

Registration No.:

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Total Number of Pages: 02

Course: B.Tech/IDD  
Sub\_Code: 23ES1006

1<sup>st</sup> / 3<sup>rd</sup> Semester Regular/Back Examination: 2024-25

SUBJECT: Basic Mechanical Engineering

BRANCH(S): CE, CHEM, CHEM, CIVIL, BIOTECH, BIOMED, AE, AERO, AEIE, AUTO, CIVIL, CSE, CSE, CSEAI, CSEAIML, CSEDS, CSEDS, ECE, ECE, ECE, CST, ETC, ETC, EE, EEE, EEE, ELECTRICAL & C.E, ELECTRICAL, ELECTRICAL, MECH, METTA, MECH, METTA, MINERAL, MINERAL, IT, MANUTECH, MINING, MINING, MMEAM, MME, MME, PLASTIC, PT, CSEIOT, EEVDT

Time: 3 Hours

Max Marks: 100

Q.Code: R543

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

**Part-I**

**Q1 Answer the following questions: (2 x 10)**

- What are thermodynamic properties? Differentiate between intensive and extensive properties.
- State the Zeroth Law of Thermodynamics and explain its significance.
- Define entropy and explain its physical significance.
- Differentiate between a 2-stroke and a 4-stroke internal combustion engine.
- Define the term "specific gravity" of a fluid.
- How does the viscosity of fluid vary with temperature?
- What is thermal conductivity? How does it vary for solids and gases?
- Mention the advantages of metal forming process over other manufacturing processes.
- Mention the key principles of a robot.
- Differentiate between shaft and axle in power transmission devices.

**Part-II**

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)**

- Using the First Law of Thermodynamics, derive the energy balance equation for a closed system undergoing a cyclic process.
- Discuss the importance of the Second Law of Thermodynamics in determining the direction of spontaneous processes.
- What is a polytropic process? Derive an expression for the work done during a polytropic process in terms of pressure and volume.
- Illustrate the working cycle of a 4-stroke internal combustion engine with a schematic diagram. Explain each stroke in detail.
- Differentiate between (I) Laminar vs Turbulent Flow, (II) Uniform vs Non-uniform Flow, (III) Steady vs Unsteady Flow, and (iv) Compressible vs Incompressible Flow.

- f) Name the fluid properties responsible for the following actions in fluid mechanics: (I) transport of water from root to the leaves of a plant, (II) spherical form of water bubbles, (III) small insects being able to walk on water surface, (IV) cavitation, (V) no-slip condition, and (VI) boiling of water below 100 °C temperature.
- g) Explain the classification of heat transfer processes, and discuss how convection heat transfer is influenced by fluid motion.
- h) Classify engineering materials and describe their characteristics with examples. Discuss the advantages and limitations of composite materials.
- i) Highlight the requirements of a good gating system in the casting process.
- j) Discuss the commonly encountered defects in sand casting process.
- k) Discuss the advantages and disadvantages of spur gears and helical gears used for power transmission between two shafts.
- l) Highlight different industrial applications of robots.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** a) Air at 12 °C and 85 kPa enters the diffuser of jet engine steadily with a velocity of 220 m/s. The inlet area of the diffuser is 0.38 m<sup>2</sup>. The air leaves the diffuser at a negligible velocity compared to inlet velocity. Calculate (i) mass flow rate of air (ii) the temperature of air leaving the diffuser. **(8+8)**
- b) A heat pump is used to heat the house in the winter. A house requires 50 kJ/s heat for heating in winter which is delivered by heat pump from outside air. Work required to operate the heat pump is 8 kW. Calculate COP of heat pump and heat abstracted from the outside.
- Q4** a) Two parallel plates are separated by a fluid layer of thickness 0.01 m. The lower plate is stationary, and the upper plate is subjected to a force of 10 N over an area of 0.2 m<sup>2</sup>. The fluid has a dynamic viscosity of 0.8 Pa. Determine the velocity of the upper plate. **(8+8)**
- b) What is the vapor pressure of a liquid? How is it related to cavitation? Explain the factors that influence the vapor pressure of a liquid.
- Q5** a) The velocity vector in a fluid flow is given as:  $V = 4x^3 \hat{i} - 10x^2y \hat{j} + 2t \hat{k}$  **(8+8)**  
Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time t = 1.
- b) A plane wall of 10 cm thickness and 3 m<sup>2</sup> area is made of a material whose conductivity is 8.5 W/mK. The temperatures of the wall surfaces are steady at 100 °C and 30 °C respectively. Find the temperature gradient and heat flow across the wall.
- Q6** a) Define and explain the following mechanical properties: elasticity, plasticity, toughness, and hardness. Provide examples where these properties are critical in material selection. **(8+8)**
- b) Explain the types of joints commonly used in robots, such as prismatic, revolute, and spherical joints. Provide examples of where each type is used.