

## **Week-1**

### **Introduction to Mechanical Engineering**

1. What is Mechanical Engineering, and what are its core areas of study?
2. What is the current and future scope of Mechanical Engineering in India and globally?
3. What are the major job roles available for Mechanical Engineers in both public and private sectors?

### **Fundamental Units**

1. What are fundamental units, and why are Length, Mass, Time, and Temperature considered fundamental quantities?
2. Define the CGS, FPS, MKS, and SI systems of units.
3. What are the units of Length, Mass, Time, and Temperature in CGS, FPS, MKS, and SI systems?
4. How do you convert units of Length, Mass, Time, and Temperature from one system (e.g., CGS) to another (e.g., SI)?
5. Why is the SI system preferred over other systems in scientific and engineering applications?

### **Derived Units**

6. What are derived units? Give examples related to Area, Volume, Density, Velocity, Acceleration, Force, Work, Energy, and Power.
7. What are the formulas for calculating Area, Volume, Density, Velocity, Acceleration, Force, Work, Energy, and Power?
8. What are the units of Area, Volume, Density, Velocity, Acceleration, Force, Work, Energy, and Power in CGS, FPS, MKS, and SI systems?
9. How do you convert derived units such as Force or Energy from one system to another?
10. Solve a simple numerical example converting force from CGS to SI units.

## **Week-2**

### **Material Science**

1. What are the main categories of engineering materials?
2. How are metals and non-metals classified and differentiated in engineering materials?
3. What are ferrous and non-ferrous metals? Give examples of each.

### **Mechanical Properties**

1. What is elasticity, and how does it differ from plasticity in materials?
2. Define malleability and ductility, and explain their importance in material selection.
3. What is brittleness, and how does it affect the behaviour of materials under stress?
4. Explain the terms strength, toughness, hardness, and stiffness with examples.
5. What is resilience, and how is it measured in engineering materials?
6. Describe the phenomena of creep and fatigue in materials and their impact on material performance.
7. What is endurance limit, and why is it significant in mechanical design?
8. How does machinability influence the choice of materials in manufacturing?

### **Thermal Properties**

9. What is thermal conductivity, and why is it important in material applications?
10. Define specific heat capacity and thermal expansion and their roles in engineering.
11. What is thermal diffusivity, and how does it affect heat transfer in materials?
12. Explain thermal fatigue and thermal shock with examples of where they occur.
13. How does melting point influence the selection of materials for high-temperature applications?

### **Electrical Properties**

14. Define resistivity and conductivity and explain their relationship.
15. What is dielectric strength, and why is it important for insulating materials?
16. Explain the temperature coefficient of resistance and its effect on electrical conductors.

### **Chemical Properties**

17. How do engineering materials react with oxygen, and what is the effect of oxidation or corrosion?
18. Describe the reaction of metals with water and its practical implications.
19. What happens when engineering materials react with acids and bases? Provide examples.
20. How do chemical properties influence the durability and maintenance of engineering materials?

### **Magnetic Properties**

1. What are diamagnetic materials, and how do they respond to magnetic fields?

2. Define paramagnetic materials and explain their magnetic behavior.
3. What are ferromagnetic materials, and why are they important in engineering applications?
4. Explain the terms magnetic permeability and magnetic susceptibility. How are they related?
5. What is magnetic flux density, and how does it differ from magnetic field strength?
6. Define magnetic moment and magnetization. How do they contribute to a material's magnetic properties?
7. How is magnetization measured, and what factors affect it in materials?
8. What are some common applications of materials with different magnetic properties?
9. How do temperature and external magnetic fields influence ferromagnetism?
10. Explain the concept of hysteresis in ferromagnetic materials.

### **Week-3**

### **Ferrous Materials**

#### **Cast Iron**

1. What are the different types of cast iron and how do they differ in properties and composition?
2. Describe the characteristics and applications of Grey Cast Iron.
3. What are the key properties and typical uses of White Cast Iron?
4. Explain Malleable Cast Iron and its significance in engineering.
5. How does the carbon content affect the properties of cast iron?

#### **Steel**

6. What are the main types of steel based on carbon content?
7. How do the properties and applications vary among Low Carbon Steel, Mild Steel, Medium Carbon Steel, and High Carbon Steel?
8. What is the designation system for different types of steel?
9. Why is Mild Steel commonly used in construction and manufacturing?
10. How does increasing carbon content influence the hardness and ductility of steel?

#### **Alloy Steel**

11. What are alloy steels and how do they differ from plain carbon steels?
12. Describe the properties and applications of Tool Steel and Tungsten Steel.

13. What makes Stainless Steel corrosion-resistant, and where is it typically used?
14. Explain the characteristics and uses of High-Speed Steel (HSS).
15. How do alloying elements affect the mechanical and chemical properties of steel?

## **Week-4**

### **Non-Ferrous Materials**

#### **Aluminum and Aluminum Alloys**

1. What are the key properties of aluminum that make it suitable for engineering applications?
2. What is Duralumin, and what are its composition and typical uses?
3. Describe Y-Alloy and its advantages over pure aluminum.
4. What role does magnesium play in aluminum alloys like Hindalium?
5. How do aluminum alloys compare with other metals in terms of strength and corrosion resistance?

#### **Copper and Copper Alloys**

6. What are the main properties and applications of copper in engineering?
7. How do brass, bronze, and gunmetal differ in composition and usage?
8. What are bearing metals, and why are they important in mechanical systems?
9. Describe the composition and uses of zinc-based alloys like solder and German silver.
10. How do lead and tin improve the properties of copper alloys?

#### **Nickel-Based Alloys**

11. What are the characteristics of nickel-based alloys like Inconel and Monel?
12. How do Inconel and Monel perform in high-temperature and corrosive environments?
13. What are the common applications of nickel-based alloys in industry?
14. How does the composition of nickel-based alloys affect their mechanical and chemical properties?
15. Why are nickel-based alloys preferred for aerospace and chemical processing equipment?

## **Week-5**

## **Non- Metals**

### **Polymers**

1. What is the difference between thermoplastics and thermosetting polymers?
2. What are the key properties and common applications of thermoplastics like PE, PLA, PVC, Nylon, and ABS?
3. Describe the properties and uses of thermosetting polymers such as Bakelite and Epoxy.
4. What are biodegradable polymers, and why are they important in today's environment?
5. How do the mechanical and thermal properties of thermoplastics differ from thermosetting polymers?

### **Ceramics**

6. What are the main types of ceramics, particularly oxides and carbides?
7. What properties make ceramics suitable for high-temperature and wear-resistant applications?
8. What are some common engineering applications of oxide and carbide ceramics?
9. How do ceramics compare to metals in terms of brittleness and hardness?
10. What role do ceramics play in electrical and thermal insulation?

### **Composites**

11. What are composites, and how do they differ from traditional engineering materials?
12. What are GFRP (Glass Fiber Reinforced Polymer) and CFRP (Carbon Fiber Reinforced Polymer), and what are their key properties?
13. In what industries are GFRP and CFRP commonly used, and why?
14. What advantages do composites offer in terms of strength-to-weight ratio?
15. What are the limitations or challenges associated with using composite materials?

## **Week-6**

### **Carpentry Practice**

1. What are the common types of wood used in carpentry, and what are their key properties?
2. Describe the differences between hardwood and softwood with examples.
3. What are the essential hand tools used in carpentry, and what are their specific uses?
4. How is a carpenter's square used to check and mark right angles?

5. Explain the purpose and method of making a mortise and tenon joint.
6. What safety precautions should be taken while working with carpentry tools?
7. Describe the steps involved in preparing timber for construction or furniture making.
8. What are the common types of saws used in carpentry, and how do you select the appropriate saw for a job?
9. How do you measure and mark wood accurately before cutting?
10. What are the different types of nails and screws used in carpentry, and when should each be used?
11. Explain the use and maintenance of chisels in carpentry.
12. What are the basic finishing techniques used to protect and beautify wood surfaces?
13. How is a wood joint tested for strength and durability?
14. Describe the process of bending wood in carpentry and the tools involved.
15. What is seasoning of timber, and why is it important?

## **Week-7**

### **Fitting Practice**

1. What is fitting, and why is it an essential skill in mechanical workshops?
2. What are the common tools used in fitting practice, such as files, hacksaws, chisels, and hammers?
3. Describe the types of files and their specific uses in fitting operations.
4. What are the safety precautions to be followed while performing fitting work?
5. Explain the procedure for marking and measuring in fitting tasks.
6. What are the common types of joints made during fitting, such as lap joints, butt joints, and T-joints?
7. How do you perform drilling and tapping operations in fitting practice?
8. What is the purpose of reaming in fitting, and how is it performed?
9. How do you select the appropriate size and type of fasteners (nuts, bolts, screws) during fitting?
10. Describe the process of assembling and dismantling mechanical components in fitting.

11. What are the common defects encountered during fitting and how can they be prevented?
12. How do you check the accuracy and finish of a fitting job?
13. Explain the importance of surface finish and tolerances in fitting practice.
14. What is the use of a vernier caliper and micrometer in fitting operations?
15. How is filing done correctly to achieve a smooth surface and proper fit?

## **Week-8**

### **Basics of Kinematics of Machines**

1. What is a kinematic link or element, and what are the different types of links used in mechanisms?
2. Define a kinematic pair and explain its classification based on relative motion.
3. What are the types of constrained motions in mechanical systems?
4. Define kinematic chain and explain its significance in machine design.
5. Differentiate between a machine, a structure, and a mechanism with examples.
6. What is inversion of a kinematic chain? Give examples of different types of inversions.
7. Explain the four-bar chain mechanism and its common applications.
8. What is a beam engine, and how is it related to kinematic chains?
9. How do lower pairs differ from higher pairs in kinematic pairs?
10. What is the role of kinematic pairs in the mobility and functionality of a mechanism?

## **Week-9**

### **Inversions and Kinematic Chains**

1. What is a Single Slider Crank Chain, and how does it function in mechanical systems?
2. Describe the working principle of the Crank and Slotted Lever mechanism.
3. What is a Quick Return Motion Mechanism, and where is it commonly used?
4. Explain the Double Slider Crank Chain and its applications.
5. What is the Scotch Yoke mechanism, and how does it convert rotary motion to reciprocating motion?

6. Describe the construction and working of a Pantograph mechanism.
7. How do the Single Slider Crank and Double Slider Crank mechanisms differ in terms of movement and application?
8. What are the advantages of using the Quick Return Mechanism in shaping and slotting machines?
9. How does the Pantograph mechanism help in scaling drawings or mechanical movements?
10. Explain the significance of kinematic pairs in the operation of these mechanisms.

## **Week-10**

### **Transmission System**

#### **Belt Drives**

1. What are the different types of belt drives, and how do they differ?
2. How do you calculate the length of a belt in open and cross belt drives?
3. Define velocity ratio in belt drives and explain its significance.
4. What are slip and creep in belt drives, and how do they affect performance?
5. What materials are commonly used for manufacturing belts, and why?
6. What are the advantages and disadvantages of belt drives compared to other transmission systems?

#### **Rope Drives**

7. What are rope drives, and in what applications are they commonly used?
8. How do rope drives compare to belt drives in terms of power transmission and efficiency?
9. What are the materials typically used for ropes in rope drives?
10. What are the key factors affecting the performance and lifespan of rope drives?

#### **Chain Drives**

11. What are chain drives, and where are they commonly applied?
12. How do chain drives differ from belt drives in terms of load capacity and efficiency?
13. What types of chains are used in chain drives?
14. What are the advantages and limitations of chain drives in mechanical systems?
15. How is maintenance of chain drives important for their longevity?

## **Week-11**

### **Gears and Gear Trains**

#### **Gear Drives**

1. What are gear drives, and why are they used in mechanical systems?
2. How are gears classified based on their shapes and orientations?
3. Explain common gear terminology such as pitch circle, module, number of teeth, and pressure angle.
4. What are the advantages of using gear drives over other types of power transmission?

#### **Gear Trains**

5. What is a gear train, and what are the different types of gear trains?
6. Differentiate between simple and compound gear trains with examples.
7. What is a reverted gear train, and where is it typically used?
8. Explain the working and applications of epicyclic (planetary) gear trains.
9. How are gear trains used in machines like lathes, milling machines, and gearboxes?
10. What factors affect the velocity ratio in gear trains?

#### **Practical Applications and Calculations**

11. How do you determine the velocity ratio in belt drives and gear drives?
12. Solve simple problems involving velocity ratios in gear trains.
13. How is velocity ratio important in the operation of lathe, drilling, shaping, planer, and grinding machines?
14. What role do gear trains play in controlling speed and torque in machine tools?
15. How does the design of a gear train impact the efficiency and performance of a machine?

## **Week-12**

### **Metal Joining processes**

1. What are the main differences between temporary and permanent joining processes?
2. What are fasteners, and what are the common types used in mechanical joining?
3. Describe the different types of rivets and their typical applications.

4. What are the types of bolts and nuts, and how are they selected for different joints?

### **Welding**

5. How are welding processes classified?

6. Explain the principle and working of the arc welding process.

7. What types of electrodes are used in arc welding, and how are they selected?

8. Describe the main equipment used in arc welding.

9. What are TIG (GTAW) and MIG (GMAW) welding processes? How do they differ?

10. What are common defects found in the arc welding process, and how can they be prevented?

### **Practical Welding Practice**

11. What safety precautions should be followed during arc welding to prevent accidents and injuries?

12. What are the essential tools and equipment required for performing arc welding?

13. Describe the step-by-step process of performing arc welding.

14. How do you interpret and follow a welding drawing or model for practice?

15. How is quality checked in a completed arc welding joint?

### **Week-13**

#### **Gas welding**

1. What is CO<sub>2</sub> welding, and how does it differ from oxy-acetylene gas welding?

2. Explain the working principle of the oxy-acetylene gas welding process.

3. What are the different types of flames used in gas welding, and how are they classified?

4. How does the flame type affect the welding process and the quality of the weld?

5. What safety precautions are essential to follow during gas welding?

6. What are the basic tools and equipment used in gas welding?

7. Describe the procedure for setting up and performing gas welding with different flames.

8. How do you practice welding straight line beads and multi-layer welds on mild steel plates?

9. Explain the technique for performing a structural pipe welding butt joint in the 1G position.

10. What are common defects encountered in gas welding, and how can they be detected and prevented?

### **Practical Welding Practice**

11. How is flame adjustment done for different types of welding tasks?

12. What is the significance of practicing on MS plates and pipes before actual production welding?

13. How do you inspect a weld bead for quality and defects?

14. What are the challenges in welding a 10 mm thick MS plate and how can they be addressed?

15. Describe the steps to ensure proper welding in horizontal and 1G pipe positions.