



# **BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT**

(Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE New Delhi)

Yelahanka, Bengaluru 560119



**Bachelor of Engineering**

**Department of Mechanical Engineering**

**VII Semester Scheme and Syllabus  
2022 Scheme  
Effective from the AY2025-26  
2022 Batch**

Approved in the BoS meeting held on 14.08.2025

## **Vision and Mission of the Department**

### **Vision**

To establish a hub of excellence in diverse field of Mechanical Engineering for research and innovation to meet the industrial and societal challenges.

### **Mission**

Impart quality education in mechanical engineering and allied areas through effective teaching-learning process and state-of-the-art infrastructure.

Provide a conducive environment to excel in research and innovation for sustainable solutions through industrial collaboration, co-curricular and extracurricular activities.

## **Program Educational Objectives (PEOs)**

**PEO1:** Be successful professionals in the field of Mechanical Engineering and allied areas.

**PEO2:** Exhibit skills to work effectively and ethically in multiple domains of engineering as part of a team.

**PEO3:** Excel in higher studies, research and adapt in a world of constantly developing technology.

## **Program Specific Outcomes (PSOs)**

**PSO1:** Design and analyse the mechanical components and systems.

**PSO2:** Analyse the fluid and thermal aspects of different mechanical systems and components.

**PSO3:** Manufacture mechanical components and systems adopting effective managerial techniques.



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**BMS Institute of Technology and Management**

(An Autonomous Institution, Affiliated to VTU Belagavi)

Avalahalli, Doddaballapur Main Road, Bengaluru, Karnataka – 560064

Ref.: BMSIT&M/Exam/2023-24/ 104

Date: 21.09.2024

**CONTINUOUS INTERNAL EVALUATION (CIE)  
AND  
SEMESTER END EXAMINATION (SEE) PATTERN**

(Applicable to UG students admitted from the 2022 batch, effective from the Academic year 2024-25 onwards)

The UG students admitted from the 2022 batch onwards are hereby informed to note the following regarding Continuous Internal Evaluation and Semester End Examination pattern:

- The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Examination (SEE) is 50%.
- The Minimum passing mark for the CIE is 40% of the Maximum marks (i.e. 20 marks out of 50) and for the SEE minimum passing mark is 35% of the Maximum marks (i.e. 18 out of 50 marks).
- A student will be declared to have passed the course if they secure a minimum of 40% (i.e. 40 marks out of 100) in the combined total of the CIE and SEE.

The following tables summarize the CIE and SEE Patterns for the courses of various credits:

INTEGRATED PROFESSIONAL COMPETENCE COURSE (IPCC) COURSES 4 OR 3 CREDITS							
Evaluation Type		Internal Assessments (IAs)	Test/ Exam Marks Conducted for	Marks to be scaled down to	Min. Marks to be Scored	Evaluation Details	
Theory Component	CIE - Internal Assessment (IA) Tests	CIE – Test 1 (1.5 hr)	40	20	-	The sum of the two internal assessment tests will be <b>80 Marks</b> and the same shall be scaled down to <b>20 Marks</b> .	
		CIE – Test 2 (1.5 hr)	40				
	CIE – CCA (Comprehensive Continuous Assessment)	CCA	10	10	-		Any one assessment method can be used from the list appended below.
	<b>Total CIE Theory</b>			<b>30</b>	<b>12</b>		
Practical Component	CIE - Practical		30	10	-	Each laboratory experiment is to be	

NON-IPCC COURSES

**01 CREDIT - MULTIPLE CHOICE QUESTION TYPE**

Evaluation Type		Internal Assessments (IAs)	Test/ Exam Marks Conducted for	Marks to be scaled down to	Min. Marks to be Scored	Evaluation Details	
Continuous Internal Evaluation Component	CIE - IA Tests (MCQs)	CIE - Test 1 (1 hr)	40	40	-	<p>The question paper pattern for this course shall be an <b>MCQ of 1 or 2 Marks (s)</b>.</p> <p>The questions with 2 Marks can be framed based on a higher Bloom's level.</p> <p>The sum of the two internal assessment tests will be <b>80 Marks</b>, and the same will be scaled down to <b>40 Marks</b>.</p>	
		CIE - Test 2 (1 hr)	40				
	CIE - CCAs	CCA	10	10	-		Any One Assessment method can be used from the list provided below.
	<b>Total CIE</b>				<b>50</b>		<b>20</b>
<b>SEE (MCQ Type)</b>				50	18	<p>The question paper pattern for this course shall be an <b>MCQ of 1 or 2 Marks (s)</b>.</p> <p>The questions with 2 Marks can be framed based on higher Bloom's level.</p> <p>MCQ-type question papers of 50 questions with each question of a <b>01 Mark</b>, the examination duration is 01 hour.</p>	
<b>CIE + SEE</b>				<b>100</b>	<b>40</b>		

					assessed for <b>30 Marks</b> using appropriate rubrics.
	CIE Practical Test	20	10	-	One test after all experiments to be conducted for <b>20 Marks</b>
	<b>Total CIE Practical</b>		<b>20</b>	<b>08</b>	
<b>Total CIE Theory + Practical</b>			<b>50</b>	<b>20</b>	
	<b>SEE</b>	100	50	18	SEE exam is a theory exam, conducted for <b>100 Marks</b> , scored marks are scaled down to <b>50 Marks</b> .
	<b>CIE + SEE</b>		<b>100</b>	<b>40</b>	
<b>Note:</b> The assessment of the laboratory component for the IPCC courses shall be restricted to CIE only.					

<b>PROFESSIONAL CORE COURSES (PCC) / ENGINEERING SCIENCE COURSES (ESC)</b>						
<b>03 OR 02 CREDITS</b>						
<b>Evaluation Type</b>		<b>Internal Assessments (IAs)</b>	<b>Test/Exam Marks Conducted for</b>	<b>Marks to be scaled down to</b>	<b>Min. Marks to be Scored</b>	<b>Evaluation Details</b>
Theory Component	CIE - IA Tests	CIE - Test 1 (1.5 hr)	40	30	-	The sum of the two internal assessment tests will be <b>80 Marks</b> and the same will be scaled down to <b>30 Marks</b> .  Any Two assessment methods can be used from the list. If it is project-based, one CCA shall be given.
		CIE - Test 2 (1.5 hr)	40			
	CIE - CCAs	CCA	20	20	-	
	<b>Total CIE Theory</b>				<b>50</b>	
<b>SEE</b>			100	50	18	SEE is a theory exam, conducted for <b>100 Marks</b> , scored marks are scaled down to <b>50 Marks</b> .
<b>CIE + SEE</b>				<b>100</b>	<b>40</b>	

PROFESSIONAL CORE COURSE LABORATORY (PCCL) / ABILITY ENHANCEMENT COURSE LABORATORY (AEC)					
01 CREDIT					
Evaluation Type	Internal Assessments (IAs)	Test/ Exam Marks Conducted for	Marks to be scaled down to	Min. Marks to be Scored	Evaluation Details
Continuous Internal Evaluation	CIE - Practical	30	30		Each laboratory experiment is to be evaluated for <b>30 Marks</b> using appropriate rubrics.
	CIE - Practical Test	50	20		One test after all experiments is to be conducted for <b>50 Marks</b> and to be scaled down to <b>20 Marks</b> .
	<b>Total CIE</b>	-	<b>50</b>	<b>20</b>	
Semester End Examination		100	50	18	SEE to be conducted for <b>100 Marks</b> .
<b>CIE+SEE</b>		<b>100</b>		<b>40</b>	

NON-IPCC / ABILITY ENHANCEMENT COURSE (AEC)						
01 CREDIT - DESCRIPTIVE TYPE						
Evaluation Type	Internal Assessments (IAs)	Test/ Exam Marks Conducted for	Marks to be scaled down to	Min. Marks to be Scored	Evaluation Details	
Theory Component	CIE - IA Tests	CIE - Test 1 (1.5 hr)	40	30	-	The sum of the two internal assessment tests will be <b>80 Marks</b> and the same will be scaled down to <b>30 Marks</b> .  Any Two assessment methods can be used from the list. If it is project-based, one CCA shall be given.
		CIE - Test 2 (1.5 hr)	40			
	CIE - CCAs	CCA	20	20	-	
	<b>Total CIE Theory</b>			<b>50</b>	<b>20</b>	

<b>SEE</b>	100	50	18	SEE is a theory exam, conducted for <b>100 Marks for 02 Hours duration</b> , scored marks are scaled down to <b>50 Marks.</b>
<b>CIE + SEE</b>		<b>100</b>	<b>40</b>	

**COMPUTER AIDED ENGINEERING DRAWING (BCEDK103/BCEDK203)  
3 CREDIT**

Evaluation Type		Topics/ Modules	Computer Printout	Preparatory Sketch	Max Marks	Total Marks	Marks to be Scaled Down to	Min Marks to Pass
<b>CIE</b>	<b>Sketch Book and CAD Modelling</b>	Projection of Points	10	05	15	200	20	-
		Projection of Lines	10	10	20			
		Projection of Planes	20	15	35			
		Projection of Solids	40	20	60			
		Isometric Projections	20	15	35			
		Development of lateral surfaces	20	15	35			
	<b>Test 1</b>	Module 1 & 2	24	06	30	70	20	-
		Module 3	32	08	40			
	<b>Test 2</b>	Module 3	32	08	40	70	20	-
		Module 4	24	06	30			
	<b>CCA 1</b>	Module 5	08	02	10	10	10	-
	<b>CCA 2</b>	Module 5	08	02	10			
<b>CIE Total</b>							<b>50</b>	<b>20</b>
<b>SEE</b>	Module 1 & 2	24	06	30	100	50	18	
	Module 3	32	08	40				
	Module 4	24	06	30				
<b>CIE + SEE</b>							<b>100</b>	<b>40</b>

**COMPUTER AIDED MODELLING FOR MANUFACTURING (BME305)**

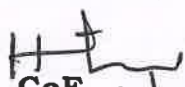
**1 CREDIT**

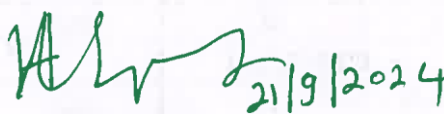
Evaluation Type		Topics/ Modules	Computer Printout	Preparatory Calculations / Sketch	Max Marks	Total Marks	Marks to be Scaled Down to	Min Marks to Pass
<b>CIE</b>	<b>Sketch Book and CAD Modelling</b>	Module 1	60	30	90	200	20	
		Module 2	40	20	60			
		Module 3	40	10	50			
	<b>Test 1</b>	Module 1	20	10	30	60	20	-
		Module 2	20	10	30			
	<b>Test 2</b>	Module 1	20	10	30	60		
		Module 3	20	10	30			
	<b>CCA</b>	Module 1	30	10	40	40	10	-
	<b>CIE Total</b>							<b>50</b>
<b>SEE</b>	Module 1	30	10	40	100	<b>50</b>	<b>18</b>	
	Module 2	20	10	30				
	Module 3	20	10	30				
<b>CIE + SEE</b>							<b>100</b>	<b>40</b>

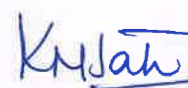
**Learning Activities for CCAs:**

A faculty member may choose the following CCAs based on the needs of the course:

1. Course project
2. Literature review
3. MOOC
4. Case studies
5. Tool exploration
6. GATE-based aptitude test
7. Open book tests
8. Industry integrated learning
9. Analysis of Industry / Technical / Business reports
10. Programming assignments with higher Bloom level
11. Group discussions
12. Industrial / Social / Rural projects

  
CoE 21/09/2024

  
Principal 21/9/2024

  
Dean - AA 21/09/24

**Copy To:**

1. The Vice-Principal, Deans, HoDs, and Associate HoDs
2. All faculty members and students of 2022, 2023, and 2024 batch.
3. Examination Section



# BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institution Affiliated to VTU, Belagavi)

**B. E. in Mechanical Engineering**

**Scheme of Teaching and Examinations – 2022 Scheme**

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022-23 onwards)

## VII Semester

Sl. No.	Course Category	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Credits Distribution				Examination				Contact Hours/week
					L	T	P	Total	CIE Marks	SEE Marks	Total Marks	SEE Duration (H)	
1	IPCC	BME701	Computer Aided Manufacturing	TD: ME PSB: ME	3	0	1	4	50	50	100	3	5
2	PCC	BME702	Finite Element Methods		2	1	0	3	50	50	100	3	4
3	PEC	BME703X	Professional Elective Course III		3	0	0	3	50	50	100	3	3
4	OEC	BME704X	Open Elective Course II		3	0	0	3	50	50	100	3	3
5	PW	BMEP705	Major Project Phase II		0	0	7	7	100	100	200	3	14
6	PCCL	BMEL706	Finite Element Method and Analysis Lab		0	0	1	1	50	50	100	3	2
<b>TOTAL</b>					<b>11</b>	<b>1</b>	<b>9</b>	<b>21</b>	<b>350</b>	<b>350</b>	<b>700</b>	<b>-</b>	<b>31</b>

**IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Courses, **PCCL:** Professional Core Course laboratory, **UHV:** Universal Human Value Course, **NMC:** Non Credit Mandatory Course, **ESC:** Engineering Science Course **AEC:** Ability Enhancement Course, **SEC:** Skill Enhancement Course, **L:** Lecture, **T:** Tutorial, **P:** Practical, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.

**Integrated Professional Core Course (IPCC):** Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

Professional Elective Course III		Open Elective Course II	
Course Code	Course Name	Course Code	Course Name
BME703A	Additive Manufacturing	BME704A	Innovative Product Development
BME703B	Fluid Power Systems	BME704B	Supply Chain Management
BME703C	Organizational Behavior	BME704C	Automotive Technology
BME703D	IC Engines and Advanced Vehicle Control Systems		
BME703E	IP and Innovation Management		
BME703F	Product Design and Manufacturing		

**National Service Scheme /Physical Education/Yoga/NCC/Music:** All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

**Open Elective Courses (OEC):** Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

**Selection of an open elective shall not be allowed if,**

- The candidate has studied the same course during the previous semesters of the program.
- The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the program.
- The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

**Major Project Phase II:** The objective of the Project work is (i) To encourage independent learning and the innovative attitude of the students. (ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills. (iii) To impart flexibility and adaptability. (iv) To inspire teamwork. (v) To expand intellectual capacity, credibility, judgment and intuition. (vi) To adhere to punctuality, setting and meeting deadlines. (vii) To instill responsibilities to oneself and others. (viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

**Mini Project:** The Mini Project Work is a part of the curriculum in the pre-final year. Mini Project is a course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications. Based on the ability/abilities of the student/s and recommendations of the mentor, a Mini- project can be assigned to a group having not more than 4 students. A comprehensive report is to be prepared after completion of the project work.

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**COMPUTER AIDED MANUFACTURING (3:0:1) 4**

Course Code	BME701	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Marks	50
Total Number of Contact Hours	40 + 12 sessions of Practical	Exam Hours	03

**Course Objectives:**

This course will enable students to:

1. Introduce the need for the adoption of computers in the manufacturing sector.
2. Train the students to analyze the part profiles and to write the CNC part programming.
3. Categorize the methods required to ascertain the quality of the product produced using CNC machines.

**Preamble:** Impact of CAM in modern manufacturing sector, Societal relevance of computerizing the factory environment.

**Module – 1**

**Introduction to CAM:** Definition of CAD, CAM and CIM. Production systems, Manufacturing support systems, Automation: Definition, Types of Automation, Reasons for Automation. Mathematical models and matrices: Manufacturing lead time, production rate, production capacity, utilization and availability, work-in- process, work-in- process ratio and time -in-process ratio. Numerical problems.

**Computerized Manufacture Planning and Control System:** Computer Aided Process Planning (CAPP), Retrieval and Generative CAPP Systems, benefits of CAPP, Material Requirement Planning (MRP): Introduction, Fundamental concepts of MRP, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning. **(08 Hours)**

**Module – 2**

**Line Balancing:** Introduction, Terminologies used in line balancing procedure, Methods of line balancing, Numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.

**Computer Numeric Control:** Introduction, Basic Components of CNC Systems, Features of CNC, Classification of CNC Systems, CNC Co-Ordinate System, Advantages and Disadvantages. CNC Machining Centres, CNC Turning Centres, Machine Control unit. **(08 Hours)**

**Module – 3**

**CNC Programming:** Introduction, Part Program Fundamentals, Manual part programming, Programming formats, Axes standards for turning and milling, NC block, Preparatory functions, Miscellaneous functions, Tool-length Compensation, Cutter-Radius compensation, Canned Cycles in Turning and Milling, Simple programming exercises in turning using canned cycles for rough turning, finish turning, axial drilling, grooving and thread cutting. Simple programming exercises in Milling for operations like Face milling and end milling. Use of Canned cycles in milling for Drilling, Peck drilling, Reaming, Boring and tapping operations. **(08 hours)**

**Module – 4**

**Group Technology:** Definition, Part families and Machine groups, Part family, Parts classification and coding, Production Flow Analysis, Cellular manufacturing, Types of machine cells, Machine cell layouts, Applications of Group Technology.

**Flexible Manufacturing Systems:** Fundamentals of Flexible Manufacturing Systems, Types of flexibility tests, Types of FMS, FMS components, FMS layout configurations, FMS Applications, FMS planning issues, FMS design issues, FMS operations management issues, FMS benefits.

**(08 hours)**

### **Module – 5**

**Computer Aided Quality Control:** Introduction, Objectives, Advantages, Inspection procedure, Inspection accuracy, Automated inspection, Techniques of automated inspection – Contact and non-contact, Co-ordinate Measuring Machine (CMM): Constructional features, Types of mechanical structure, Application and benefits. Machine Vision, Components of machine vision system and applications.

**Manufacturing support systems:** Concurrent Engineering, Design for Manufacturing and Assembly, Advanced Manufacturing Planning, Shop Floor Control: Order release, Order Scheduling, Order Progress, Lean Production and Waste in manufacturing, Structure of Lean production, Just In Time production systems.

**(08 hours)**

### **Practical Components for IPCC**

1. **CNC part programming for Turning operations:** Canned Cycles in Turning, Simple Programming Exercises in Turning using canned cycles for Rough turning, finish turning, Axial drilling, Grooving and Thread cutting. (Minimum 5 Exercises).
2. **CNC part programming for Milling operations:** Canned Cycles in Milling, Simple programming exercises in milling for operations like Face milling and end milling. Use of Canned cycles in Milling for Drilling, Peck drilling, Reaming, Boring and Tapping operations. (Minimum 5 Exercises). Simulation to be carried out using simulation packages.
3. Creation of the part profile and CNC code generation for the various Turning operations like Facing, Step turning, Contour turning, Thread cutting, Grooving and Axial drilling. (Minimum 3 exercises)
4. Creation of the part profile and CNC code generation for the various Milling operations like Face milling, End milling, Drilling, Reaming, Boring, Pocketing. (Minimum 3 exercises)

### **Course Outcomes:**

The students will be able to:

- CO 1: Apply the computer aided manufacturing concepts to improve the efficiency of an automated system.
- CO 2: Apply the principles of Group Technology & Flexible Manufacturing Systems for automated systems development.
- CO 3: Analyze the algorithms of line balancing to reduce the cycle time in an automated flow line.
- CO 4: Illustrate the various Computer Aided Quality Control techniques and Manufacturing support systems.
- CO 5; Develop CNC programs for machining operations using the software and prepare a report.

### **Textbooks:**

1. Mikell P Groover, “Automation, Production Systems and Computer-Integrated Manufacturing”, Pearson Publications, 4<sup>th</sup> Edition, 2015.

2. P. N. Rao, "CAD/CAM Principles and Application", Tata McGraw Hill, International, 3<sup>rd</sup> Edition, 2014.

**References:**

1. Ibrahim Zeid, "CAD/CAM", 3<sup>rd</sup> Edition, Tata McGraw Hill, 2015.
2. S. Kant Vajpayee., "Principles of Computer Integrated Manufacturing", 3<sup>rd</sup> Edition, Prentice Hall of India, 2006.
3. Dr. P. Radhakrishnan., "CAD/CAM/CIM", 3<sup>rd</sup> Edition, New Age International Publishers, 2004.

**Alternate Assessment Tools (AATs) suggested:**

- Technical report analysis
- Modern tool usage
- Industrial visits
- Case study
- Literature review

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**FINITE ELEMENT METHOD (2:1:0) 3**

Course Code	<b>BME702</b>	CIE Marks	50
Teaching Hours/Week (L:T:P)	2:2:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	03

**Course objectives:**

This course will enable students to:

1. Illustrate the basic concepts involved in finite element method.
2. Determine stresses and strains in bar and beam for different loading conditions and boundary conditions
3. Analyze trusses for different boundary loading conditions and loading conditions.
4. Examine heat transfer and fluid flow problems using finite element method.
5. Determine stresses and strains torsional and dynamic loading problems using finite Element method.

**Preamble:** Historical background, importance of FE Analysis for Mechanical, aerospace, automotive industry.

**Module – 1**

**Finite Element Method:** Engineering applications, advantages, General steps, Element types, Convergence criteria, Coordinate systems, commercial packages pre-processor, solver and post processor. Principles of Elasticity: Strain-displacement relations, Stress-strain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions, Numerical Methods, Potential energy method, Rayleigh-Ritz method and Galerkin method applied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads. **(08 Hours)**

**Module – 2**

**One Dimensional Element:** Formulation of a linear bar element, Shape Functions Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary conditions by elimination method and penalty method, Numerical Problems on straight and stepped bars

**2-Dimensional elements:** Degrees of freedom, displacement vector for three noded triangular & four noded quadrilateral elements. Derivation of shape functions for 3 noded triangular elements and 4 noded quadrilateral elements in terms of natural co-ordinates. 2D iso-parametric element **(08 Hours)**

**Module – 3**

**Truss:** Introduction, different types of trusses, plane trusses, direction cosines, transformation matrix and stiffness matrix for 2-D plane truss element. Element stresses and strains. Finite Elements Formulations for truss element. Displacements vectors, force vector. Numerical problems of trusses with different boundary and loading conditions.

**Beams:** Boundary conditions, load vectors, Hermite shape function, Element stiffness matrix for beam. Numerical problems on beams with concentrated and uniformly distributed loads. **(08 Hours)**

**Module – 4**

**Heat Transfer:** Differential equation for a 1-D heat conduction. Boundary conditions, 1-dimension finite element formulation for heat transfer, Thermal conductivity matrix. Numerical problems on heat transfer

through composite sections with temperature gradient and heat fluxes.

**Fluid Flow:** Basic differential equation for fluid flow in pipes and porous media. Finite element formulation for flow through a porous medium and flow through pipes of uniform cross sections. Numerical problems on fluid flow. **(08 Hours)**

### Module – 5

**Torsion of Shafts:** Introduction, torsional equation, derivation of torsional stiffness matrix, shear stresses and strain torsion of shafts, finite element formulation of torsion of circular shafts Numerical problems on determination of stress and twists in the circular shafts.

**Dynamic Analysis:** Introduction to Finite element analysis for vibration problems, consistent mass matrix for bar element, derivation of consistent element mass matrix for one dimensional bar element. **(08 Hours)**

#### Course outcomes:

The students will be able to:

CO 1: Illustrate the basic concepts involved in finite element method.

CO 2: Analyse the bar, beam and trusses for different loading and boundary conditions.

CO 3: Analyze heat transfer and fluid flow problems using FEM.

CO 4: Estimate stresses and strains in torsional and dynamic loading problems using FEM.

CO 5: Perform the structural and thermal analysis using advanced solver options.

#### Textbooks:

1. Chandrupatla T. R., “Finite Elements in engineering”, 2nd Edition, PHI, 2013.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.

#### References:

1. K. J. Bathe., “Finite Element Procedures”, Prentice Hall, 2006.
2. Tirupathi. R., Chandrupatla. Ashok. D., Belegundu. “Introduction to Finite Elements in Engineering”, 4<sup>th</sup> Edition, Pearson, 2015.
3. Seshu. P., “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd, 2013.
4. C. S. Desai and J. F. Abel, “Introduction to the Finite-Element Method”, Nostrand Reinhold Company, New York, 2019.

#### Alternate Assessment Tools (AATs) suggested:

- Analysis of bar, beam, truss, heat transfer using ANSYS and compare the results with FEM analytical solution
- Analysis of a machine component using any two FEA softwares and compare the results.

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**ADDITIVE MANUFACTURING (3:0:0) 3**

Course Code	BME703A	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

**Course objectives:**

This course will enable students:

1. To understand why additive manufacturing is necessary.
2. To comprehend the numerous additive manufacturing processes.
3. To know various rapid tooling techniques using additive manufacturing processes.
4. To comprehend additive manufacturing tools and minimize errors.

**Preamble:** Additive manufacturing, also referred to as 3D printing, is a cutting-edge technology that makes it possible to construct three-dimensional objects from a digital model layer by layer. By providing more design flexibility, lower waste, and quicker production periods than conventional manufacturing techniques, this ground-breaking approach has revolutionised a number of industries.

**Module – 1**

**Principles of Additive Manufacturing:** Need for Additive Manufacturing, AM classification, Generic AM process, benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.

**Photo polymerization processes:** Stereolithography (SL) process, materials, Process parameter, advantages and limitations, applications. **(08 hours)**

**Module – 2**

**Powder bed fusion processes:** Introduction, Selective laser Sintering (SLS) process, materials, process parameters, powder fusion mechanism, Electron Beam melting (EBM), advantages and limitations, applications.

**Extrusion-based systems:** Fused Deposition Modelling (FDM) process, process parameters, materials, Process parameters, advantages and limitations, applications. **(08 hours)**

**Module – 3**

**Laminated Object Manufacturing:** Principle, process details, materials, advantages, limitations, applications.

**Solid Ground Curing:** Principle of operation, process details, machine details, advantages, limitations, Applications. **(08 hours)**

**Module – 4**

**Indirect Rapid Tooling:** Introduction, Indirect rapid tooling - silicone rubber tooling, vacuum casting, aluminum filled epoxy tooling, spray metal tooling.

**Direct Rapid tooling** - Direct AIM, quick cast process, rapid tool, copper polyamide, DMLS, sand casting tooling, laminate tooling, soft tooling v/s hard tooling. **(08 hours)**

**Module – 5**

**Rapid Manufacturing Process Optimization:** Factors influencing accuracy, Data preparation-errors due to tessellation, errors due to slicing, Part building errors, Part finishing, Selection of part build orientation.

**Direct Write Technologies:** Background, ink –based DW, laser transfer, DW thermals pray, DW beam deposition, DW liquid-phase direct position. **(08 hours)**

**Course outcomes:**

The students will be able to:

CO 1: Choose appropriate additive manufacturing processes to build the part

CO 2: Interpret the process parameters that affect the additive manufacturing processes.

CO 3: Apply the various additive manufacturing processes in direct and indirect rapid tooling.

CO 4: Infer the benefits, drawbacks and uses of various additive manufacturing processes.

**Textbooks:**

1. Dr. Ian Gibson., Dr. David. W. Rosen., Dr. Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, Springer, 2nd Edition, 2014
2. D T Pham., S. S. Dimov., “Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling”, 1st edition, Springer, 2001.

**References:**

1. Andreas Gebhardt., “Rapid Prototyping”, Hanser Pub Inc, 1st Edition, 2003.
2. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim., “Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling”, 2nd edition, World Scientific, 2010.

**Alternate Assessment Tools (AATs) suggested:**

- Industrial expert talk
- Case study presentation

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)  
SEMESTER – VII (2022 SCHEME)  
**Professional Elective Course**

**FLUID POWER SYSTEMS (3:0:0) 3**

Course Code	BME703B	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

**Course Objectives:**

This course will enable students:

1. To gain knowledge on how pressurized fluid generates power, the types of fluid power control systems and its applications.
2. Understand the construction and function of various components of fluid power systems.
3. Know how the components are selected and integrated into a system.
4. Know how to read basic circuits troubleshoots and analyse the operation of basic circuits.

**Preamble:** Most automated systems are hydraulically or pneumatically actuated; for examples, air drill used by dentists, brakes in heavy vehicle, agriculture, construction and mining machines, excavators and to the extent of tiny robots. Fluid power is ideal for high speed, high force and high power applications compared to all other actuation technologies, including electric motors. Fluid power systems have a higher bandwidth than electric motors and can be used in applications that require fast starts, stops and reversals, or that require high frequency oscillations. This course provides a comprehensive introduction to fluid power, including both oil hydraulic and pneumatic systems.

**Module – 1**

**Fluid Power:** Fundamentals of fluids and Pascal's law. Fluid power control systems-Advantages and applications. Structure of hydraulic system and pneumatic system - Advantages, limitations and applications. Numerical on Pascal's law.

**Hydraulic Pumps:** Pumping theory & types of positive displacement pumps, Construction and working of gear, vane and piston pumps. Pump performance and pump selection, Graphic symbols. Numerical. **(08 Hours)**

**Module – 2**

**Hydraulic Actuators:** Linear actuators-types and hydraulic cylinder cushioning. Rotary actuators-Gear, Vane and Piston motors, hydraulic motor performance, and graphic symbols. Numerical.

**Control devices:** Directional control valves (DCV)-Check, shuttle valve, pilot operated check valve and spool valves (2- way valve, 3-way valve and 4- way valve), solenoid valve. Pressure control valves (PCV) – Pressure relief valve, pilot operated pressure relief valve. Flow control valves (FCV) - Needle valve. Graphic symbols. **(08 Hours)**

**Module – 3**

**Accumulators:** Types of accumulators, Construction and working of weighted loaded, spring-loaded type and gas-loaded type.

**Design of hydraulic circuit and Application:** Direct control of single and double acting cylinders, regenerative circuits, cylinders synchronization circuits, meter-in and meter-out circuits and accumulator circuits. Applications - Hydraulic circuit for sheet metal punching and drilling operations. **(08 Hours)**

**Module – 4**

<p><b>Pneumatic system components:</b> Control valves – Poppet valve, spool valve, needle valve, time delay valve and quick exhaust valve, FRL unit. <b>Pneumatic Actuators:</b> Linear actuators – types of cylinders, working, and end position cushioning. Graphic symbols of linear and rotary actuators.</p> <p><b>Pneumatic control circuits:</b> Direct and indirect actuation single and double cylinders, speed control of cylinders - supply air throttling, exhaust air throttling and application of time delay valve. Applications – Pneumatic circuit for pneumatic braking system. <b>(08 Hours)</b></p>
<p><b>Module – 5</b></p>
<p><b>Signal Processing Elements:</b> Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples and circuits involving the use of logic gates.</p> <p><b>Multi- Cylinder Application:</b> Coordinated and sequential motion control, motion and control diagrams. Circuits for automatic control applications. Cascading method- principle, Practical application examples (upto two cylinders).</p> <p><b>Electro- Pneumatic Control:</b> Principles - Signal input and output, use of relay and contactors. Control circuitry for simple signal cylinder application. <b>(08 Hours)</b></p>
<p><b>Course Outcomes:</b> The students will be able to: CO1: <b>Compute</b> the actuators force and speed using Pascal’s law. CO2: <b>Analyse</b> the operation of simple hydraulic and pneumatic circuits. CO3: <b>Design</b> a fluid power system for a given industrial / societal problem.</p>
<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. Anthony Esposito., “Fluid Power with Applications”, 7<sup>th</sup> Edition, Pearson Education, 2008.</li> <li>2. James Johnson., “Introduction to Fluid Power”, 1st Edition, Cengage Learning, 2002.</li> <li>3. Andrew Parr., “Hydraulics and Pneumatics: A Technician’s and Engineer’s Guide”, 3rd Edition, Heinemann, Imprint of Elsevier, 2011.</li> <li>4. S. Majumdar., “Pneumatic Systems: Principles and Maintenance”, 2nd Edition, McGraw Hill Education, 2017.</li> </ol> <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. EurIng Ian C. Turner., “Engineering Applications of Pneumatics and Hydraulics”, 1st Edition, Butterworth-Heinemann, 1996.</li> <li>2. S. Majumdar., “Oil Hydraulic Systems: Principles and Maintenance”, 2nd Edition, McGraw Hill Education, 2017.</li> </ol>
<p><b>Alternate Assessment Tools (AATs) suggested:</b></p> <ul style="list-style-type: none"> <li>• Finite Element Analysis of Tractor Brack link using SolidWorks and Ansys</li> <li>• Finite Elements Analysis of a Machine Component (Curved Beam) and compare the results with analytical solution</li> </ul>

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**Professional Elective Course****ORGANIZATIONAL BEHAVIOR (3:0:0)3**

Course Code	<b>BME703C</b>	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

**Course objectives:**

This course will enable students to:

1. To recognize the importance of human behaviour at work in organizations.
2. To relate human behaviour with learning and demonstrate how the two go together.
3. To identify the importance of motivation in learning and other performance attributes.
4. To know and locate the importance of group interactions and group behaviour in organizations.
5. To manage and resolve conflicts through effective communication.

**Preamble:** Organizational Behavior (OB) is about understanding how people think, feel, and act within the workplace. It's the study of human behavior in organizations, examining why people do what they do and how those behaviors shape the success or setbacks of the business. It's a cross-disciplinary field that blends psychology, sociology, anthropology, communication, economics, and systems thinking.

**Module – 1**

**Introduction to Organization Behavior:** Historical development, Environmental context (Information Technology and Globalization, Diversity and Ethics, Design and Cultural, Reward Systems). The Individual: Foundations of individual behavior, individual differences. Ability. Attitude, Aptitude, interests. Values – Types of Values, hanging Values. **(08hours)**

**Module – 2**

**Learning:** Definition, theories of learning, individual decision making, classical conditioning, operant conditioning, social learning theory, continuous and intermittent reinforcement. Perception: Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect **(08 hours)**

**Module – 3**

**Motivation:** Maslow's Hierarchy of Needs theory, Mc-Gregor's theory X and Y, Hertzberg's motivation Hygiene theory, David Mc-Clelland's three needs theory, Victor Vroom's expectancy theory of motivation. **(08 hours)**

**Module – 4**

**Groups Behavior:** Classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, group processes, group tasks, group decision making. **(08 hours)**

**Module – 5**

**Conflict & Stress Management:** functional and dysfunctional conflict, stages of conflict process. Sources of stress, fatigue and its impact on productivity. Job satisfaction, job rotation, enrichment, job enlargement and reengineering work process.

**Communication:** Principles of Communication: Useful definitions, communication principles, communication system, role of communication in management, barriers in communication, how to overcome the barriers, rule of effective communication. **(08 hours)**

**Course outcomes:** Upon the completion of course students will be able to:

CO 1: Illustrate human behavior at work.

CO 2: Analyse how learning depends on behavioral aspects.

CO 3: Describe Value motivation and work and demonstrate their motivational skills.

CO 4: Asses to manage organizational conflict and be able to produce results.

**Textbooks:**

1. Organizational Behaviour, Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002.
2. Organizational Behaviour, Fred Luthans, 9th Edition, Mc Grew Hill International Edition, ISBN-0-07-04-002.

**References:**

1. Organizational Behaviour, Aswathappa - Himalaya Publishers, 2001.
2. Organizational Behaviour, (Human behaviour at work) 9th Edition, John Newstron/ Keith Davis, 2002.
3. Organizational Behaviour, Hellriegel, Srocum and Woodman, Thompson Learning, 9th Edition, Prentice Hall India, 2001.
4. Organizational Behaviour, VSP Rao and others, Konark Publishers, 2002.

**Alternate Assessment Tools (AATs) suggested:**

- Technical report analysis
- Modern tool usage
- Case study
- Literature review

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**Professional Elective Course****IC ENGINES AND ADVANCED VEHICLE CONTROL SYSTEMS (3:0:0) 3**

Course Code	<b>BME703D</b>	CIE Marks	<b>50</b>
Teaching Hours/Week (L:T:P)	<b>3:0:0</b>	SEE Marks	<b>50</b>
Total Number of Lecture Hours	<b>40</b>	Exam Hours	<b>03</b>

**Course Objectives:**

1. Study the different properties of fuels and also study the evaluating procedure of properties of fuel.
2. Identify the suitable oils and fuels required for particular engines.
3. Differentiate CI and SI engine in terms of combustion phenomenon.
4. Know about the fuel supply methodology and the method to control the combustion.

**Preamble:** Internal Combustion engine refers to heat engine where combustion takes place in closed chamber. For the combustion process to occur, heat, hydrocarbon and oxygen is required. Properties of fuels, method of supplying the fuel and air into the combustion chamber is major focus of the course.

**Module – 1**

**Liquid Fuels:** Origin, Chemistry of petroleum, Refining of petroleum, Properties and tests for petroleum products, Various petroleum products.

**Fuel Treatment:** Production of liquid fuels, Removal of sulphur compounds, Contaminants, Asphaltenes, Gum, Sediment, Ash, Water, Sodium, Vanadium, Additives, Gum prevention, Corrosion inhibition/lubricity improvers, Anti icing, Antistatic and static dissipators, Metal deactivators, Antismoke. **(08 hours)**

**Module-2**

**Combustion:** Deflagration, Detonation, Classification of flames, Physics of combustion chemistry, Flammability limits, Weak mixture, Rich mixture, Laminar premixed flames.

**Laminar and turbulent flame:** Burning velocity, Measurement techniques for flame velocity, Factors influencing laminar flame speed, Equivalence ratio, Initial temperature and pressure of laminar diffusion flames, Turbulent premixed flames, Flame propagation in heterogeneous mixture of fuel drops, Fuel vapor and air. **(08 hours)**

**Module-3**

**Automotive Control Systems:** Digital Engine Control System, Vehicle Motion Control System: Typical Cruise Control System, Stepper Motor-Based Actuator for Cruise Control, Antilock Braking Systems, Traction Control System, Electronically controlled power steering systems. **(08 hours)**

**Module-4**

**Combustion in SI Engines:** Limits and stages of combustion, Factors affecting ignition lag, Flame propagation, Effect of engine variable on flame propagation, Abnormal combustion, Effect of detonation, Detonation and engine variables and other factors affecting knocking and its prevention, Theory of detonation in SI engines and chemistry of detonation, Ignition advance, Control of detonation surface ignition. Exhaust emissions and its control mechanisms. **(08 hours)**

## Module-5

**Combustion in CI Engines:** Stages of combustion in CI engines, Air fuel ratio, Delay period or ignition lag, Variables effecting delay period, Diesel knock, Methods of controlling diesel knock, Effect of fuel injection parameters, CI engine combustion chamber requirements, Types of combustion chambers, Cold starting of CI engine and cold starting aids. CI engine emissions and its control mechanisms. **(08 hours)**

### Course Outcomes:

The students will be able to:

- CO 1: Classify the fuels based on their properties, able to determine the properties of fuels, and understand the working of IC engines components.
- CO 2: Apply the concept of engineering to understand the flame behavior and combustion phenomenon in IC engines.
- CO 3: Analyze the reason for malfunctioning of IC engines.
- CO 4: Demonstrate the Working of IC engines and evaluate the performance of IC engines.

### Textbooks:

1. JohnB. Heywood, "Internal combustion engines fundamentals", McGraw – Hill international editions.
2. Edward F. Obert, "Internal combustion engines and air pollutions", Intext education publishers.

### Reference Books:

1. Richard stone, "Introduction to internal combustion engines" 3rd edition, society of automotive engineers.
2. S P Sharma and Chander Mohan, "Fuels and Combustion", McGraw – Hill Publishing Company Limited.
3. A M.L.Mathur and R.P.Sharma, "Course internal combustion engines", Dhanapat Rai publications.

### Alternate Assessment Tools (AATs) suggested:

- Testing of properties of different fuels other than diesel.
- Performance test of Computerized CI engine using Alternate fuel.
- Poster Presentation on recent advancement in Automobiles.

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**Professional Elective Course****IP AND INNOVATION MANAGEMENT (3:0:0)3**

Course Code	BME703E	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	03

**Course Objectives:**

This course will enable students:

- 1 To provide an insight into IP and project management.
- 2 To enrich the knowledge on creativity, design and innovation.
- 3 To acquire knowledge on innovation IP strategies.
- 4 To impart knowledge on innovation process and disruption.
- 5 To acquaint with startup innovation and IP management.

**Module – 1**

**Creating IP:** Need for creating IP: Wealth creation, Identity in the market, Entering into new markets, Creation of entry barriers.

**IP Management:** Definition, Need and importance of IP Management, procedure for grant of patent, Challenges in patent: Evergreening of patents, commercialization, awareness and funding. Converging technologies and emerging IPR issue

**Project Management and IP:** The knowledge canopy, Incorporating IPR in Project Management, IPR as part of Project Management: Concepts, Innovation process, output and Market. **(08 Hours)**

**Module – 2**

**Creativity:** Inversion, analogy, fantasy, morphological analysis. Creative techniques: Provocation techniques, Synectics, Bionics.

**Emotional Design:** Emotional design, multiple faces of emotion and design, Focus and creativity, Levels of design: Visceral, behavioural and reflective design. Procedure for registration of Industrial Design in India.

**Innovating Organisation:** Characteristics of innovating organisation: Open atmosphere, Tolerance to failure, Free communication and Quest for knowledge. **(08 Hours)**

**Module – 3**

**Managing the Strategy Development:** Two processes of strategy formulation: Deliberate and emergent strategies. Design thinking as a strategy for innovation. Strategies for idea generation: Attack problem, uniqueness, intersection, collaborations.

**Patent Strategy:** Reason company needs a patent strategy, Different strategies: Sword strategy, shield strategy and design around.

**Search strategies:** Objectives of search, novelty search, Boolean search, validity search, freedom to operate search. Data bases for prior art search: Google patents, InPASS, Espacenet, USPTO patent search. **(08 Hours)**

**Module -4**

**Innovation Process:** Innovation Engine elements: Customer insight, Managed innovation process, Strategic foresight and strategic alignment. Creating culture of innovation, Rules and habits of innovation.

**Smart Innovation:** Art of smart innovation, insight on creative collaborations, Open innovation, SMART innovation method, Collaborative open innovation.

**Disruptions:** Types of disruptions, Third dimensions of the disruptive innovation model, New-market disruptions, low-end disruptions. **(08 Hours)**

### Module -5

**Startup Innovation and IP:** Motivating factors to innovate, rules for Startup innovation and habits of Startup innovators, Key characteristics of designer, Developing design thinking capability in Startup, Relevance of IP for Startup, Patent claim, structure of claims

**IP Management activities:** International patent classification, Search report and examination report. IP Intelligence, acquisition of IP, commercialization of IP, Managing IP Portfolio, IPR management imperatives: Role of a group managing institutional IPR, Essential for management of IPR. **(08 Hours)**

#### Course Outcomes:

The students will be able to:

- CO1: Illustrate IP and project management.
- CO2: Demonstrate the creativity, design and innovation.
- CO3: Develop innovation and IP strategies.
- CO4: Summarise innovation process and disruption.
- CO5: Elaborate Startup innovation and IP management.

#### Textbooks:

1. Neeraj Pandey, Khushdeep Dharani, "Intellectual Property Rights", PHI Learning, 2014.
2. Stevan Fisher, Startup Equation, McGraw Hill Education (India) Private Limited, 2016

#### Reference Books:

1. Clayton M. Christensen, The Innovator's Solution, Harvard Business Review Press, 2003
2. Prabhuddha Ganguli, "Intellectual Property Rights", Tata Mc-Graw –Hill, 2017.
3. Dr. S R Myneni, "Patent Drafting & Specification Writing", New Era Law Publication, 2020.
4. Don Norman, Emotional Design, Donald A. Norman, 2004.

#### Alternate Assessment Tools (AATs) suggested:

- Case studies
- Literature survey

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**Professional Elective Course****PRODUCT DESIGN AND MANUFACTURING (3:0:0) 3**

Course Code	<b>BME703F</b>	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours	Exam Hours	03

**Course Objectives:**

This course enables the students :

1. To understand and simulate the different phases of product design with relevant flow charting and industrial practices in the area of product design.
2. To understand the various material properties and loading conditions for the product design based on the manufacturing possibilities.
3. To understand the product design optimization by using different approaches such as differential Calculus, Lagrange Multipliers,
4. To understand the safety, reliability, and manufacturing aspects related to the economics of the product design
5. To understand the value engineering by adopting the various steps in problem solving leading to the effective solution for the challenge.

**Preamble:** This course presents an overview of the product design and development process along with the manufacturing systems aspects. The concepts of optimization, economics and manufacturing would help the students learn to conceptualize, design and manufacture competitively-priced quality products.

**Module – 1**

**Product Design: Asimow's model:** Concepts of product design, Design by Evolution, Design by Innovation, Essential Factors of Product design, Production-Consumption Cycle, Flow and Value Addition in the Production-Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and Flowcharting,

**Product Design Practice:** Product Strategies, Time to Market, Analysis of the Product, The S's Standardization, Simplification, the designer and his role, Basic design considerations, Problems faced by industrial designer, Procedure adopted by industrial designers, Types of models designed by industrial designers, Role of Aesthetics in Product Design, Functional Design Practice.

**Module-2**

**Strength Consideration in Product Design:** Principal Stress Trajectories (Force-Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience Designing for Uniform Strength, Tension vis-a-vis Compression

**Design for Stiffness and Rigidity:** Structure involving both tension and compression members, Mapping of principal stresses, Buckling and instability, Theory of long columns, Hollow columns, Plastic design, Practical ideas for material saving in design. **(08 Hours)**

**Module-3**

**Design for Production- Metal Parts:** Producibility requirements in the Design of machine Components, Forging Design, Pressed components Design, Casting Design, and Design for Machining Ease, The Role of Process Engineer, Ease of Location and clamping, Casting and Special Casting.

**Designing with Plastic, Rubber, And Ceramics:** Approach to design with plastics, plastic bush bearings, gears in plastics, rubber parts, design recommendations for rubber parts, Production design factors for ceramic and glass parts. **(08 Hours)**

#### **Module-4**

**Human Engineering Considerations in Product Design:** Human being as Applicator of Forces, Anthropometry; Man as occupant of Space, The Design of Controls, of controls, the Design of Displays, Man/Machine Information Exchange.

**Optimization in Design:** Siddal's Classification of Design Approaches, Optimization by Differential Calculus, Lagrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method of Optimum Design. **(08 Hours)**

#### **Module-5**

**Economic Factors Influencing Design:** Product Value, Design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break – even Analysis.

**Value Engineering and Product Design:** What is Value? Nature and Measurement of Value, Normal Degree of Value, Importance of Value, The Value analysis Job Plan, Creativity, Steps to Problems-solving and Value Analysis, Value Analysis Test, Value Engineering Idea Generation Check-list Cost Reduction through value engineering.

**Modern Approaches to Product Design:** Concurrent Design and Quality Function Deployment (QFD). **(08 Hours)**

#### **Course Outcomes:**

**At the end of the course, students will be able to**

1. Explain the design principles and practices related to metallic and nonmetallic products.
2. Apply suitable design guidelines in developing a product based on strength, stiffness and rigidity
3. Utilize the optimization techniques and human engineering concepts in designing a new products.
4. Analyze the economic factors and value engineering in product design.

#### **TEXT BOOKS**

1. A.C. Chitale and R.C. Gupta -Product Design and Manufacturing, PHI, 5<sup>th</sup> Edition, 2011.
2. Karl T. Ulrich & Steven D., Epingner -Product Design and Development –Tata Mc Graw Hill, 5<sup>th</sup> Edition, 2012.

#### **REFERENCES**

1. Geoffery Boothroyd, Peter Dew Hurst and Winston Knight - Product Design for Manufacture and Assembly -3rdEdition, Taylor & Francis Group,2011
2. Tim Jones, Butterworth Heinmann-New Product Development, Oxford, UIC1997.

#### **Alternate Assessment Tools (AATs) suggested:**

##### **Course Project:**

Students need to design and fabricate any ONE product by adopting product design concept and techniques. At the end, they need to present their work and submit the report.

**B.E., MECHANICAL ENGINEERING**

Choice Based Credit System (CBCS)

SEMESTER – VII (2022 SCHEME)

**Open Elective Course****INNOVATIVE PRODUCT DEVELOPMENT (3:0:0) 3**

Course Code	<b>BME704A</b>	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	03

**Course outcomes:**

This course will enable students to:

1. Understand innovation, innovation culture and structure.
2. Develop creative thinking and creative process.
3. Analyse problems and innovative solutions.
4. Develop design process and design management for innovation
5. Gain knowledge on product development and prototype for innovative products.

**Preamble:** This course provides an insight into innovation, critical thinking, Problems analysis, synthesis, product design and development process.

**Module – 1**

**Innovation:** Concepts and importance of innovations, A framework for innovation strategy, Strategy and vision, agile innovation, lean innovation. Types of innovations: Disruptive innovation, radical innovation, incremental innovation, and product innovations.

**Innovative Cultures:** The Paradox of innovation culture: Tolerance for failure, collaboration, willingness to experiment and strong leadership. Innovating organization: open atmosphere, free communication, quest for knowledge.

**Innovation Structure:** Centralized innovation structure, decentralized innovation structure, hybrid innovation structure  
**(08 Hours)**

**Module – 2**

**Critical Thinking:** The essentials of critical thinking, Creative critical thinking, Elements of critical thinking, K-W-L charts, SCAMPER Techniques. white, red, black, yellow, green and blue thinking Hats. benefits of critical thinking, Barriers to critical thinking.

**Creative Process:** Preparation, incubation, illumination and ideation. Intuitive creative techniques: semantic intuition. Walt-Disney method, Mind mapping, rules for mind mapping. Innovation Check list: Description of system and problem, cause and history of the problem, improvement of the system. Evolution of Ideas: PPCO.  
**(08 Hours)**

**Module – 3**

**Problems Analysis:** Blind spot knowledge and awareness. Problem Analysis: Ishikawa diagram. Novel solution, Assessment system for evaluating novelty: prior art search. Creative problem solving: learn through analogies, Synectic's.

**Innovative Solutions:** Technology landscape, technology scouting, ideation and collaboration, innovative culture and challenges. Synthesis: Synthesis in innovation, role of creativity in synthesis. Levels of thinking: Deductive thinking, inductive thinking, abductive thinking.  
**(08 Hours)**

**Module – 4**

**Design Process:** Engineering design interface. Management of industrial design process: Technology driven product and user driven product. Performance requirements: Functions, Aesthetics, reliability, ergonomics.

**Design Management:** Technical Management structure, Engineering Design Management Process, Engineering design management principle. Product design specification Criteria: Performance, manufacturing, operation and acceptance standard. **(08 Hours)**

### Module – 5

**Product Development:** Characteristics of successful product development, who designs and develops of products. Industrial Design: ergonomics and aesthetics. Agility in product development, The Scrum Guide for product development. Product Life Cycle Management.

**Building Prototype:** Lean Startup method, MVP as test method, Kano Model, Prototyping technologies: 3D CAD modelling and Free-form fabrication. Quality: User interface, emotional appeal, use of resources, product differentiation. **(08 Hours)**

**Course outcomes:** The students will be able to:

CO 1: Summarize innovation, innovation culture and structure.

CO2: Develop creative thinking and creative process.

CO 3: Analyse problems and solutions.

CO4: Apply design process and design management for innovation

CO 5: Illustrate product development and prototype for innovative products.

**Textbooks:**

1. Ken S. Hurst, Engineering Design Principles, Elsevier Ltd, 2010.
2. Karl T. Ulrich, Steven D. Eppinger, Product Design and Development, McGraw-Hill Higher Education, 2016.

**References:**

1. Gary P. Pisano, Creative Construction: DNA of Sustained Innovation, BBS Public Affairs, New York, 2019
2. Steven Schuster, The Critical Thinker, Jaico Publishing House, 2022
3. Christian Mueller-Rotorberg, Handbook of Design Thinking, Copyright© 2018 Christian Mueller-Rotorberg

**Alternate Assessment Tools (AATs) suggested:**

- Case study
- Literature review

**B.E MECHANICAL ENGINEERING**Choice Based Credit System (CBCS)  
SEMESTER – VII (2022 SCHEME)**Open Elective Course****SUPPLY CHAIN MANAGEMENT (3:0:0)3**

Course Code	<b>BME740B</b>	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

Course objectives:

1. To understand the objectives of Supply Chain Management
2. To optimize inventory levels through demand forecasting and just-in-time inventory practices to reduce carrying costs.
3. To negotiate favorable contracts with carriers, optimize routing, and explore transportation options to minimize costs while ensuring timely deliveries.
4. To collaborate with suppliers on demand forecasting, production preparation, and inventory management.

**Preamble:** Supply chain management (SCM) is the centralized management of the flow of goods and services and includes all processes that transform raw materials into final products. By managing the supply chain, companies can cut excess costs and deliver products to the consumer faster and more efficiently

**Module – 1**

**Introduction: Supply Chain** – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures **(08 hours)**

**Module – 2**

**Strategic Sourcing Outsourcing Make Vs buy** - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing **(08 hours)**

**Module – 3****Warehouse Management Stores management-**

Stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement. Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models. **(08 hours)**

**Module – 4**

**Supply Chain Network optimization models.** Impact of uncertainty on Network Design - Network Design decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management **(08 hours)**

**Module – 5****Current Trends:**

Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain.  
IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain- EBusiness in supply chain. **(08 hours)**

**Course outcomes:** Upon the completion of course students will be able to:

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

CO 1: Illustrate the framework and scope of supply chain management.

CO 2: Develop a competitive supply chain using strategies, models.

CO 3. Describe SCM techniques and Supply Chain Network

CO 4: Analyse the SCM Models and emerging trends and impact of IT on SCM

**Textbooks:**

1. Supply Chain Management– Text and Cases Janat Shah Pearson Education 2009
2. Supply Chain Management Strategy Planning and Operation Sunil Chopra and Peter Meindl PHI Learning / Pearson Education 2007

**References:**

1. Business Logistics and Supply Chain Management Ballou Ronald H Pearson Education 5th Edition, 2007
2. Designing and Managing the Supply Chain: Concepts, Strategies, and Cases David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi Tata McGraw-Hill 2005
3. Supply Chain Management Concept and Cases Altekar Rahul V PHI 2005
4. Modeling the Supply Chain Shapiro Jeremy F Thomson Learning Second Reprint, 2002
5. Principles of Supply Chain Management- A Balanced Approach Joel D. Wisner, G. Keong Leong, Keah Choon Tan South-Western, Cengage Learning 2008

**Alternate Assessment Tools (AATs) suggested:**

- Technical report analysis
- Modern tool usage
- Industrial visits
- Case study
- Literature review

<b>B.E MECHANICAL ENGINEERING</b> Choice Based Credit System(CBCS) SEMESTER – VII (2022 SCHEME) <b>Open Elective Course</b>			
<b>AUTOMOTIVE TECHNOLOGY (3:0:0) 3</b>			
Course Code	<b>BME704C</b>	CIE Marks	<b>50</b>
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	<b>50</b>
Total Number of Lecture Hours	03	Exam Hours	<b>03</b>
<b>Course Objectives:</b> This course will enable students to: <ol style="list-style-type: none"> <li>1. Understand the layout and arrangement of principal parts of an automobile.</li> <li>2. Understand the working of transmission and brake systems.</li> <li>3. Comprehend operation and working of steering and suspension systems.</li> <li>4. Analyze the Injection system and its advancements.</li> <li>5. Enumerate the automobile emissions and its effects on environment.</li> </ol>			
<b>Preamble:</b> The course gives an insight to the various parts and functioning of the automobile. The functioning of the automobile systems like transmission, steering, ignition etc are highlighted to ensure that the student gets an overall picture of the working of the automobile. The prevention of emission and the government regulations pertaining to emissions are also discussed along with the recent advancements in automotive technology.			
<b>Module – 1</b>			
<b>Types of Automobiles:</b> Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I.Engine and C.I.Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.			
<b>Cooling And Lubrication:</b> Cooling requirements, Types of cooling- Thermo siphon system, Forced circulation water cooling system, Water pump, Radiator, Significance of lubrication, Splash and Forced feed <span style="float: right;"><b>(08 hours)</b></span>			
<b>Module-2</b>			
<b>Transmission Systems:</b> Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.			
<b>Brakes:</b> Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock, & Numerical <span style="float: right;"><b>(08 hours)</b></span>			

### Module-3

**Steering And Suspension Systems:** Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

**Ignition System:** Battery Ignition system, Magneto Ignition system, electronic Ignition system.

**(08hours)**

### Module-4

**Superchargers And Turbochargers:** Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

**Fuels, Fuel Supply Systems For SI And CI Engines:** Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D.& C.C. carburetors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection.

**(08 hours)**

### Module-5

**Automotive Emission Control Systems:** Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.

**Emission Standards:** Euro I, II, III and IV norms, Bharat Stage II, III, IV, VI norms. Motor Vehicle Act.

**EV Technology and Batteries :** Basic parts and functions of EV parts, Battery: types of batteries used in EV.

**(08 hours)**

#### Course Outcomes:

The students will be able to:

**CO 1:** Recognize the various parts of an automobile and its functioning.

**CO 2:** Illustrate the working principle of various automobile systems

**CO 3:** Comprehend the knowledge of steering, ignition, suspension and transmission systems

**CO 4:** Analyze the fuel injection systems and its advancements.

**CO5:** Appraise the importance of various emission control systems and highlight the EV technology for sustainability.

#### Text Books:

1 Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011

2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 ,2<sup>nd</sup> Edition

#### Reference Books :

1. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2012

2. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc

3. Fundamentals of Automobile Engineering K.K. Ramalingam Scitech Publications (India) Pvt. Ltd

#### Alternate Assessment Tools (AATs) suggested:

AAT1: Power point Presentation

AAT2 : Gate based MCQ