquist plot and Nyquist stability criterion, Relative Stability Concepts, Phase and Gain Margins, Numerical problems B**ode Plots:** Bode attenuation diagrams, Stability Analysis using Bode plots,		
Pedagogy	Chalk and talk, Power point presentation, Use of Charts, MATLAB	12 Hours
Module -5		
ROOT LOCUS PLOTS: Definition of root loci, general rules for constructing root loci, Analysis using root locus plots. **State Variable Characteristics of Linear Systems:** Classical control v/s Modern control approach, Introduction to State, State Variables, State vectors, State Space, State Trajectory, State equation, output equation, State Model of linear systems. Matrix representation of state equations, Transfer functions for State variables. Numerical Problems		
Pedagogy	Chalk and talk, Power point presentation, Use of Charts, MATLAB	10 Hours
Assignment: (Use of Software 'MATLAB' on the below topics.) 1. Study of Control Modes like P, PD, PI, PID Controllers 2. Time Response analysis of 1st and 2nd order system 3. Assignment on Root Locus, Bode Plots and Nyquist Plots.		
Text Books: 1. Modern control Engineering K. Ogata Pearson 5th Edition, 2010 2. Control Systems Engineering IjNagrath, M Gopal New Age International (P) Ltd 2018 **Reference Books:** 1. Automatic Control Systems Farid G., Kuo B. C McGraw Hill Education 10th Edition,2018 2. Control systems Manik D. N Cengage 2017 3. Modern control Systems Richard C Dorf Pearson 2017 4. Control System Engineering by U A Bakshi and V U Bakshi, Technical publications ISBN 8184318553 5. Control Systems Engineering S Palani Tata McGraw Hill Publishing Co Ltd ISBN-13 9780070671935 **E-Resources** https://www.youtube.com/playlist?list=PLGiGNMkNq6QsFhPf8VYzH8pv8Jn4Ef5ZZ		

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to Control systems & Mathematical models of physical systems	**Introduction to Control System:** Definition of control system, Open loop and closed loop systems, Examples, Classification of closed loop control system, Requirements, Advantages, limitations, Block diagram representation of Closed loop control system. **Modeling of Physical Systems:** Mathematical Models of Mechanical systems
2	Week 3-4: Mathematical models of physical systems &Block Diagram reduction	**Modeling of Physical Systems:** DC Motors, Electrical, Thermal, Liquid level system, Pneumatic actuator, Analogous system (FV & FI analogy). Numerical problems **Block diagram Algebra**:, Reduction of block dia. to obtain closed loop transfer function. Numerical Problems
3	Week 5-6: Signal Flow graphs and Control action and Controllers	**Signal flow graphs:** Mason's gain formula, Problems **Control action and Controllers:** Control actions, Proportional, Integral, derivative, Proportional-Integral, Proportional- Derivative and Proportional- Integral- Derivative controllers.
4	Week 7-8: Time domain	**Time domain performance of control systems**: Introduction, Types of input signals, **Steady State Error Analysis:** Steady state error, Steady

	performance of the system and Systems Stability	state analysis, Numerical Problems. **Transient Analysis**: Time Response for first order system response to step, ramp and parabolic inputs, Time response for second order system response to unit step input with damping. Numerical problemsTime domain specifications, problems **System stability**: RH Criterion. Numerical problems
5	Week 9-10: Frequency Domain analysis	**Frequency Domain Analysis**: Introduction to frequency Response, Frequency response function, Frequency domain specifications. **Polar and Nyquist Plots :**Polar plot, Nyquist plot and Nyquist stability criterion, , Numerical problems
6	Week 11-12: Root locus Plots	B**ode Plots:** Stability Analysis using Bode plots, **ROOT LOCUS PLOTS:** Definition of root loci, general rules for constructing root loci, Analysis using root locus plots.
7	Week 13 State variable characteristics of linear systems	**State Variable Characteristics of Linear Systems:** Classical control v/s Modern control approach Important definitions State Model of linear systems. Matrix representation of state equations, Transfer functions for State variables. Numerical Problems

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Chalk and Talk method	Most of the problems and derivations are solved using chalk and talk method.
2	Power Point presentations	Concepts like control action and controllers and introduction to control system can be presented using power points.
3	Use of Charts	Semi log sheets are used to solve frequency response analysis
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
5	Real-World Application	Practical applications like to connect theoretical concepts with real-world competencies.
6	MATLAB Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	TotalMarks			**50**	**20**

FinalCIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	TLP Strategies:	Description
1	Chalk and Talk method	Most of the problems and derivations are solved using chalk and talk method.
2	Power Point presentations	Concepts like control action and controllers and introduction to control system can be presented using power points.
3	Use of Charts	Semi log sheets are used to solve frequency response analysis
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
5	Real-World Application	Practical applications like to connect theoretical concepts with real-world competencies.
6	MATLAB Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME703.1	Identify the type of control systems and controllers
M23BME703.2	Develop the mathematical model of the physical systems.
M23BME703.3	Solve the complex physical system using block diagram algebra and signal flow graph and obtain transfer function.
M23BME703.4	Analyze a linear feedback control system for stability using time response analysis, Hurwitz criterion, Root locus technique &State space approach.
M23BME703.5	Determine the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.
M23BME703.6	Construct frequency plots for linear feedback control systems using MAT LAB.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME703.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME703.2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BME703.3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME703.4	-	-	-	3	-	-	-	-	-	-	-	-	-	3
M23BME703.5	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME703.6	-	-	-	-	3	-	-	-	-	-	-	-	3	3
M23BME703	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**CO6**	**Total**
Module 1	**5**	**5**					**10**
Module 2	**5**		**5**				**10**
Module 3				**10**			**10**
Module 4				**7**		**3**	**10**
Module 5					**7**	**3**	**10**
Total	**10**	**5**	**5**	**17**	**7**	**6**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**	**10**				**20**
Module 2	**10**		**10**			**20**
Module 3				**20**		**20**
Module 4				**20**		**20**

Module 5					**20**	**20**
Total	**20**	**10**	**10**	**40**	**20**	**100**

10. Future with this Subject:

The "Control Engineering" course in the seventh semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

- **Advanced Multi-disciplinary Courses:** The knowledge gained in this course, covering principles of control systems serves as a prerequisite for more mechatronics design. Students can delve deeper into topics such as modeling and analysis of any digital systems.
- **Synergetic Integration Course:** Understanding Control systems design and its application is crucial for students pursuing courses related to interdisciplinary scenario. The ability to model, simulate, and synthesize of control systems using is directly applicable in the design and implementation of any mechanical systems with synergetic integrations.
- **Project Work and Research:** The hands-on experience gained through MATLAB programming assignments enables the students to build interface control systems for extensive in their Multidisciplinary projects.
- **Industry Applications:** The course provides modeling skills that are directly applicable in industries related to Multidisciplinary design approach. Graduates are well-prepared to contribute to industries developing precise control equipment.

In summary, the "Control engineering" course serves as a stepping stone, equipping students with foundational knowledge and skills that are essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

7th Semester	Professional Elective (PE) Tribology	M23BME704A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Mathematics**	Proficiency in differential equations and numerical methods to solve problems related to pressure distribution, load capacity, and bearing performance.
2	**Fundamentals of Engineering Mechanics**	Understanding basic concepts of forces, moments, and equilibrium to grasp the principles of friction and bearing analysis.
3	**Introduction to Thermodynamics**	Knowledge of heat transfer principles and fluid properties to comprehend viscosity, lubrication principles, and the behavior of oils.
4	**Fluid Mechanics**	Familiarity with fluid dynamics, including the equations of flow and properties of fluids, essential for understanding lubrication and viscosity.
5	**Material Science**	Basic knowledge of material properties, including the behavior of metals and non-metals, to understand wear mechanisms and material selection for bearings.

2. Competencies

S/L	Competency	KSA Description
1	**Introduction to tribology**	**Knowledge**: Understand and explain the properties of oils, viscosity concepts, and lubrication principles, including the application of Newton's Law of viscosity and Hagen-Poiseuille Law. **Skill**: Apply viscosity measurement techniques and lubrication principles to analyze and solve practical lubrication problems, optimizing oil flow and performance in engineering systems. **Attitude**: Value the critical role of accurate lubrication and flow analysis in enhancing system efficiency and reliability, adopting a thorough and systematic approach to tribological challenges.
2	**Friction and Wear**	**Knowledge**: Grasp friction theories, measurement methods, and wear mechanisms, including delamination and debris analysis, along with the classification and testing standards for different wear types. **Skill**: Measure and analyze friction in metals and non-metals, apply wear mechanisms to solve practical problems, and use testing methods to evaluate wear effectively through case studies. **Attitude**: Recognize the critical role of friction and wear analysis in engineering, demonstrating a proactive approach to solving wear-related issues and enhancing system reliability and performance.
3	**Hydrodynamic Lubrication and Journal bearing**	**Knowledge**: Learn hydrodynamic lubrication principles, including friction and pressure in bearings. Understand idealized journal bearings, load capacities, and numerical methods. **Skill**: Apply laws and equations to solve bearing problems. Analyze performance, including friction and load capacities. **Attitude**: Value precision in lubrication analysis. Approach bearing design with a focus on optimizing performance and reliability.
4	**Slider / Pad Bearing With A Fixed & Pivoted Shoe Hydrostatic Lubrication**	**Knowledge**: Understand pressure distribution, load capacity, and friction in slider/pivoted bearings. Learn hydrostatic lubrication principles and analyze load carrying and oil flow in hydrostatic step bearings. **Skill**: Calculate bearing performance metrics such as load capacity and friction. Solve numerical problems related to slider bearings and hydrostatic lubrication. **Attitude**: Approach lubrication challenges with a methodical mindset. Emphasize accuracy in calculations and the application of theoretical concepts to practical problems.
5	**Bearing Materials and Surface Engineering**	**Knowledge**: Identify and evaluate different bearing materials and their properties. Understand surface engineering concepts, including modification and coating processes for wear and corrosion resistance. **Skill**: Assess and select appropriate bearing materials and surface coatings based on performance requirements. Apply surface engineering techniques to enhance material properties.

		Attitude: Value material selection and surface treatment as crucial for component longevity. Approach engineering problems with a focus on optimizing material performance and durability.

3. Syllabus

TRIBOLOGY **SEMESTER – VII**			
Course Code	**M23BME704A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**50 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives: Students will be able

1. **To understand the** fundamental concepts of tribology, including viscosity, flow equations, lubrication principles, and the classification of lubricants.
2. Explore the origins and theories of friction, measurement techniques, and various wear mechanisms and testing methods through practical case studies.
3. Study friction forces, power loss, and pressure development in hydrodynamic lubrication, including the application of Petroff's law and Reynolds' equation.
4. Learn about idealized journal bearings and slider/pivoted shoe bearings, focusing on pressure distribution, load carrying capacity, and numerical problem-solving.
5. Understand surface engineering concepts, including modification techniques and coatings, and evaluate commonly used bearing materials for their properties and applications

Module -1

Introduction to tribology: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants.

Module -2

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals.
Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies

Module -3

Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, and mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D.
Idealized Journal Bearing: introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Somerfield's numbers and significance of it; Partial bearings, end leakages in journal bearing,
numerical problems.

Module -4

Slider / Pad Bearing With A Fixed And Pivoted Shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical examples.
Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples

Module -5

Bearing Materials: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials.
Introduction to Surface engineering: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo-chemical processes. Surface Coating – plating, fusion processes, vapour phase processes. Selection of coating for wear and corrosion resistance

TEXTBOOKS:

1. "Introduction to Tribology", B. Bhushan, John Wiley & Sons, Inc., New York, 2002
2. "Engineering Tribology", Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011.
3. "Engineering Tribology", J. A. Williams, Oxford Univ. Press, 2005.

REFERENCE BOOKS:

1. "Introduction to Tribology in bearings", B. C. Majumdar, Wheeler Publishing.
2. "Tribology, Friction and Wear of Engineering Material", I. M.Hutchings, Edward Arnold,London,

1992.
3. "Engineering Tribology", G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann,1992.
4. "Friction and Wear of Materials", Ernest Rabinowicz, John Wiley & sons, 1995. "Basic Lubrication Theory", A. Cameron, Ellis Hardwoods Ltd., UK.
5. "Handbook of tribology: materials, coatings and surface treatments", B.Bhushan, B.K.Gupta,McGraw-Hill, 1997

VIDEO LINKS:

1. http://www.digimat.in/nptel/courses/video/112102014/L01.html
2. https://youtu.be/XLHrfeVlSew?list=PLGiGNMkNq6QsIvEGyOxqS29XJzpNYUsuY

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to tribology	Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants.
2	Week 4-6: Friction and Wear	Origin, friction theories, measurement methods, friction of metals and non-metals. Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies
3	Week 7-10: Hydrodynamic Lubrication and Idealized Journal Bearing	Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, and mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Somerfield's numbers and significance of it; Partial bearings, end leakages in journal bearing, numerical problems.
4	Week 11-13: Slider / Pad Bearing With A Fixed And Pivoted Shoe Hydrostatic Lubrication	Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical examples. Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples
5	Week 14-16: Bearing Materials and Surface Engineering	Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials. Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo-chemical processes. Surface Coating – plating, fusion processes, vapour phase processes. Selection of coating for wear and corrosion resistance

5. Teaching-Learning Process Strategies

S/L	TLP Strategies	Description
1	**Lectures and Theoretical Instruction**	Deliver comprehensive lectures covering tribology fundamentals, lubrication principles, friction, wear, and bearing mechanics. Use visual aids, diagrams, and equations to clarify complex concepts.
2	**Hands-On Tutorials**	Conduct hands-on demonstrations of viscosity measuring apparatus and lubrication systems. Showcase experiments related to friction, wear testing, and bearing analysis to illustrate theoretical principles
3	**Interactive Simulations**	Employ software tools and simulations to model and analyze lubrication systems, bearing performance, and surface engineering processes. Facilitate interactive sessions where students can experiment with different parameters and visualize outcomes.
4	**Problem-Based Learning**	Utilize real-world case studies and numerical problems to engage students in practical applications. Analyze and discuss different scenarios related to friction, wear, and lubrication in various engineering contexts.
5	**Group Projects and Collaboration**	Encourage collaborative projects where students work together to investigate specific tribological problems, design experiments, and present their findings. Facilitate group discussions to enhance understanding and application of course

		concepts.
6	**Assignments and Assessments**	Implement regular assignments, quizzes, and exams to evaluate students' comprehension and application of the material. Provide feedback to help students improve their problem-solving skills and theoretical understanding.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

5. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
6. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
7. The students have to answer 5 full questions selecting one full question from each module.
8. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	**Understand Properties and Flow**	Explain oil properties, viscosity, and flow equations. Describe lubrication principles and classify different types of lubricants.
2	**Analyze Friction and Wear**	Identify friction theories and measurement methods. Analyze wear mechanisms, including delamination and debris, using case studies and testing standards.
3	**Apply Bearing Concepts**	Calculate friction forces, power loss, and pressure development in bearings. Apply Petroff's law, Reynolds' equation, and analyze journal bearing performance, including load capacity and leakages.
4	**Evaluate Bearing Performance**	Assess pressure distribution, load capacity, and friction in pivoted shoe bearings. Solve numerical problems related to these bearings
5	**Explore Hydrostatic Lubrication**	Understand hydrostatic lubrication principles and analyze oil flow and load capacity in hydrostatic step bearings. Solve related numerical examples.
6	**Select and Apply Surface Engineering**	Describe surface engineering concepts and techniques. Evaluate and select appropriate surface modifications and coatings for wear and corrosion resistance.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME704A.1	Describe oil properties, viscosity concepts, and flow equations. Apply lubrication principles and classify lubricants to analyze and solve practical lubrication problems.
M23BME704A.2	Analyze friction theories and wear mechanisms. Measure friction in different materials and evaluate wear through testing and case studies.
M23BME704A.3	Apply concepts of friction and pressure in bearings. Analyze and solve problems related to journal bearings, including load capacity and leakages
M23BME704A.4	Apply concepts of pressure, load capacity, and friction in bearings. Analyze and solve problems related to hydrostatic lubrication and bearing performance.
M23BME704A.5	Identify and evaluate bearing materials and their properties. Understand surface engineering techniques and choose suitable coatings for wear and corrosion resistance.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME704A.1	3	-	3	-	-	-	3	-	-	-	-	-	3	-
M23BME704A.2	3	3	-	3	-	-	-	-	-	-	-	-	3	3
M23BME704A.3	-	-	3	-	-	-	-	-	-	-	-	-	3	3
M23BME704A.4	-	-	3	-	-	-	-	-	-	-	-	-	3	3
M23BME704A.5	-	-	-	-	-	-	3	-	-	-	-	3	-	-
M23BME704A	**3**	**3**	**3**	**3**	-	-	**3**	-	-	-	-	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**	-	-	-	-	**10**
Module 2	-	**10**	-	-	-	**10**
Module 3	-	-	**10**	-	-	**10**
Module 4	-	-	-	**10**	-	**10**
Module 5	-	-	-	-	**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**	-	-	-	-	**20**
Module 2	-	**20**	-	-	-	**20**
Module 3	-	-	**20**	-	-	**20**
Module 4	-	-	-	**20**	-	**20**
Module 5	**20**	-	-	-	**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

1. **Advanced Lubricants**: Development and use of novel lubricants, including nano-lubricants and environmentally friendly alternatives, to improve performance and reduce environmental impact.
2. **Smart Bearings**: Integration of sensors and smart technologies in bearings for real-time monitoring and predictive maintenance, enhancing operational efficiency and lifespan.
3. **Surface Engineering Innovations**: Progress in surface modification techniques such as advanced coating technologies and multifunctional coatings that improve wear resistance, reduces friction, and provide corrosion protection.
4. **Tribological Materials Research**: Exploration of new materials and composites with improved tribological properties for high-performance applications, including aerospace, automotive, and renewable energy sectors.
5. **Computational Tribology**: Advancements in computational methods and simulations for accurate prediction of tribological behaviors, including the use of machine learning and AI to optimize lubrication systems and material performance.
6. **Sustainability and Green Tribology**: Focus on sustainable practices and materials in tribology, promoting the development of low-impact lubricants, efficient energy use, and reduced waste in industrial applications.

7th Semester	Professional Elective (PE) IC ENGINES	M23BME704B

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Physics	• Basic understanding of classical mechanics, thermodynamics, and electromagnetism. • Knowledge of energy forms, energy conversion, and basic principles of heat transfer.
2.	Basic Chemistry	• Understanding of chemical reactions and properties of fuels. • Understanding the materials and reactions involved in energy storage, bioenergy, and fuel cells.
3.	Mathematics	• Understanding of basic algebraic & differential equations. • Understanding of basic trigonometric functions.
4.	Environmental Science	• Basic understanding of Ecology, Pollution & Environmental Impact and Sustainability. • Understanding of the air pollution & its impact.
5.	Conventional Engines	• Basic knowledge of automobile vehicles & its engine types.

2. Competencies

S/L	Competency	KSA Description
1	**Engine Components and Function**	**Knowledge:** • Understanding the knowledge of each parts of an IC Engine. • Understanding the functioning of different types of Engines. **Skills:** • Able to follow instructions to assemble or disassemble basic engine components. • Able to recognize basic symptoms of engine problems and perform simple diagnostics. **Attitudes:** • Exhibits a proactive approach to problem-solving, anticipating potential issues before they arise.
2	**Engine Fuels**	**Knowledge:** • Understanding the energy content of different fuels and how it impacts on engine performance. • Awareness of alternative fuels such as ethanol, methanol, biodiesel, natural gas (CNG, LNG), and hydrogen. **Skills:** • Ability to identify common fuel-related issues, such as blockages, leaks, and contamination, and take corrective action. • Ability to optimize engines for biofuel use, including adjusting fuel injection timing, modifying fuel filters, and using compatible materials to prevent corrosion. **Attitudes:** • Showing concern for the ecological footprint of fuel use and striving to reduce it.
3	**Operation & Mechanisms**	**Knowledge:** • Knowledge of how the air-fuel mixture is prepared and its significance for efficient combustion. • Knowledge of different combustion chamber designs and how they influence efficiency, power output, and emissions. • Knowledge of how the oil pump circulates oil throughout the engine to lubricate moving parts and reduce friction. **Skills:** • Ability to inspect and replace air filters to ensure the engine receives clean air for combustion. • Ability to adjust carburetors to achieve the correct air-fuel mixture, improving engine performance and efficiency. • Ability to test and replace ignition coils, distributors, and related

		components to ensure a strong and consistent spark. **Attitudes:** • Providing professional and courteous service, addressing customer queries and concerns with respect and competence.
4	**Ethical and Environmental Awareness**	**Knowledge:** • Knowledge of how IC engines impact the environment and ways to reduce this impact through efficient practices. • Awareness of the pollutants produced by burning different fuels and their impact on air quality and human health. **Skills:** • Conducting emissions tests to measure pollutants such as CO2, NOx, and particulate matter produced by different fuels. • Ability to implement strategies to reduce emissions. **Attitudes:** • Demonstrating a commitment to reducing emissions and supporting sustainability initiatives.

3. Syllabus

IC ENGINES **SEMESTER – VII**			
Course Code	**M23BME704B**	CIE Marks	**50**
No. of Lecture Hours/Week(L:T:P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

- To provide the sufficient knowledge of concept, applications, importance of IC engines.
- To familiarize the students about the IC engines systems, processes, alternative fuels etc...
- To acquire knowledge of different Injection Systems and Engine emissions and their control.

Module -1

Introduction: Definition of Engine & Heat engine, Classification of Heat Engines, Basic Engine Components and Nomenclature, Working Principle of Engines, classification of IC engines, Application of IC Engines. Engine Performance Parameters, Simple Problems.

Module -2

Conventional Fuels: Introduction, Types of Fuels, Petroleum Refining Process, Important Qualities of Engine Fuels, Rating of fuels.

Alternative Fuels: Possible Alternatives, Surface-Ignition Alcohol CI Engine, Spark-Assisted Diesel, Vegetable Oil, Biodiesel, Hydrogen Engines, Dual Fuel Operation.

Module -3

Carburetion: Definition of Carburetion, factors affecting Carburetion, essential parts of a Carburetor, principle of Carburetion, the simple Carburetor, types of Carburetors, automobile Carburetors**,** air–fuel mixtures, automotive engine air–fuel mixture requirements.

Ignition: Energy Requirements for Ignition, the Spark Energy and duration, Ignition system, Requirements of an Ignition system, Battery Ignition system, Magneto Ignition.

Module -4

Mechanical Injection Systems: Functional requirements of an Injection system, classification of Injection systems, Fuel feed pump, Injection pump, Injection pump governor, Mechanical governor, Fuel Injector, Injection in SI Engine.

Electronic Injection Systems: Types of Injection Systems**,** Components of Injection System**,** Electronic Fuel Injection System**,** Merits & Demerits of EFI System**,** Multi-point fuel injection (MPFI) system, Electronic control system, Electronic Diesel Injection system.

Module -5

Engine Friction and Lubrication: Friction Losses, Mechanical Efficiency, Mechanical Friction, Blowby Losses, Lubrication, Function of Lubrication, Mechanism of Lubrication. Lubrication of engine components. Lubrication System. Properties of lubricants, SAE rating of lubricants. Additives for lubricants.

Engine Emissions and their Control: Air pollution due to IC engines, Engine Emissions, Hydrocarbon

emission from CI Engines. Emission Control Methods.

Text Books:

1. IC Engines, V Ganesan, Tata McGraw Hill Education Private Limited, New Delhi, Fourth Edition, 2012.
2. Internal Combustion Engine, R K Rajput, Lakshmi Publications Ltd.
3. Internal Combustion Engine, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, New Delhi, 2010

Reference Books:

1. Automotive Mechanics, William H Crouse & Donald L Anglin, Tata McGraw Hill Publishing Company, 10th Edition 2007.
2. Automotive Mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc.

Links

1. https://youtu.be/H_RgFXjg-5s?si=QObM5ZCfBm2U6aNH
2. https://youtu.be/u-aPzg7saeY?si=_amm1ahNdOOPqzVG

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction	Definition of Engine & Heat engine, Classification of Heat Engines, Basic Engine Components and Nomenclature, Working Principle of Engines, classification of IC engines, Application of IC Engines. Engine Performance Parameters, Simple Problems.
2	Week 3-4: Conventional Fuels & Alternative Fuels	Introduction, Types of Fuels, Petroleum Refining Process, Important Qualities of Engine Fuels, Rating of fuels. Possible Alternatives, Surface-Ignition Alcohol CI Engine, Spark-Assisted Diesel, Vegetable Oil, Biodiesel, Hydrogen Engines, Dual Fuel Operation.
3	Week 5-6: Carburetion & Ignition	Definition of Carburetion, factors affecting Carburetion, essential parts of a Carburetor, principle of Carburetion, the simple Carburetor, types of Carburetors, automobile Carburetors, air–fuel mixtures, automotive engine air–fuel mixture requirements. Energy Requirements for Ignition, the Spark Energy and duration, Ignition system, Requirements of an Ignition system, Battery Ignition system, Magneto Ignition.
4	Week 7-8: Mechanical Injection Systems & Electronic Injection Systems:	Functional requirements of an Injection system, classification of Injection systems, Fuel feed pump, Injection pump, Injection pump governor, Mechanical governor, Fuel Injector, Injection in SI Engine. Types of Injection Systems, Components of Injection System, Electronic Fuel Injection System, Merits & Demerits of EFI System, Multi-point fuel injection (MPFI) system, Electronic control system, Electronic Diesel Injection system.
5	Week 9-10: Engine Friction and Lubrication	Friction Losses, Mechanical Efficiency, Mechanical Friction, Blowby Losses, Lubrication, Function of Lubrication, Mechanism of Lubrication. Lubrication of engine components. Lubrication System. Properties of lubricants, SAE rating of lubricants. Additives for lubricants.
6	Week 11-12: Engine Emissions and their Control	Air pollution due to IC engines, Engine Emissions, Hydrocarbon emission from CI Engines. Emission Control Methods.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of the concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Fundamental Concepts of IC Engine	Students will learn the basic operating principles of internal combustion engines, including the differences between spark-ignition (SI) and compression-ignition (CI) engines.
2	Fuels in Engine	Students will learn the chemical composition and physical properties of conventional fuels such as gasoline and diesel, and **explain** how these properties affect combustion and engine performance.
3	Carburetor & Ignition	Students will learn about the types & functioning of carburetor & ignition system to maintain the smooth operation of the IC Engines.
4	Injection System	Students will learn the basic principles of mechanical fuel injection systems, including the role of components such as fuel pumps, injectors, and governors in delivering fuel to the engine. Also learn the mechanical and electrical injection systems influence on engine performance characteristics.
5	Friction & Lubrication	Students will learn the types of friction losses and its effect on engine and different types of lubricants used in internal combustion engines, including mineral oils, synthetic oils, and blended oils, in terms of their properties.
6	Emission Control System	Students will learn the key pollutants in internal combustion engines and identify the major global and regional emission regulations and standards that govern automotive emissions.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME704B.1	**Identify** the key components of internal combustion engine & **calculate** the engine performance parameters.
M23BME704B.2	**Infer** the concepts of Conventional & Alternative fuels related to IC Engine.
M23BME704B.3	**Illustrate** the fundamentals of carburetors and ignition systems to achieve the optimal air-fuel mixture for different engine operating conditions.
M23BME704B.4	**Interpret** the types & operating principles of mechanical & electrical injection system with their merits & demerits.
M23BME704B.5	**Classify** the different types of frictional losses & lubricants of different characteristics and also describe the importance of Emission Control system in IC Engine.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME704B.1	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BME704B.2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
M23BME704B.3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME704B.4	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME704B.5	**3**	**-**	-	-	-	-	-	-	-	-	-	-	3	-
M23BME704B	**3**	**-**	-	-	-	-	-	-	-	-	-	-	**3**	**2**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- **Advanced Engine Technologies**
  - Hybrid and Electric Vehicles: Understanding how IC engines integrate with hybrid systems and the potential for advancements in engine design to complement electric powertrains.
  - Turbocharging and Supercharging: Innovations in forced induction systems to enhance performance and efficiency while reducing emissions.
  - Variable Valve Timing: Advancements in valve timing technologies (e.g., VTEC, VVT) to optimize engine performance and fuel efficiency across a range of conditions.
- **Alternative Fuels**
  - **Biofuels and Synthetic Fuels**: Research into renewable and synthetic fuels that can reduce the carbon footprint of IC engines while maintaining performance and efficiency.
  - **Hydrogen Engines**: Exploration of hydrogen as a fuel for combustion engines and the challenges associated with its use, such as storage, distribution, and combustion characteristics.
- **Emission Control Technologies**
- **Advanced Emission Control Systems**: Development of new technologies and materials for catalytic converters, particulate filters, and selective catalytic reduction (SCR) systems to meet increasingly stringent emissions regulations.
- **On-Board Diagnostics (OBD)**: Enhancements in diagnostic tools and systems for real-time monitoring and management of engine emissions and performance.

7th Semester	Professional Elective (PE) HYDRAULICS AND PNEUMATICS	M23BME704C

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Fundamental principles of fluid mechanics	Understanding applications of Pascal's law. Familiarity with fundamental principles of fluid mechanics, including concepts such as pressure, flow, viscosity, and fluid behavior under different conditions.
2.	Basic components of fluid power system	Knowledge of the various components used in hydraulic and pneumatic systems, such as pumps, valves, cylinders, and actuators, including their functions, operating principles, and selection criteria.
3.	Fundamentals of Mechanics	Understanding of fundamental mechanical concepts such as force, work, energy, and power. Knowledge of statics and dynamics, including Newton's laws of motion, torque, and equilibrium of forces.
4.	Fundamentals of logic gates	Knowledge of basic logic gates, which are fundamental building blocks of digital circuits, enables the performance of logical operations (such as AND, OR, and NOT) on binary inputs to produce a binary output.
5.	Basics of electrical engineering	Knowledge of electrical circuits and components is necessary for understanding the electrical aspects of hydraulic and pneumatic systems, such as solenoid valves and electrical sensors.

2. Competencies

S/L	Competency	KSA Description
1.	**Basics principles of fluid and its properties**	**Knowledge:** Understanding of fluid mechanics principles such as pressure, flow rate, Bernoulli's equation, and continuity equation. Knowledge of relevant fluid properties including viscosity, density, compressibility, and surface tension. **Skills:** Selecting appropriate fluids based on system requirements and operating conditions. **Attitudes:** Openness to solve problems related to fluid flow and behavior.
2.	**Fundamental knowledge on hydraulic system**	**Knowledge:** Principles of hydraulics, including fluid properties, pressure, flow, and power. **Skills:** Ability to analyze system requirements and select appropriate components. **Attitudes:** Attention to detail to ensure proper component selection and system design.
3.	**Hydraulic and Pneumatic system design**	**Knowledge:** Knowledge of system components pumps, actuators, valves, reservoirs for hydraulics; compressors, cylinders, valves for pneumatics. **Skills:** Ability to select appropriate components based on system requirements, considering factors like pressure, flow rate, and operating environment. Designing and integrating hydraulic and pneumatic components to achieve desired functionality. **Attitudes:** Identifying potential issues and developing solutions during design and troubleshooting.

4.	**Integration of Electrical system**	**Knowledge:** Understanding of the interaction between hydraulic/pneumatic and electrical systems. Knowledge of sensors, actuators, relays, solenoids and PLCs used for integration. **Skills:** Designing interfaces between electrical and fluid power systems, including signal conversion and control strategies. **Attitudes:** Mindset to work effectively with different engineering disciplines.

3. Syllabus

HYDRAULICS AND PNEUMATICS
SEMESTER – VII

Course Code	**M23BME704C**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

This course will enable students to:

1. Gain knowledge of basics of hydraulic and pneumatic systems.
2. Understanding the working principles of hydraulics and pneumatics components.
3. Engineering application of hydraulic and pneumatic systems.

MODULE - 1 (8 Hours)

Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law.

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit.

Maintenance of Hydraulic System: Hydraulic Oils - Desirable properties, general type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, Pressure switches, trouble shooting.

MODULE 2 (8 Hours)

Control Components in Hydraulic Systems: Classification of control valves**, Directional Control Valves**- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, **Pressure control valves** - types, direct operated types and pilot operated types. **Flow Control Valves** -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols.

MODULE 3 (8 Hours)

The source of Hydraulic Power: Pumps Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps.

Hydraulic Actuators and Motors: Classification of cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).

MODULE 4 (8 Hours)

Pneumatic Actuators: Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols.

Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.

Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle, Construction, practical applications.
MODULE 5 (8 Hours)
Hydraulic Circuit Design And Analysis: Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits. **Simple Pneumatic Control:** Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling.
TextBook(s)
1. Fluid Power with Applications, Anthony Esposit, Pearson Education Inc., 6th Edition 2000. 2. Pneumatics and Hydraulics, Andrew Parr, Jaico Publishing Co, 1993.
ReferenceBooks
1. Industrial Hydraulics, Pippenger Hicks, McGraw Hill, New York. **2.** Hydraulic & Pneumatic Power for Production, HarryL. Stewart,Industrial Press US, 1997. **3.** Pneumatic Systems, S. R. Majumdar, TATA McGraw Hill Publish, 1995. **4.** Hydraulic & Pneumatics' CMTI Data Book.
Web links and Video Lectures (e-Resources): https://archive.nptel.ac.in/courses/112/106/112106300/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to Hydraulic Power, pneumatic control and maintenance of hydraulic system	**Competency:** Understanding of hydraulic and pneumatic systems, including their design, operation, and maintenance. **Knowledge:** Understanding the properties of fluids and materials used in system components. **Skills:** Identify and describe different components used in pneumatic system.
2	Week 3-5: Control components in hydraulic and pneumatic systems	**Competency:** Understanding the roles of control valves, actuators, sensors, and regulators in hydraulic and pneumatic systems. **Knowledge:** Knowledge of how control components are integrated into circuits to regulate flow, pressure, and direction. **Skills:** Ability to select appropriate control components based on system requirements.
3	Week 6-8: Hydraulic Actuators and Pumps	**Competency:** Understanding the principles of hydraulic actuators (linear or rotary) and pumps. **Knowledge:** Knowledge of different types of hydraulic actuators (linear, rotary), pumps and their applications. **Skills:** Identify and select the appropriate hydraulic actuators (linear or rotary) and pumps based on specific system requirements and factors.
4	Week 9-10: Pneumatic Actuators and Electro Pneumatic Control	**Competency:** Understanding the principles of pneumatic actuators (linear or rotary) and role of electro pneumatic components. **Knowledge:** Understand the working of different types of pneumatics actuators and gain knowledge about how electrical control systems are integrated with pneumatic systems. **Skills:**Identify and select the appropriate pneumatic actuators and design electro-pneumatic circuits, including solenoid valves, relays, and sensors for controlling pneumatic actuators.
5	Week 11-12: Hydraulic and pneumatic	**Competency:** Ability to design simple hydraulic and pneumatic circuits for various applications by selecting appropriate

	circuit Design and Analysis	components (pumps, actuators, valves) to meet system requirements. **Knowledge:** Understand the basics of hydraulics and pneumatics (Pascal's law, Boyle's law) and knowledge about functions of different hydraulic and pneumatic components. **Skills:** Identifying and interpreting hydraulic and pneumatic circuit diagrams by understanding symbols, flow paths, and functional relationships between components.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Hydraulics and Pneumaticsconcepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the working of various hydraulics and pneumatics components by performing few experiments.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:
The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	TotalMarks			**50**	**20**

FinalCIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Introduction to Hydraulic Power, pneumatic control and maintenance of hydraulic system	Students will be able to understand the fundamental principles, components, and operation of hydraulic and pneumatic systems.

2	Control components in hydraulic and pneumatic systems	Students will be able to identify, describe, and analyze the control components of hydraulic and pneumatic systems.
3	Hydraulic Actuators and Pumps	Students will be able to understand the operation, selection, and application of hydraulic actuators and pumps, including their role in system performance and efficiency.
4	Pneumatic Actuators and Electro Pneumatic Control	Students will be able to understand the operation and applications of pneumatic actuators and electro-pneumatic control systems, including their integration and impact on overall system functionality.
5	Hydraulic and pneumatic circuit Design and Analysis	Students will be able to design and analyze hydraulic and pneumatic circuits, understanding how to optimize system performance and troubleshoot issues based on circuit specifications and operational requirements.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME704C.1	**Apply** the fundamental principles of hydraulics and pneumatics, including the properties of fluids, Pascal's Law, and the behavior of gases, to solve practical engineering problems.
M23BME704C.2	**Analyze** control circuits, choosing the right valves for specific functions and applications by **Using**the concepts of hydraulic and pneumatic valves like DCV, PCV, and FCV to design.
M23BME704C.3	**Optimize** fluid power systems for various engineering applicationsand**Apply** the knowledge of hydraulic pumps, actuators, and motors, including their types, working principles.
M23BME704C.4	**Illustrate** the operation and application of pneumatic actuators, electro-pneumatic control systems, and signal processing elements in simple cylinder control circuits.
M23BME704C.5	**Design and evaluate**different hydraulic and pneumatic circuits.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME704C.1	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME704C.2	-	**3**	-	-	-	-	-	-	-	-	-	-	-	-
M23BME704C.3	-	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME704C.4	-	**3**	-	-	-	-	-	-	-	-	-	-	-	-
M23BME704C.5	**-**	**-**	**3**	-	-	-	-	-	-	-	-	-	-	**3**
M23BME704C	**3**	**3**	**3**	-	-	-	-	-	-	-	-	-	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject

1. **Integration with Industry 4.0 and Smart Manufacturing:**
   Students will need to focus on learning how to design and maintain smart fluid power systems that can communicate with other machines and systems, self-diagnose issues, and optimize their performance automatically.
2. **Electrification and Energy Efficiency**:
   Understanding the principles of energy efficiency, and learning about electric actuators and hybrid systems that combine electrical and fluid power technologies will be crucial for future engineers.
3. **Advanced Materials and Additive Manufacturing:**
   Students should gain knowledge about the properties of new materials and how additive manufacturing can be used to design and produce custom fluid power components that are lighter, stronger, and more efficient.
4. **Simulation and Modeling:**
   Proficiency in simulation software that can predict system behavior, optimize designs, and reduce the need for physical prototyping will be highly valuable. This includes learning tools like MATLAB, Simulink, or specialized fluid power simulation software.
5. **Sustainability and Environmental Impact:**
   Students should focus on learning how to design systems that meet strict environmental regulations, understand the lifecycle impact of hydraulic and pneumatic systems, and explore alternatives to traditional hydraulic fluids.
6. **Miniaturization and Micro fluidics:**
   Gaining expertise in micro fluidics, including the principles of fluid behavior at small scales and the design of micro-scale components, will be important for working in cutting-edge fields like biomedical engineering and robotics.
7. **Remote Monitoring and Predictive Maintenance:**
   Students should become familiar with the principles of condition monitoring, the use of sensors to collect data, and the application of predictive maintenance strategies to increase system reliability and reduce downtime.
8. **Robotics and Automation:**
   Learning how fluid power systems are applied in robotics, including in autonomous systems and collaborative robots will be crucial for those interested in automation and robotics engineering.
9. **Globalization and Cross-disciplinary Collaboration:**
   Developing strong communication skills, cultural competence, and the ability to collaborate with professionals from different fields and countries will be essential for success in a globalized industry.
10. **Education and Lifelong Learning:**
    Embracing a mindset of lifelong learning, being open to new technologies, and regularly updating skills through courses, certifications, and hands-on experience will be critical for staying relevant in the field.

7th Semester	Professional Elective (PE) ORGANIZATIONAL BEHAVIOUR	M23BME705A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Psychology	A foundational understanding of human behaviour, personality, and motivation is essential for grasping the core concepts in organizational behaviour.
2	Sociology	Knowledge of group dynamics, social structures, and organizational culture provides a broader context for studying organizational behavior.
3	Statistics	Basic statistical skills are necessary for analyzing data and understanding research findings in the field.
4	Communication Skills	Effective communication is crucial for understanding and applying organizational behavior concepts, as well as for interacting with colleagues and stakeholders.
5	Problem-Solving & Critical Thinking	The ability to analyse complex organizational issues and develop effective solutions is fundamental to organizational behavior.

2. Competencies

S/L	Competency	KSA Description
1	**Organizational Awareness**	**Knowledge:** Understanding the historical evolution of organizational behavior and its significance in contemporary organizations. Knowledge of the external environment, including technological, global, and cultural factors impacting organizations. **Skills:** Ability to analyse the impact of organizational culture and design on employee behavior and performance. Skill in identifying ethical dilemmas and developing ethical decision-making frameworks **Attitudes:** A willingness to embrace diverse perspectives and challenge existing assumptions about organizational practices. A strong sense of integrity and commitment to upholding ethical standards in organizational behavior
2	**Individual Development**	**Knowledge:** Understanding of individual differences, including personality traits, abilities, and learning styles. Knowledge of various learning theories and their applications in organizational settings **Skills:** Ability to assess individual learning needs and develop tailored development plans. Skill in applying reinforcement principles to shape desired behaviours. **Attitudes:** Openness to continuous learning and personal development. Belief in the potential for individuals to grow and develop through learning experiences.
3	**Interpersonal Effectiveness**	**Knowledge:** Understanding the perception process and factors influencing it, including attribution theory and biases. Knowledge of various motivation theories and their applications in different organizational contexts. **Skills:** Ability to build rapport and establish effective relationships with others.

		Skill in motivating and inspiring individuals to achieve their full potential. **Attitudes:** Empathy and understanding of others' perspectives. Belief in the importance of positive interpersonal relationships for organizational success.
4	**Teamwork and Collaboration**	**Knowledge:** Understanding group dynamics, including group formation, development, & decision making processes. Knowledge of conflict management strategies and their applications in organizational settings. **Skills:** Ability to build and maintain effective teams, fostering collaboration and cooperation. Skill in managing conflict constructively and finding win-win solutions. **Attitudes:** Willingness to cooperate and support team members. Belief in the importance of teamwork for achieving organizational goals.
5	**Effective Communication**	**Knowledge:** Understanding the communication process, including its components and barriers. Knowledge of various communication channels and their effectiveness in different contexts. **Skills:** Ability to communicate clearly and concisely, both verbally and in writing. Skill in active listening and providing constructive feedback. **Attitudes:** Openness to diverse communication styles and perspectives. Commitment to effective communication as a foundation for building strong relationships.

3. Syllabus

ORGANIZATIONAL BEHAVIOUR SEMESTER – VII			
Course Code	**M23BME705A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. Understand the foundations of organizational behavior and its role in organizational success.
2. Analyze individual behavior, learning processes, and motivation within organizational contexts.
3. Develop skills in perception, decision-making, and managing individual differences.
4. Examine group dynamics, conflict resolution, and stress management strategies.
5. Master effective communication principles and their application in organizational settings.
6. Apply organizational behavior knowledge to enhance performance & employee well-being.

Module -1

Introduction: Definition of Organization Behaviour and Historical development, Environmental context Information Technology and Globalization, Diversity and Ethics, Design and Culture. Reward systems in organizational context.

Module -2

The Individual and Learning: Foundations of individual behaviour, Individual differences. Ability. Attitude, Aptitude, Interests, Values. Definition of learning, Theories of Learning, Individual decision making, Classical conditioning, Operant conditioning, Social learning theory, Continuous & Intermittent reinforcement, Schedules of reinforcement

Module -3

Perception and Motivation: Definition, Factors influencing perception, Attribution theory, Selective perception, projection, Stereotyping, Halo effect. Maslow's Hierarchy of Needs theory, McGregor's theory X and Y, Hertzberg's motivation Hygiene theory, David McClelland's three needs theory. Victor Vroom's expectancy theory of motivation.
Module -4
The Groups: Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, Group processes, Group tasks, Group decision making. **Conflict and Stress Management:** Definition of conflict, Functional and dysfunctional conflict, Stages of conflict process. Sources of stress, fatigue, and its impact on productivity. Job satisfaction and Job rotation.
Module -5
Principles of Communication: Introduction, Communication principles, Communication system, Role of communication in management, Barriers in communication, Rules of effective communication, Case studies on communication **Recent trends in Organizational Behaviour:** AI-driven HR, Automation of tasks, Employee wellbeing, Mental health, Continuous learning and lifelong learning**,** Remote and hybrid work.
TEXTBOOKS: 1. Organizational Behaviour by Fred Luthans, McGraw-Hill Education, 12th Edition, 2012. 2. Organizational Behaviour by Stephen P Robbins, Prentice Hall. 2009 3. Organizational Behaviour by Kondalkar, New Age International Publishers, 2019. **REFERENCE BOOKS:** 1. Organizations Behaviour, Structure, Processes by James L Gibson, McGraw-Hill, 2011. 2. Fundamentals of Organizational Behaviour, Robert Kreltner, Angelo and Nina Cole, Mc-Graw Hill, 2002

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to Organization Behaviour	Definition of Organization Behaviour and Historical development, Environmental context Information Technology and Globalization, Diversity and Ethics, Design and Culture. Reward systems in organizational context.
2	Week 4-6: The Individual and Learning	Foundations of individual behaviour, Individual differences. Ability. Attitude, Aptitude, Interests, Values. Definition of learning, Theories of Learning, Individual decision making, Classical conditioning, Operant conditioning, Social learning theory, Continuous & Intermittent reinforcement
3	Week 7-8: Perception and Motivation	Definition, Factors influencing perception, Attribution theory, Selective perception, projection, Stereotyping, Halo effect. Maslow's Hierarchy of Needs theory, McGregor's theory X and Y, Hertzberg's motivation Hygiene theory, David McClelland's three needs theory. Victor Vroom's expectancy theory of motivation.
4	Week 9-10: The Groups Conflict and Stress Management	Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, Group processes, Group tasks, Group decision making. Definition of conflict, Functional and dysfunctional conflict, Stages of conflict process. Sources of stress, fatigue, and its impact on productivity. Job satisfaction and Job rotation.
5	Week 11-12: Principles of Communication	Introduction, Communication principles, Communication system, Role of communication in management, Barriers in communication, Rules of effective communication, Case studies on communication. Recent trends in Organizational Behaviour: AI-driven HR, Automation of tasks, Employee wellbeing, Mental health, Continuous learning and lifelong learning, Remote and hybrid work.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of organizational behaviour concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Introduction	Understand the fundamental concepts of organizational behavior and its significance in shaping organizational culture and performance.
2	The Individual and Learning	Analyse the impact of individual differences, learning processes, and decision-making on individual behavior within organizational settings.
3	Perception and Motivation	Explain how perception and motivation influence individual behaviour, and apply motivation theories to enhance employee performance.
4	The Groups, Conflict & Stress Management	Analyse group dynamics, decision-making processes, and conflict management strategies to enhance team effectiveness and organizational performance.
5	Principles of Communication	Develop effective communication strategies to facilitate information sharing, build relationships, and enhance organizational performance.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME705A.1	Interpret the organizational environment, including the impact of technology, globalization, diversity, ethics, and culture on organizational behaviour and performance.
M23BME705A.2	Apply learning theories to understand & predict individual behaviour within organizations.
M23BME705A.3	Apply the factors influencing perception and motivation to understand motivational

	theories and enhance organizational effectiveness.
M23BME705A.4	Analyze group dynamics, conflict, and stress within organizations, and develop strategies for effective group functioning and conflict management.
M23BME705A.5	Assess impact Effectively communicate within organizations and understand the impact of emerging trends, such as AI, automation, and remote work, on organizational behavior and human resources.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME705A.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705A.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705A.3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705A.4	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705A.5	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705A	3	3	-	-	-	-	-	-	-	-	-	-	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- AI and Human Interaction: The increasing role of AI in the workplace will necessitate a deeper understanding of how humans interact with technology and how to manage AI-driven teams. Organizational behavior will focus on developing strategies to optimize human-AI collaboration and address ethical implications.
- Remote and Hybrid Work: As remote and hybrid work models become more prevalent, the study of virtual teams, leadership styles, and employee engagement in these settings will be crucial. Organizational behavior will explore effective communication strategies, team building, and performance management in remote environments.
- Diversity, Equity, and Inclusion (DEI): Creating inclusive workplaces will continue to be a priority. Organizational behavior will delve deeper into understanding unconscious bias, cultural competence, and strategies for fostering equitable environments. Research on intersectionality and the experiences of marginalized groups will be essential.
- Employee Well-being and Mental Health: The impact of work-life balance, stress, and burnout on employee performance and organizational outcomes will be a focus. The impact of work-life balance, stress, and burnout on employee performance and organizational outcomes will be a focus.
- Sustainability and Corporate Social Responsibility: Understanding the relationship between organizational behavior and sustainability practices will become increasingly important. Research will focus on how to integrate sustainability into organizational culture and decision-making processes.

7th Semester	Professional Elective (PE) Total Quality Management	M23BME705B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics and Statistics	Basic knowledge of statistics is crucial for understanding data analysis, quality metrics, and performance measurement, all of which are integral to TQM.
2	Basic Management Principles	Understanding fundamental concepts of management, such as planning, organizing, leading, and controlling, helps in grasping how TQM fits into broader management practices.
3	Problem-Solving and Analytical Skills	Ability to analyze and solve problems is important for identifying and addressing quality issues.
4	Communication Skills	Effective communication is key to implementing TQM principles, as it involves coordinating with various teams and stakeholders.

2. Competencies

S/L	Competency	KSA Description
1	Fundamentals of Quality Management	**Knowledge:** Knowledge of key TQM concepts such as customer focus, continuous improvement, and employee involvement. **Skills:** Ability to analyse quality issues, interprets data, and develops effective solutions. **Attitudes:** A willingness to continuously seek opportunities for improvement and to embrace change as a means of enhancing quality.
2	Statistical and Analytical Methods	**Knowledge:** Understanding statistical tools and methods for quality control and improvement, including descriptive statistics, inferential statistics, and process capability analysis. **Skills:** Ability to use quality management and statistical software tools (e.g., Minitab, Excel) for data analysis and quality improvement. **Attitudes:** An openness to new ideas, techniques, and changes in quality management practices, with a flexible approach to adapting to evolving conditions

3. Syllabus

Total Quality Management SEMESTER –VII			
Course Code	**M23BME705B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

Students will be able to :

1. Understand various approaches to TQM
2. Understand the characteristics of quality leader and his role.
3. Develop feedback and suggestion systems for quality management.
4. Enhance the knowledge in Tools and Techniques of quality management

Module -1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements

Module -2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making

Module -3

Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies
Module -4
Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.
Module -5
Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance. Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS
TEXTBOOKS: 1. Total Quality Management Dale H. Besterfield Pearson Education India, Edition 03. ISBN: 8129702606, 2 Total Quality Management for Engineers M. Zairi Wood head Publishing ISBN:185573024 3 Managing for Quality and Performance Excellence James R. Evans and William M Lindsay Cengage Learning. 9th edition **REFERENCE BOOKS:** 1. Four revolutions in management Shoji Shiba, Alan Graham, David Walden Oregon 1990 2. Organizational Excellence through TQM H. Lal New age Publications 200864 Engineering Optimization Methods and Applications A Ravindran, K, M. Ragsdell Willey India Private Limited 2nd Edition,2006 3. Introductions to Operations Research- Concepts and Cases F.S. Hillier. G.J. Lieberman Tata McGraw Hill 9th Edition

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3:	Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements
2	Week 4-6:	Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making
3	Week 8-11:	Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies
4	Week 7-8:	Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.
5	Week 9-12:	Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance. Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of TQM concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	TotalMarks			**50**	**20**

FinalCIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME705B.1	Explain the various approaches of TQM
M23BME705B.2	Infer the customer perception of quality
M23BME705B.3	Analyse customer needs and perceptions to design feedback systems
M23BME705B.4	Apply statistical tools for continuous improvement of systems
M23BME705B.5	Apply the tools and technique for effective implementation of TQM

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME705B.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705B.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705B.3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705B.4	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705B.5	**3**	**-**	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705B	**3**	**3**	-	-	-	-	-	-	-	-	-	-	3	3

8. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

9. Future with this Subject:

The future of Total Quality Management (TQM) holds exciting opportunities and developments. As organizations continue to prioritize quality and efficiency, TQM principles and practices are likely to evolve and expand in several ways:

1. **Integration with Technology**: TQM will increasingly integrate with advanced technologies such as artificial intelligence, machine learning, and big data analytics. These technologies can enhance quality control processes, predict potential quality issues, and provide more detailed insights into performance metrics.
2. **Focus on Sustainability**: Quality management will likely emphasize sustainability and environmental responsibility. Organizations will integrate TQM practices with sustainable practices to reduce waste, improve resource efficiency, and meet regulatory requirements for environmental impact.
3. **Enhanced Customer Experience**: As customer expectations continue to rise, TQM will focus more on delivering exceptional customer experiences. This will involve using data-driven insights to anticipate customer needs and continually improve products and services.
4. **Global Standards and Compliance**: With globalization, TQM will adapt to international quality standards and compliance requirements. Organizations will need to align their quality management practices with global standards to operate effectively across different regions.

7th Semester	Professional Elective (PE) Engineering Economics	M23BME705C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Mathematics	Understanding of arithmetic, basic calculus and mathematics fundamentals are essential for economic calculations and financial analysis.
2	Critical thinking skills	The ability to critically evaluate financial data, identify assumptions and limitations of economic models, and choose the most suitable analysis method for a given problem.
3	Basic Engineering Principles	Understanding of cost estimation, project lifecycles, and basic engineering calculations.
4	Problem-solving skills	The ability to analyze engineering problems from a financial perspective and apply mathematical techniques to find optimal solutions.
5	Financial analysis skills	Understanding and applying time value of money concepts (present worth, future worth, annual worth) to evaluate investment options.
6	Communication	Clearly explain economic analysis findings verbally and in written reports.

2. Competencies

S/L	Competency	KSA Description
1	Introduction to engineering economics	**Knowledge:** Understand the principles of engineering economics. Learn the laws of demand and supply, elasticity, and the law of returns. Comprehend interest factors and cash flow diagrams. **Skills:** Analyze demand and supply curves. Calculate price and income elasticity. Solve problems involving simple and compound interest, personal loans, and EMI calculations. **Attitudes:** Develop a detail-oriented approach to economic analysis. Foster critical thinking in problem-solving and decision-making. Maintain an ethical perspective in economic evaluations.
2	Present-Worth and Future-Worth Comparisons	**Knowledge:** Understand conditions and methods for present-worth and future-worth comparisons. Learn about net present worth and payback comparisons. **Skills:** Perform present-worth and future-worth calculations. Compare assets with unequal and infinite lives. Solve related problems. **Attitudes:** Show precision in financial analysis. Maintain a critical perspective in evaluating investment options. Exhibit a methodical approach to financial evaluations
3	Equivalent Annual-Worth Comparisons	**Knowledge:** Learn methods and situations for equivalent annual-worth comparisons. Understand the comparison of assets with different lives. **Skills:** Conduct equivalent annual-worth comparisons. Solve problems related to asset comparison **Attitudes:** Maintain an analytical and meticulous attitude towards financial evaluations. Develop consistency in applying comparison methods. Encourage systematic problem-solving techniques.
4	Rate-of-Return Calculations and Depreciation	**Knowledge:** Understand the concepts of rate of return, IRR, and cost of capital. Learn methods of computing depreciation charges. **Skills:** Calculate IRR, minimum acceptable rate of return. Compute depreciation using straight line, declining balance, and sum of years methods. Solve related problems. **Attitudes:** Show critical thinking in financial decision-making. Maintain ethical considerations in financial reporting. Exhibit attention to detail in depreciation calculations.
5	Costing and Finance Functions	**Knowledge:** Know the components of costs and cost estimation methods. Understand financial statements, balance sheets, and profit and loss accounts. **Skills:** Estimate costs including marginal cost, first cost, and overheads. Analyze financial statements to derive financial information. Solve problems related to cost estimation and financial analysis. **Attitudes:** Develop an ethical approach to financial management. Maintain a detail-oriented perspective in cost estimation. Foster a professional attitude towards financial reporting and analysis.

3. Syllabus

Engineering Economics **SEMESTER – VII**			
Course Code	**M23BME705C**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

1. To analyze engineering economics decision making process and cash flow diagrams.
2. To compare the relevance of present worth and future worth comparisons.
3. To apply numerical techniques to solve problems on equivalent annual worth.
4. To discuss the concepts of investments using non-discounted and discounted cash flow and Evaluate depreciation problems.
5. To explain the various cost concepts, cost estimation methods.

Module -1

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems

Module -2

Present-Worth and Future worth Comparisons: Introduction, present worth method of comparison, Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present-worth, Assets with unequal lives, infinite lives, Discussions and problems.

Future -worth comparison, Payback comparisons, Discussions and problems

Module -3

Equivalent Annual-Worth Comparisons: Introduction, Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Problems.

Module -4

Rate-Of-Return Calculations and Depreciation: Rate of return, Minimum acceptable rate of return, IRR, ERR , IRR and misconceptions, Cost of capital concepts.

Depreciation: Introduction, Causes of Depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, Discussions and problems.

Module -5

Costing and Introduction to Scope of Finance Functions: Introduction to Costing , need of costing, Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, methods of costing, estimation of costs for simple components, idling time.

Statements of Financial Information: Introduction, Source of financial information, financial statements, Balance Sheet, Profit and loss account.

Text Books:

1. JAMES L RIGGS, Engineering Economy, Mcgraw Hill, 2002.
2. Engineering Economics, R. Paneerselvam, Eastern economic edition, PH1.
3. Engineering Economy, Tarachand, 2000.

Reference Books:

1. GERALD J THUESEN, Engineering Economy, Prentice-Hall-India, Pvt Ltd, 2002.
2. PRASANNA CHANDRA, Financial Management, Tata Mc Graw Hill, 2004.
3.Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons, 2000.

Web/Digital resources:

1. Engineering Economy, IEGR 350-summer 2017-M.Salimian.
2. Engineering Economy, IEEE Xplore, Richard Darin Ellis.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Fundamentals of Engineering Economics	Introduction to Engineering Economics: Meaning, scope, and importance. Problem-solving and decision-making. Laws of demand and supply. Equilibrium between demand & supply.
2	Week 3-4: Interest and Interest Factors	Interest and Interest Factors: Simple and compound interest. Cash flow diagrams. Personal loans and EMI payment calculation with flexible interest rates.
3	Week 5-6: Present-Worth and Future-Worth Comparisons	Present-worth comparisons, conditions, and equivalence. Net present-worth, asset comparisons with unequal and infinite lives. Payback comparisons.
4	Week 7-8: Equivalent Annual-Worth Comparisons	Methods and situations for equivalent annual-worth comparisons. Asset life consideration, comparison of assets with equal and unequal lives.
5	Week 9-10: Rate-of-Return Calculations and Depreciation	Rate of return, Minimum acceptable rate of return, IRR, ERR, Depreciation, Causes of Depreciation and methods of computing depreciation charges
6	Week 11-12: Costing and Financial Statements	Cost components, selling price estimation, marginal cost, overheads, indirect cost estimation. Introduction to financial statements, sources, balance sheet, and profit and loss account.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Collaborative Learning	Encourage collaborative learning for improved competency application.
3	Project-Based Learning	Assign projects where students calculate and compare the EA-W of different investment options for a chosen engineering scenario.
4	Group Discussions	Facilitate discussions on the strengths and limitations of each method (PW vs. FW) for different scenarios.
5	Visual Aids	Utilize charts, graphs, and financial calculators to illustrate PW and FW calculations and interpretations.
6	Real-World Application	Discuss real-world examples of how economic principles like demand, supply, elasticity, and interest impact engineering decisions.
7	In-class Calculations	Guide students through calculations of internal rate of return (IRR) using different methods.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.

2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding the Economic & Financial Concepts	Define and recall key economic principles (demand, supply, elasticity) and financial terminology (present worth, interest, depreciation).
2	Time Value of Money	Grasp the significance of considering the time value of money when evaluating project costs and benefits.
3	Cost Components	Differentiate between various cost categories (fixed, variable, marginal, overhead) in engineering project analysis.
4	Financial Analysis Technique	Apply methods like present worth (PW), future worth (FW), equivalent annual worth (EA-W), and internal rate of return (IRR) to compare investment options for engineering projects
5	Depreciation Methods	Utilize different depreciation methods (straight line, declining balance, sum-of-years-digits) to calculate depreciation charges for assets.
6	Project Cost Estimation & Analyze Financial Impact	Estimate selling price based on cost factors and desired profit margin, and construct cash flow diagrams to represent project costs and benefits over time. Evaluate the impact of factors like project life, cost structure, and interest rates on the results of financial analysis.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME705C.1	**Interpret** the engineering economics decision making process and cash flow diagrams.
M23BME705C.2	**Compare** the relevance of present worth and future worth comparisons.
M23BME705C.3	**Apply** numerical techniques to solve problems on equivalent annual worth.
M23BME705C.4	**Analyse** the concepts of investments using non-discounted and discounted cash flow and Evaluate depreciation problems.
M23BME705C.5	**Estimates** the various cost concepts, cost estimation methods and financial concept.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME705C.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME705C.2	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705C.3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705C.4	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705C.5	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME705C	**3**	**3**	-	-	-	-	-	-	-	-	-	-	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

With a comprehensive understanding of the subject, students will be well-prepared for a variety of career paths and practical applications in both engineering and economic fields. Here's a look at the future opportunities for students who study these topics

Financial Reporting Competence: Ability to prepare and analyze financial statements prepares students for careers in accounting, auditing, and financial consulting.

Enhanced Decision-Making Skills: Students will develop strong problem-solving and decision-making abilities, essential for roles such as Project Managers and Engineering Economists.

Market Analysis Proficiency: Understanding demand, supply, and elasticity enables students to analyze market trends, forecast demand, and set strategic pricing, valuable in business development and market research roles.

Financial Planning Expertise: Proficiency in interest calculations, cash flow analysis, and EMI payments prepares students for careers in financial planning, banking, and investment analysis.

Asset Management Abilities: Understanding depreciation methods and asset life management helps students manage company assets effectively, useful for roles in accounting and asset management.

Cost Management Knowledge: Skills in costing, including estimating selling prices and overheads, are critical for cost management, financial controlling, and strategic pricing roles.

7th Semester	Professional Elective (PE) Operations management	M23BME705D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Fundamental Business Knowledge	Understanding basic business principles, management functions, and organizational behaviour.
2	Mathematics and Statistics	Proficiency in basic mathematics and statistical methods for data analysis, forecasting, and decision-making.
3	Introduction to Management	Basic knowledge of management principles, including planning, organizing, leading, and controlling.
4	Basic Economics	Understanding of economic principles such as supply and demand, cost analysis, and market structures.
5	Information Technology	Familiarity with basic IT tools and software, including spreadsheets and databases.

2. Competencies

S/L	Competency	KSA Description
1	Operational Efficiency	**Knowledge**: Understanding of various production systems, productivity factors, and operations management functions. **Skills**: Ability to analyse and improve operational processes to enhance efficiency. **Attitudes**: Commitment to continuous improvement and operational excellence.
2	Strategic Forecasting and Decision-Making	**Knowledge**: Familiarity with forecasting techniques, decision-making models, and their applications in operations. **Skills**: Proficiency in using forecasting tools and decision-making models to make informed operational decisions. **Attitudes**: Analytical mind-set and readiness to base decisions on data-driven insights.
3	Capacity and Location Planning	**Knowledge**: Insight into capacity planning methods, location decision criteria, and facilities layout principles. **Skills**: Ability to evaluate capacity requirements, make location decisions, and design effective facility layouts. **Attitudes**: Strategic thinking and attention to detail in planning and decision-making processes.
4	Aggregate Planning and Scheduling	**Knowledge**: Understanding of aggregate planning strategies, master scheduling, and production planning techniques. **Skills**: Capability to develop and manage aggregate plans, create master schedules, and apply various planning techniques. **Attitudes**: Focus on aligning production plans with organizational goals and market demands.
5	Material Requirement Planning (MRP) and Supply Chain Management (SCM)	**Knowledge**: Knowledge of MRP systems, inventory management, and SCM principles. **Skills**: Ability to implement MRP systems, manage inventory effectively, and optimize supply chain processes. **Attitudes**: Commitment to efficient resource utilization and effective supply chain management.

3. Syllabus

Operations Management SEMESTER – VII			
Course Code	**M23BME705D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Course Objectives:			

1. To Understand Fundamental Operations Management Concepts
2. To Develop Decision-Making Skills in Operations
3. To Equip Students with Forecasting Techniques
4. To Analyze and Plan for Capacity and Location Decisions
5. To Introduce and Apply Aggregate Planning and Scheduling Techniques
6. To Understand and Implement Material Requirement Planning (MRP) and Supply Chain Management

Module -1

Introduction: Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity. **Decision Making:** The decision process, characteristics of operations decisions, use of models, decision-making environments, graphical linear programming, analysis and trade-offs.

Module -2

Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast.

Module -3

Capacity & Location Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout – need for layout decisions, types of processing.

Module -4

Aggregate Planning & Master Scheduling: Aggregate planning – Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning – graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

Module -5

Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP – MRP inputs and outputs, MRP processing, ERP capacity requirement planning, benefits and limitations of MRP. **Purchasing and Supply Chain Management (SCM):** Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.

Textbooks:

1. "Operation Management, Author- Joseph G Monks McGrew Hill Publication, International Edition-1987.
2. "Production and Operation Management" ,Author-Pannerselvam R. PHI publications, 2nd edition
3. "An Introductory book on lean System, TPS Yasuhiro Modern.

Reference books:

1. "Production and Operation Management" Chary S. N. Tata McGraw Hill 3rd edition.
2. "Production and Operations Management", Everett E. Adams, Ronald J. Ebert, Prentice Hall of India Publications, Fourth Edition.
3. Modern Production/Operations Management, Buffia, Wiely India Ltd 4th Edition.

5. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	**Week 1-2:** Introduction to Operations Management	Functions within business organizations, the role of operations management, classification of production systems, productivity, and factors affecting productivity. Decision-making process and use of models.
2	**Week 3-4:** Decision-Making in Operations	Characteristics of operations decisions, decision-making environments, graphical linear programming, analysis and trade-offs.
3	**Week 5-6:** Forecasting	Steps in the forecasting process, judgment and opinion-based forecasts. Introduction to time-series data-analysis and accuracy control, Choosing forecasting techniques, elements of a good forecast, and detailed analysis of time series methods.
4	**Week 7-8:** Capacity Planning-Part 1	Importance of capacity decisions, defining and measuring capacity, and determinants of effective capacity. Introduction to developing capacity alternatives.

5	**Week 9-10:** Capacity Planning - Part 2	Evaluating capacity alternatives, importance of location decisions, and general procedures for making location decisions.
6	**Week 11-12:** Facilities Layout and Aggregate Planning- Part 1	Types of processing, need for layout decisions, and different types of facility layouts, Nature and scope of aggregate planning, strategies of aggregate planning, and graphical techniques
7	**Week 13-14:** Aggregate Planning - Part 2 and Material Requirement Planning- Part-1	Mathematical techniques for aggregate planning, introduction to master production scheduling, and master scheduling methods, Overview of MRP, dependent vs. independent demand, and MRP inputs and outputs.
8	**Week 15-16:** Material Requirement Planning (MRP) - Part 2 and Purchasing and Supply Chain Management (SCM)	MRP processing, ERP capacity requirement planning, benefits and limitations of MRP, Introduction to SCM, importance of purchasing, and the procurement process, Concept of tenders, approaches to SCM, and vendor development.

6. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lectures and Presentations	Deliver theoretical concepts and frameworks through lectures supported by presentations. Use visual aids, slides, and real-world examples to explain complex topics.
2	Case Studies	Analyse real-life case studies to apply theoretical concepts. Facilitate group discussions to enhance understanding of practical applications and decision-making in operations management.
3	Hands-on Exercises	Implement practical exercises, such as simulations and software tools, to practice forecasting, capacity planning, and scheduling techniques. Provide opportunities for students to work on problem-solving tasks.
4	Group Projects	Assign group projects that require students to collaboratively work on operational problems, develop solutions, and present their findings. This fosters teamwork and application of course concepts.
5	Guest Lectures and Industry Experts	Invite guest lecturers or industry experts to provide insights into current trends and real-world challenges in operations management. Encourage students to interact and ask questions.
6	Quizzes and Assessments	Use quizzes, mid-term assessments, and assignments to evaluate students' understanding of key concepts. Provide feedback to help students improve their grasp of the material.

7. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

5. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
6. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
7. The students have to answer 5 full questions selecting one full question from each module.
8. Marks scored will be proportionally scaled down to 50 marks

8. Learning Objectives

S/L	Learning Objectives	Description
1	Understand Core Concepts Description	Gain a comprehensive understanding of core concepts in operations management, including production systems, productivity, decision-making processes, and forecasting techniques.
2	Apply Forecasting Techniques	Develop the ability to apply various forecasting methods to predict future trends and make data-driven decisions in operations planning.
3	Conduct Capacity and Location Planning	Learn to assess and plan for capacity requirements and make informed location decisions that optimize operational efficiency and resource utilization.
4	Implement Aggregate Planning and Scheduling	Acquire skills to create and manage aggregate plans and master production schedules, using both graphical and mathematical techniques to align production with demand.
5	Utilize Material Requirement Planning and Supply Chain Management	Understand and apply Material Requirement Planning (MRP) systems and principles of Supply Chain Management (SCM) to enhance inventory control, procurement, and overall supply chain efficiency.

9. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BME705D.1	Comprehend and articulate fundamental principles of operations management, such as productivity, decision-making processes, and production systems.
M23BME705D.2	Implement various forecasting methods and techniques to generate accurate predictions and make informed operational decisions.
M23BME705D.3	Critically assess capacity requirements and location planning decisions, evaluating their impact on operational efficiency and effectiveness.
M23BME705D.4	Assess and review different aggregate planning and scheduling techniques, selecting the most appropriate methods based on specific operational needs.
M23BME705D.5	Develop and design effective Material Requirement Planning (MRP) systems and supply chain management strategies to optimize inventory control and procurement processes.

CO-PO-PSO Mapping

Co's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME705D.1	3	-	-	-	-	-	-	-	-	-	2	-	-	2
M23BME705D.2	-	3		-	-	-	-	-	-	-	-	-	3	-
M23BME705D.3	-	-	3	-	-	-	-	-	2	-	3	-	-	-
M23BME705D.4	-	-	3	-	2	3	-	-	-	2	-	-	-	-
M23BME705D.5	-	-	-	3	-	-	2	2	3	-	-	2	-	3
M23BME705D	3.0	3.0	3	2.5	2	3.0	2.0	2.0	2.5	2.0	2.5	2.0	3.0	2.5

10. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	10%	10%				20%
Module 2	5%	5%		10%		20%
Module 3		5%		5%	10%	20%
Module 4			20%			20%
Module 5	5%			5%	10%	20%
Total	20%	20%	20%	20%	20%	100%

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	10%	10%				20%
Module 2	5%	5%		10%		20%
Module 3		5%		5%	10%	20%
Module 4			20%			20%
Module 5	5%			5%	10%	20%
Total	20%	20%	20%	20%	20%	100%

11. Future with this Subject:

- **Adoption of Advanced Technologies:** AI and machine learning are increasingly being used for predictive analytics, process optimization, and automation in operations management. These technologies enable real-time decision-making and enhance efficiency **(Artificial Intelligence (AI) and Machine Learning) and /or** IoT technology connects devices and systems, providing valuable data for improving operational processes, monitoring equipment health, and optimizing supply chains (**Internet of Things (IoT))**
- **Sustainable and Green Operations:** There is a growing emphasis on sustainability and environmental responsibility in operations management. Companies are adopting green practices such as reducing waste, optimizing resource use, and implementing energy-efficient technologies (**Sustainable Practices) and /or** the circular economy model focuses on reusing, recycling, and reducing waste. Operations management is evolving to incorporate these principles, aiming for a more sustainable and closed-loop production system **(Circular Economy)**
- **Supply Chain Digitalization:** Block-chain is being utilized to enhance transparency, traceability, and security in supply chains. It helps in tracking the origin of products, ensuring compliance, and reducing fraud **(Block-chain Technology)** and / or Big data analytics and advanced data visualization techniques are transforming supply chain management by providing deeper insights and enabling better decision-making **(Advanced Analytics)**
- **Customization and Personalization:** Operations management is shifting towards enabling mass customization, allowing companies to offer personalized products and services while maintaining efficient production processes **(Mass Customization)** and /or There is a focus on understanding and responding to individual customer preferences and demands, which requires flexible and responsive operational strategies **(Customer-Centric Strategies)**
- **Agility and Resilience:** The need for agility in operations management has become more critical, especially in response to market fluctuations and disruptions. Agile methodologies and practices is being adopted to enhance flexibility and responsiveness **(Agile Operations)** and / or **Building** resilience against disruptions, such as supply chain interruptions or market volatility, is a key focus. Strategies include diversifying suppliers, building redundancies, and enhancing risk management **(Resilience Building)**
- **Human-Centric Operations:** The future of operations management involves investing in workforce development, focusing on upskilling employees, and integrating human expertise with technological advancements **(Workforce Development)** and /or Emphasis on creating collaborative and innovative work environments that foster teamwork and continuous improvement **(Collaborative Work Environments)**
- **Integration of Digital Twins:** Digital twins, which are virtual replicas of physical assets or systems, are being used for simulation, monitoring, and optimization of operations. They help in predicting performance and identifying potential issues before they occur **(Digital Twin Technology).**
- **Ethical and Social Responsibility:** Ensuring ethical sourcing and fair labor practices are becoming integral to operations management. Companies are focusing on ethical supply chains and corporate social responsibility (CSR) initiatives **(Ethical Sourcing)** and / or Emphasizing diversity and inclusion in the workplace and operational practices to create equitable and supportive environments **(Diversity and Inclusion)**

7th Semester	Professional Core Laboratory (PCL) DESIGN LABORATORY	M23BMEL706

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Engineering Mechanics	Understanding of statics, dynamics, and strength of materials is crucial for analyzing forces and stresses in machine components.
2	Material Science	Knowledge of material properties, selection, and processing is essential for choosing appropriate materials for different components.
3	Engineering Drawing	Proficiency in reading and interpreting engineering drawings is necessary for visualizing and communicating design ideas.
4	Machine Design Theory	A solid grasp of design principles, calculations, and failure theories is required for making informed design decisions.
5	Experimental skills	Basic laboratory skills, including data collection, analysis, and interpretation, are essential for conducting experiments.

2. Competencies

S/L	Competency	KSA Description
1	Mechanical Vibration	**Knowledge:** Understanding of vibration parameters like Wave motion, resonance, damping, vibration modes, forced vibration, and random vibration. **Skill:** Ability to analyze vibration data to identify problems and solutions. **Attitude:** Ability to break down complex vibration problems into manageable components.
2	Balancing of rotating masses	**Knowledge:** Understanding of balancing principles and techniques **Skill: Skill** in performing calculations and analysis related to balancing. **Attitude:** Analytical thinking to analyze vibration data and determine corrective actions.
3	Journal Bearing	**Knowledge:** Understanding of Bearing types, lubrication systems, alignment **Skill:** Test setup, data analysis, test equipment operation, report generation. **Attitude:** Problem-solving, manual dexterity, attention to detail, teamwork.
4	Strain gauge	**Knowledge:** Understanding of how strain gauges work, including the relationship between strain and resistance. **Skill:** Skill in using data acquisition systems to collect strain data. **Attitude:** Ability to interpret strain data and draw conclusions.
5	Polariscope	**Knowledge:** Understanding of light, polarization, birefringence, and other relevant optical phenomena. **Skill:** Ability to interpret polariscope images and measurements. **Attitude: Attention to detail:** Necessary for accurate observations and measurements.

3. Syllabus

DESIGN LAB SEMESTER – VII			
Course Code	M23BMEL706	CIE Marks	50
Number of Lecture Hours/Week (L: T: P: S)	(0:0:2:0)	SEE Marks	50
Total Number of Lecture Hours	15 Sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	Practical		

Course objectives: This course will enable students to:

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.

- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.
- To visualize different mechanisms and cam motions
- Modern computing techniques are preferred to be used wherever possible

Sl. No	Experiments
	PART A
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional).
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter Governor.
	PART B
5	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending).
6	Determination 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.
7	Determination of Pressure distribution in Journal bearing
8	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain gauge.
9	Determination of stresses in Curved beam using strain gauge.

Text Books:

1. Shigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGrawHill Education 10th Edition, 2015.
2. Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007 Wiley student edition.
3. Design of Machine Elements V. B. Bhandari Tata Mcgraw Hill 4th Ed 2016.

Web links:

1. https://en.wikipedia.org/wiki/Machine_element
2. www.nptel.ac.in
3. https://cosmolearning.org
4. www.vtu.ac.in
5. http://nevonprojects.com/miniprojectsformechanicalengineering/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	• Introduction to Design Lab • Determination of various parameters in a single degree of freedom vibrating systems (longitudinal and torsional)
2	Week 3-4	• Determination of unknown mass and angle for Balancing of rotating masses. • Determination of critical speed of a rotating shaft
3	Week 5-6	• Determination of equilibrium speed, sensitiveness, power and effort of Porter Governor. • Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression.
4	Week 7-8	• Determination of Fringe constant of Photo-elastic material using. b) Pure bending specimen (four-point bending). • Determination 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.
5	Week 9-10	• Determination of Pressure distribution in Journal bearing • Determination of Principal Stresses and strains in a member subjected to combined loading using Strain gauge.

6	Week 11-12	• Determination of stresses in Curved beam using strain gauge. • Internal Assessment

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Pre-Lab Sessions**	Discussions on the theoretical concepts relevant to the specific lab experiment. This could cover topics like: • The principles of vibrations, Dynamics of machines, Machine design and experimental stress analysis. • Operation and functionalities of the strain measuring instruments used in the experiment and Calibration methods.
2	**Pre-Lab Readings**	Students are assigned relevant readings from lab manuals, to make their understanding before entering the lab.
3	**Experimentation**	Students work in groups or individually to perform the assigned experiments as outlined in the lab manual. This involves: • Setting up the instruments according to the procedure. • Taking readings of the designated objects or parameters. • Recording data meticulously. • Performing calculations based on the collected data. • Analyzing the results and interpreting their meaning.
4	**Demonstration & Guidance**	Lecturer providing guidance and assistance to students as needed. This could involve: • Demonstrating proper use of the instruments. • Addressing questions and troubleshooting any issues encountered. • Ensuring students adhere to safety protocols.
5	**Lab Reports, conclusion & Inference**	Students prepare reports summarizing their lab experience. These reports typically include: • Objectives of the experiment. • Description of the procedure followed. • Recorded data in tables or graphs. • Calculations performed and analyzed results. • Discussion of observations, sources of error, and conclusions drawn

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation

- CIE marks for a practical course shall be 50 marks.
- The split up of CIE marks for record/journal and test to be split in the ratio 60:40
- Record write up for individual experiment will be evaluated for 10 Marks
- Total marks scored for record writing and conduction shall be scaled downed to 30 marks (60% of maximum marks)
- One test for 100 marks after the completion of the experiments at the end of the semester

Test

Marks distribution for Experiment based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	60
2	Viva-Voce	40%	40
Total		**100%**	**100**

The Test marks should be scaled down to 20marks (40% of the **maximum CIE Lab Marks (50)**)

Final CIE in Practical Course:

Marks distribution for Experiment based Practical Course for Final CIE

Sl. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record/journal	60% of the maximum	30
2	Scaled Down marks of test	40% of the maximum	20
Total		**100%**	**50**

SEE for practical Course (Irrespective of Experiment or program based):

1. SEE marks for practical course shall be 50 marks

Marks distribution for Experiment based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
4. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Hands-on experience	Develop practical skills in designing, analyzing, and manufacturing machine components.
2	Problem-solving	Apply theoretical knowledge to real-world engineering problems and develop effective problem-solving strategies.
3	Design process	Understand the complete design process from conceptualization to prototyping and testing.
4	Experimental techniques	Conduct experiments to validate design calculations and gather data for analysis.
5	Report writing	Effectively communicate design process, results, and conclusions through technical reports.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BMEL706.1	Apply the various principles of design and demonstrate the experiment for given problem under study, report the details of experiment.
M23BMEL706.2	Determine the required parameter using suitable formulas based on the tabulated readings
M23BMEL706.3	Analyze the key inputs and outcomes of experiment on the given problem scenario, infer the correctness of the selected parameters based on efficacy of solution.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BMEL706.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BMEL706.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BMEL706.3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BMEL706	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Total	**20**	**15**	**15**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Total	**20**	**15**	**15**	**50**

10. Future with this Subject

A strong foundation in machine design laboratory opens up a wide range of promising career paths. This practical experience equips students with the skills to analyze, design, and optimize mechanical components and systems.

Potential Career Paths

Here are some of the industries and roles that a machine design laboratory graduate can explore:

Automotive Industry

- **Vehicle Design Engineer:** Designing various components like engines, transmissions, suspension systems, and body structures.
- **Manufacturing Engineer:** Overseeing the production process of automotive parts and assemblies.
- **Quality Control Engineer:** Ensuring product quality and reliability.

Aerospace Industry

- **Aircraft Design Engineer:** Working on the design and development of aircraft components and systems.
- **Aerospace Manufacturing Engineer:** Involved in the production of aerospace components.

Manufacturing Industry

- **Product Design Engineer:** Designing consumer products, industrial machinery, and other manufactured goods.
- **Process Engineer:** Optimizing manufacturing processes for efficiency and quality.

Research and Development

- **Research Engineer:** Conducting research on new materials, manufacturing techniques, and design methodologies.
- **Design Engineer:** Developing innovative products and solutions.

Other Industries

- **Robotics:** Designing and developing robotic systems.
- **Biomedical Engineering:** Developing medical devices and equipment.
- **Energy Sector:** Designing components for renewable energy systems.

Skills Gained in Machine Design Laboratory

The skills acquired in a machine design laboratory are highly valuable to employers:

- **Problem-solving:** Identifying and resolving complex design challenges.
- **Analytical skills:** Analyzing design parameters and making informed decisions.
- **Practical skills:** Applying theoretical knowledge to real-world applications.
- **CAD/CAM proficiency:** Using computer-aided design and manufacturing software.
- **Material science knowledge:** Understanding material properties and their impact on design.
- **Manufacturing process knowledge:** Familiarity with various manufacturing techniques.

Importance of Continuous Learning

The field of engineering is constantly evolving. Therefore, it's essential for graduates to stay updated with the latest technologies and industry trends through:

- **Continuing education:** Pursuing advanced degrees or certifications.
- **Professional development:** Attending conferences, workshops, and webinars.
- **Industry networking:** Building relationships with professionals in the field.

By combining a strong foundation from the machine design laboratory with continuous learning, graduates can build successful and fulfilling careers in various engineering domains.

7th Semester	Project Work (PW) MAJOR PROJECT PHASE-II	M23BXX707

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Project Planning and Management	Basic understanding of project management principles, acquired from earlier project work and theoretical courses.
2	Experimental Design and Analysis	Knowledge of experimental techniques and data analysis from core and elective courses.
3	Technical Documentation	Competence in technical writing and report drafting.
4	Application of Theoretical Knowledge	Strong foundation in the relevant engineering principles.
5	Team Collaboration	Experience in group projects and collaborative learning environments.

2. Competencies

S/L	Competency	KSA Description
1	Project Execution	**Knowledge:** Understanding of project planning, scheduling, and resource management. **Skill:** Ability to carry out practical work systematically and efficiently. **Attitude:** Proactive and solution-oriented approach to problem-solving.
2	Data Analysis	**Knowledge:** Advanced knowledge of data analysis techniques. **Skill:** Proficiency in interpreting and analyzing experimental data. **Attitude:** Analytical mindset with a focus on accuracy.
3	Technical Communication	**Knowledge:** Mastery of technical documentation standards. **Skill:** Ability to draft comprehensive project reports. **Attitude:** Precision and clarity in communication.
4	Presentation Skills	**Knowledge:** Understanding of audience engagement techniques. **Skill:** Ability to deliver clear and impactful presentations. **Attitude:** Confidence and professionalism in public speaking.
5	Collaboration	**Knowledge:** Awareness of effective teamwork strategies. **Skill:** Ability to work collaboratively in multidisciplinary teams. **Attitude:** Respect and openness to diverse perspectives.

3. Project Timeline

S/L	Timeline	Description
1	**Week 1-2**	Review of problem statement and project plan; setting milestones.
2	**Week 3-4**	Experimental setup and initial trials.
3	**Week 5-6**	Data collection and analysis; troubleshooting.
4	**Week 7-8**	Progress review and mid-term evaluation.
5	**Week 9-10**	Refinement of experiments and final data analysis.
6	**Week 11-12**	Drafting the final report.
7	**Week 13-14**	Presentation preparation and practice.
8	**Week 15**	Final project presentation and submission of the report.

4. Course Objectives

- To execute the project work based on the defined problem statement.
- To develop skills in practical application, experimentation, and analysis.
- To enhance project management, report writing, and presentation skills.

5. Assessment Details (both CIE and SEE)

CIE procedure for Project Work Phase-II:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the
Department, one of whom shall be the Guide.
The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work Phase-II: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

6. Learning Objectives

S/L	Learning Objectives	Description
1	To execute the project plan effectively.	Students will apply their theoretical knowledge to practical tasks, managing the project from start to finish.
2	To analyze data and refine project outcomes.	Students will enhance their skills in data interpretation and problem-solving.
3	To document and present the project work comprehensively.	Students will develop a final report and presentation that reflects their project work accurately.

7. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BXX707.1	Successfully execute the project plan and achieve the defined objectives.
M23BXX707.2	Analyze and interpret experimental data to derive meaningful conclusions.
M23BXX707.3	Demonstrate the ability to apply engineering and management principles effectively within a team, managing project timelines, resources, and deliverables to achieve project goals.
M23BXX707.4	Prepare and present a comprehensive project report.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BXX707.1			3		3				3		3		3	3
M23BXX707.2	3	3		3		3					3		3	3
M23BXX707.3			3				3						3	3
M23BXX707.4								3		3	3	3	3	3
M23BXX707	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

8. Future with this Subject

This phase solidifies the student's ability to independently execute complex engineering projects. The experience gained here is directly transferable to their future academic endeavors, and professional roles in engineering.

8th Semester

8th Semester	Seminar (SR) TECHNICAL SEMINAR	M23Bxx803

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Research and Information Gathering	Familiarity with academic research and access to digital libraries or databases.
2	Content Organization and Report Writing	Basic knowledge of report writing, including the use of Microsoft Word, equation editors, and drawing tools.
3	Technical Presentation Skills	Experience with PowerPoint or other presentation software, as well as fundamental public speaking skills.
4	Critical Thinking and Discussion	Experience in group discussions and the ability to analyze and critique technical content.
5	Originality and Integrity in Work	Understanding the importance of originality in academic work.

2. Competencies

S/L	Competency	KSA Description
1	Effective Research and Literature Review	**Knowledge:** Familiarity with technical literature, research databases, and citation practices. **Skill:** Ability to conduct a thorough literature review and identify key sources of information. **Attitude:** Curiosity and a proactive approach to learning.
2	Report Writing and Documentation	**Knowledge:** Understanding of technical writing formats, structure, and referencing. **Skill:** Proficiency in using word processors, equation editors, and drawing tools to create clear and concise reports. **Attitude:** Attention to detail and commitment to producing high-quality, original work.
3	Presentation and Communication	**Knowledge:** Understanding of effective communication techniques and presentation design. **Skill:** Ability to deliver clear, engaging presentations using visual aids. **Attitude:** Confidence and professionalism in public speaking.
4	Critical Engagement and Discussion	**Knowledge:** Familiarity with group discussion dynamics and debate techniques. **Skill:** Ability to engage with peers, ask relevant questions, and respond thoughtfully to feedback. **Attitude:** Openness to different viewpoints and willingness to engage in constructive criticism.
5	Ethical Standards and Academic Integrity	**Knowledge:** Understanding of the principles of academic honesty and the consequences of plagiarism. **Skill:** Ability to produce original work and properly cite all sources. **Attitude:** Integrity and responsibility in academic work.

3. Timeline

S/L	Timeline	Description
1	**Week 1-2:** Topic Selection and Literature Review	Students will select a seminar topic relevant to their specialization and conduct a literature review to gather information.
2	**Week 3-4:** Content Organization and Report Drafting	Organize the gathered information into a coherent structure and begin drafting the seminar report.
3	**Week 5:** Report Writing and Formatting	Focus on refining the report, ensuring proper formatting, citation, and use of tools like equation editors and drawing tools.
4	**Week 6:** Presentation Preparation	Prepare the PowerPoint slides and practice the oral presentation, focusing on clarity and engagement.
5	**Week 7:** Seminar Presentation and	Deliver the seminar presentation, engage in a Q&A session, and participate in group discussions.

	Discussion	
6	**Week 8:** Report Submission and Final Evaluation	Submit the final report and undergo a comprehensive evaluation by the faculty committee.

5. Assessment Details

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Technical Seminar shall be based on the evaluation of the report, presentation skill, and question and answer session in the ratio of 50:25:25.

6. Learning Objectives

S/L	Learning Objectives	Description
1	Conduct In-Depth Research on a Technical Topic	Students will learn to independently research a technical topic, gather and analyse information, and synthesize it into a coherent understanding.
2	Develop and Deliver a Technical Presentation	Students will gain experience in creating and delivering professional technical presentation, enhancing their communication skills.
3	Engage in Technical Discussions and Debates	Students will enhance their critical thinking and discussion skills by engaging with peers in technical debates.
4	Prepare a Detailed Technical Report	Students will learn to write a detailed, well-organized technical report, ensuring proper citation and originality.

7. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BXX803.1	Conduct comprehensive research and organize technical content for a seminar presentation.
M23BXX803.2	Prepare and deliver a clear and engaging technical presentation using appropriate tools and techniques.
M23BXX803.3	Engage in technical discussions, respond to queries, and participate in group debates effectively.
M23BXX803.4	Produce a well-structured, original technical report with proper citations and references.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BXX803.1	3	-	-	-	-	-	-	-	-	-	-	-	3	3
M23BXX803.2	-	3	-	-	-	-	-	-	-	-	-	-	3	3
M23BXX803.3	-	-	3	-	-	-	-	-	-	-	-	-	3	3
M23BXX803.4	-	-	-	3	-	-	-	-	-	-	-	-	3	3
M23BXX803	3	3	3	3	-	-	-	-	-	-	-	-	3	3

8th Semester	Internship (IS) INTERNSHIP	M23Bxx804

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Understanding of fundamental concepts in the chosen field of study.	Successful completion of core courses related to the field of study.
2	Ability to analyze and solve complex problems using discipline-specific methodologies.	Analytical and problem-solving skills gained through prior coursework and lab work.
3	Capability to conduct independent research or work effectively within an industrial setup.	Experience with project-based learning or relevant coursework that involved team collaboration.
4	Communication and technical writing for the preparation of reports and presentations.	Courses in communication skills and technical writing.
5	Understanding of ethical, social, and environmental responsibilities in professional practices.	Knowledge of professional ethics and sustainable practices.

2. Competencies

S/L	Competency	KSA Description
1	Research Methodology	**Knowledge:** Understanding of current research trends and methodologies in the chosen field. **Skill:** Ability to design and conduct experiments or studies, analyze data, and draw conclusions. **Attitude:** Curiosity and commitment to scientific inquiry and continuous learning.
2	Practical Application	**Knowledge:** Familiarity with industry standards and practical applications of theoretical concepts. **Skill:** Ability to apply theoretical knowledge to solve real-world problems in an industrial or rural context. **Attitude:** Adaptability and willingness to learn from real-world experiences.
3	Presentation and Communication	**Knowledge:** Understanding of effective communication techniques and presentation design. **Skill:** Ability to deliver clear, engaging presentations using visual aids. **Attitude:** Confidence and professionalism in public speaking.
4	Communication and Presentation	**Knowledge:** Techniques for effective communication, both written and oral. **Skill:** Ability to prepare and present technical reports and presentations. **Attitude:** Confidence in public speaking and openness to feedback.
5	Teamwork and Collaboration	**Knowledge**: Principles of team dynamics and collaborative working. **Skill**: Ability to work effectively as part of a team, contributing to shared goals. **Attitude**: Cooperative mindset and respect for diverse perspectives.
6	Professionalism and Ethics	**Knowledge**: Understanding of professional ethics and legal responsibilities. **Skill**: Ability to make ethical decisions and demonstrate professional behavior in all activities. **Attitude**: Integrity and responsibility in professional conduct.

3. Assessment Details

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide/Mentor. The CIE marks awarded for the Internship shall be based on the evaluation of the report, presentation skill, and question and answer session in the ratio of 50:25:25.

4. Learning Objectives

S/L	Learning Objectives	Description
1	Understand and Apply Research Methodologies or Industry Practices	Students will gain an understanding of current research methodologies in their chosen field or industry practices in the professional setting. They will learn how to apply these methodologies or practices to real-world problems, fostering their ability to conduct independent research or contribute effectively in an industrial environment.
2	Develop Problem-Solving Skills in Real-World Contexts	Students will enhance their problem-solving abilities by working on practical issues encountered in research, industry, or rural settings. They will learn to analyze complex problems, develop viable solutions, and implement them effectively.
3	Improve Communication and Technical Writing Skills	Students will refine their communication skills, both in writing and orally. They will learn how to prepare clear and concise technical reports and deliver presentations that effectively communicate their findings and ideas to diverse audiences.
4	Foster Teamwork and Collaborative Skills	Through collaborative projects, students will develop their ability to work effectively in teams. They will learn how to contribute to group efforts, manage interpersonal dynamics, and achieve shared goals in a professional environment.
5	Cultivate Professionalism and Ethical Responsibility	Students will understand the importance of professionalism and ethical behavior in their work. They will learn to make responsible decisions that consider the broader social, environmental, and ethical implications of their actions.

5. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BXX804.1	Demonstrate the ability to apply research methodologies or industry practices to solve complex problems in a real-world context.
M23BXX804.2	Develop and implement effective solutions to technical challenges encountered during the internship, showcasing problem-solving skills.
M23BXX804.3	Communicate technical information clearly and effectively through well-structured reports and presentations.
M23BXX804.4	Demonstrate knowledge and understanding of engineering and management principles, applying them in a team to manage projects in multidisciplinary environments.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BXX804.1	3	-	-	-	-	-	-	-	-	-	-	-	3	3
M23BXX804.2	-	3	-	-	-	-	-	-	-	-	-	-		3
M23BXX804.3	-	-	3	-	-	-	-	-	-	-	-	-	3	3
M23BXX804.4	-	-	-	3	-	-	-	-	-	-	-	-	3	3
M23BXX804	3	3	3	3	-	-	-	-	-	-	-	-	3	3