Elements of Mechanical Engineering		Semester	I / II
Course Code	1BEME105/205	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3
Examination type (SEE)	Theory		

Course Outcomes

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

1. Analyse the properties of steam, various engineering materials along with their classifications and applications.
2. Illustrate the basic concepts of thermodynamics, internal combustion engines and electric/hybrid vehicles.
3. Demonstrate the working and operations of machine tools and metal joining techniques.
4. Outline the configuration, anatomy, and performance parameters of robots.
5. Apply the concepts of belt and gear drives to solve basic numerical problems related to velocity ratio in gear drives.
6. Discuss the role of computer systems in manufacturing, their contribution to automation, and the applications of 3D printing and AI in mechanical engineering.

Module-1

Engineering materials: Introduction, Classification, Ferrous and Non-Ferrous metals: Types, Properties and their applications.

Composite materials: Introduction, Constituents of a composite, Classification, Types of Matrix and Reinforcement materials, Advantages, Disadvantages and Applications of composite materials in Aerospace and Automobile industries.

Smart materials: Introduction, Types - Piezoelectric materials, MR fluids, Shape memory alloys and Advantages, Disadvantages and Applications.

Nano materials: Introduction, Types of nano materials, Advantages, Disadvantages and Applications.

Number of Hours: 8

Module-2

Concepts of Thermodynamics: Work, Energy, Heat, Modes of Heat transfer: Conduction, Convection and Radiation. Steam: Formation of steam, Properties of Steam, Numericals related to the properties of steam.

Introduction to Heat engines and Heat pumps.

Introduction to Internal Combustion engines: Working principle of Two stroke and Four stroke engines (SI & CI Engines), No Numericals.

Electric vehicles and Hybrid vehicles: Working principles, Electric and Hybrid vehicle components, Brief introduction to energy storage in Electric vehicles.

Number of Hours: 8

Module-3

Machine Tools:

Lathe: Working principle, Specifications, Operations performed – Turning, Facing, Taper turning by swivelling the compound rest, Thread cutting and Knurling.

Drilling Machine: Working principle, Specifications, Operations performed – Drilling, Reaming, Boring, Counterboring, Countersinking, Tapping.

Milling machine: Working principle, Specifications, Operations performed – Plane milling, End milling, Slot milling, Angular milling.

(Sketches of machine tools not required. Sketches to be used only for explaining the operations).

Joining Processes: Introduction, Temporary and Permanent joining methods: Working principle of Soldering, Brazing and Electric Arc welding, Advantages, Limitations and Applications.

Number of Hours: 8

Module-4

Belt drives: Introduction, Open and Cross belt drives. (No derivations and numericals), Flat belts and V belts.

Gear Drives: Types of Gears, Velocity ratio, Gear Trains - Simple and Compound gear trains and Numericals.

Robotics: Introduction, Generation of Robots, Asimov's laws of Robots, Robot anatomy - Links and Joints, Types of Robots, Configurations of Robots, Robot motion - Degrees of Freedom, Robot sensors: Tactile, Force, Proximity and Vision sensors, Definition of Work volume, Accuracy, Precision, Repeatability and Payload.

Number of Hours: 8

Module-5

Computer Numerical Control (CNC): Introduction, Definition of NC and CNC Components of CNC. Definition of CAD, CAM, CAE and CIM.

Automation: Definition, Types of Automation, Reasons for Automation.

Additive manufacturing: Introduction, Basic principles (Steps in additive manufacturing), Additive manufacturing processes – Photopolymerization technique, Material extrusion technique and Powder based fusion technique, Automotive and Aerospace applications.

Applications of AI in Mechanical Engineering: Automobile industry, manufacturing industry and Mechanical design.

Number of Hours: 8

Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):

Textbooks:

1. K R Gopala Krishna, Elements of Mechanical Engineering, Subhash Publications, 2018.
2. S K Hajra Choudhury and Nirjhar Roy, Elements of Workshop Technology (Vol. I and II), Media Promoters and Publishers Pvt. Ltd., 2016.
3. Ganeshan. V, Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012.
4. Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt) Ltd., New Delhi. 6th Edition, 2007.
5. Mikell P. Grover, Automation Production Systems and Computer Integrated Manufacturing, PHI, 2004.
6. Husain Iqbal, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 3rd Edition,

2021.
7. Ian Gibson, David. W. Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2nd Edition, 2014.
8. Mikell P. Groover and Emory W. Zimmers, CAD/CAM. Zimmer & Groover CAD/CAM, 2007.

Reference books / Manuals:

1. Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Fourth Edition, Pearson Education, Asia, 2000.
2. Radha Krishna & S. Subramanian, CAD/CAM/CIM, New Age International Publishers, 2009
3. F.L.Matthews and R.D.Rawlings, Composite materials: Engineering and Science, Woodhead Publishing Ltd. & CRC Press, 2003.
4. Mikell P.Groover and Mitchel Weiss and Roger N.Nagel Nicholas G.Odrey, Industrial Robotics technology, programming and applications, Tata McGraw Hill Edition, 2008

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112104526
- https://nptel.ac.in/courses/112104616
- https://nptel.ac.in/courses/112104769
- https://venturebeat.com/ai/how-ai-is-impacting-the-automotive-world/
- https://www.vlcsolutions.com/blog/artificial-intelligence-in-manufacturing/
- https://skill-lync.com/blogs/technical-blogs/design-applications-of-machine-learning-and-ai-in-mechanical-engineering
- https://caeassistant.com/blog/ai-in-mechanical-engineering-video/
- https://www.neuralconcept.com/post/how-is-ai-used-in-mechanical-engineering
- https://www.youtube.com/watch?v=MKiiXubKaGM
- https://www.youtube.com/watch?v=_canCYWZPsc
- https://www.youtube.com/watch?v=lQ-MYnyxh7M

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Simulation and Virtual Labs
- Partial Delivery of course by Industry experts
- ICT-Enabled Teaching
- Video demonstration

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage. The CIE component consists of IA tests for 25 marks (Average of Two Tests) and Continuous Comprehensive Assessments (CCA) for 25 marks.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.

- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA):

CCA will be conducted for a total of 25 marks. It is evaluated through the learning activities which are aimed at enhancing the holistic development of students. These activities should align with course objectives and promote higher-order thinking and application-based learning.

Learning Activity - 1: Case Study Presentation (Marks: 15 Marks)
Learning Activity - 2: Material Selection and Justification for a chosen Real-world Engineering Product (Marks: 10 Marks)

Rubrics for Learning Activity 1:

Case Study Presentation (15 Marks)

(To be conducted for 30 marks and the marks obtained shall be reduced to 15)

Case Study topic should relate to key learning area from the syllabus and allow exploration of practical applications, challenges, and innovations relevant to engineering education and industry.

Performance Indicators	Excellent	Good	Satisfactory	Needs Improvement	Poor
Understanding of Case (5 Marks) (PO 1)	Demonstrates deep understanding **(5)**	Good understanding **(4)**	Adequate understanding. **(3)**	Limited understanding **(2)**	No clear understanding. **(0-1)**
Analysis & Critical Thinking (10 Marks) (PO 2)	Thorough, logical analysis with strong reasoning and innovative insights. **(9-10)**	Clear analysis with mostly logical reasoning. **(7-8)**	Basic analysis with some reasoning gaps. **(5-6)**	Weak analysis; mostly descriptive without reasoning. **(3-4)**	No clear analysis or reasoning. **(0-2)**
Documentation & Presentation Skills (10 Marks) (PO 9)	Documentation is complete, accurate, well-structured, follows all formatting guidelines. Well-structured, clear, confident delivery; excellent visuals. **(9-10)**	Documentation is mostly complete and accurate, well-organized, follows formatting guidelines with minor deviations. Good structure, clear delivery; visuals mostly effective. **(7-8)**	Documentation covers most required elements but has some inaccuracies or omissions. Average structure; delivery clear but lacks engagement. **(5-6)**	Documentation is incomplete with noticeable inaccuracies. Poor organization; visuals unclear. **(3-4)**	Documentation is largely missing or irrelevant, lacks structure. Unclear, disorganized presentation. **(0-2)**
Q&A Handling (5 Marks) (PO 9)	Confident, accurate, and concise responses. **(5)**	Good responses with minor gaps. **(4)**	Adequate responses; some uncertainty. **(3)**	Weak or hesitant responses. **(2)**	Unable to answer questions. **(0-1)**

Rubrics for Learning Activity 2:

Material Selection and Justification for a chosen Real-world Engineering Product

(10 Marks)

(To be conducted for 20 marks and the marks obtained shall be reduced to 10)

Students will select one real-world engineering product (e.g., aircraft wing, car chassis, biomedical implant, wind turbine blade, Tennis racket etc.) and they will justify the choice of materials (Ferrous/Non-ferrous, Composite, Smart, Nano) based on properties, advantages, disadvantages, and application suitability, etc.,

Performance Indicators	Excellent	Good	Satisfactory	Needs Improvement	Poor
Material Selection & Relevance (10 Marks) (PO 1)	Chosen materials perfectly match the product requirements; strong justification using properties & industry relevance. **(9-10)**	Mostly relevant materials with good justification. **(7-8)**	Materials somewhat match requirements; justification partial. **(5-6)**	Poor material-product match; weak reasoning. **(3-4)**	Irrelevant material choice; no justification. **(0-2)**
Technical Content Accuracy (5 Marks) (PO 2)	All properties, types, advantages / disadvantages, and applications are correct and well-explained. **(5)**	Mostly accurate with minor errors. **(4)**	Adequate content; a few gaps or inaccuracies. **(3)**	Several inaccuracies; missing key aspects. **(2)**	Mostly incorrect or missing technical details. **(0-1)**
Organization & Presentation (5 Marks) (PO 10)	Well-structured, clear flow, good visuals/tables, and concise explanation. **(5)**	Clear structure; minor improvements needed. **(4)**	Acceptable structure but some clutter. **(3)**	Poor organization; difficult to follow. **(2)**	Disorganized; lacks clarity. **(0-1)**