

Registration No.:

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Total Number of Pages: 02

Course: Integrated Dual Degree  
(B.Tech and M.Tech)  
Sub\_Code: 23ES1006

2<sup>nd</sup> Semester Regular Examination: 2023-24

SUBJECT: Basic Mechanical Engineering

BRANCH(S): AEIE, AUTO, BIOTECH, CE, CHEM, CIVIL, CSE, CSEAI, CSEAIME, CSEDS,  
CSIT, CST, ECE, EEE, ELECTRICAL, ETC, MECH, METTA, MINING, MME

Time: 3 Hours

Max Marks: 100

Q.Code: P523

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)**
- Differentiate between point function and path function with examples.
  - Describe PMM1 and PMM2. Mention their thermodynamic significance.
  - Define solidification shrinkage in casting. Mention the function of riser.
  - Liquid droplets are spherical in shape. Why?
  - What is compressibility? How does compressibility affect the behavior of fluids?
  - Explain conduction and convection modes of heat transfer with suitable examples.
  - Distinguish between saturated vapor and superheated vapor.
  - Differentiate between shaft and axle in a motion and power transmission system.
  - Write down four different elements of power transmission system.
  - Highlight the advantages of belt drive over chain drive.

**Part-II**

- Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)**
- State first law of thermodynamics. Mention its limitations. How are these limitations addressed in thermodynamic system?
  - Define entropy. Highlight its characteristics. Is it a property of the system? Justify your answer.
  - Distinguish between Newtonian and Non-Newtonian fluids. Explain the characteristics of shear stress vs shear strain for different fluids.
  - Name the properties of fluids which contribute to the following effects:  
(I) walking of an insect on water surface, (II) surface erosion of turbomachinery parts,  
(III) water absorption in plant's roots, (IV) speed of sound in air, (V) boiling of water,  
and (VI) resistance to fluid flow.

- e) Explain heat transfer process because of convection. Highlight the factors which affect the rate of heat transfer because of convection. What are the possible ways to enhance heat transfer due to convection?
- f) Explain the working principle of four-stroke petrol engine with neat sketches.
- g) Show that COP of heat pump will always be greater than unity.
- h) Explain with neat sketch the working principle of reciprocating air compressor.
- i) Describe the functionalities of different parts in a sand mould casting process.
- j) Explain in details different properties of engineering materials.
- k) Define thermodynamic work. Explain any three types of thermodynamic work.
- l) Name the type of gear drives used for following power transmission purposes: (I) between two parallel shafts at low speed, (II) between two parallel shafts at high speed, (III) with large speed reduction, (IV) converting rotary motion to translatory motion, (V) between two inclined and intersecting shafts, and (VI) between two non-parallel and non-intersecting shafts.

### Part-III

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

- Q3** a)  $5 \text{ m}^3$  of air at 2 bars and  $27^\circ\text{C}$  is compressed to 6 bar in a polytropic process:  $pV^{1.3} = \text{Constant}$ . It is subsequently expanded to 2 bar in a reversible adiabatic process. Find the net work done in kJ. **(8+8)**
- b) A gas enters into a gas turbine at 40 bar,  $1047^\circ\text{C}$  having velocity 200 m/s. It leaves the turbine at 1 bar with a velocity of 100 m/s. Turbine is insulated such that process can be assumed adiabatic. Find the work output of the turbine per unit mass flow rate. (Consider  $C_p = 1.05 \text{ kJ/kg-K}$  and  $\gamma = 1.4$ )
- Q4** a) A heat pump working on a reversed Carnot cycle takes energy from a reservoir maintained at  $5^\circ\text{C}$  and deliver it to another reservoir, where temperature is  $77^\circ\text{C}$ . The heat pump takes power for its operation from a heat engine operating within higher and lower temperatures of  $1077^\circ\text{C}$  and  $77^\circ\text{C}$ . Estimate the energy taken from the reservoir at  $1077^\circ\text{C}$ . **(8+8)**
- b) A well-insulated rigid container contains  $1 \text{ m}^3$  of air having a mass of 1 kg. The pressure inside the container is  $10^5 \text{ Pa}$ . A stirrer connected to a motor of power 10.5 kW is rotated inside the container. Calculate the temperature inside the container after 2 secs. (Consider  $C_v = 0.717 \text{ kJ/kg-K}$  and  $R = 0.287 \text{ kJ/kg-K}$ ).
- Q5** a) Explain with neat sketch the working principle of steam power plant. **(8+8)**
- b) Describe p-T diagram for water highlighting all the phase change processes. Identify triple point in it. Explain why triple point is called as point of invariant.
- Q6** a) Explain welding process. Describe forehand and backhand welding with neat sketches. Highlight the functionalities of welding electrode, flux and filler rod in a welding process. **(8+8)**
- b) Describe the anatomy of a typical industrial robotic arm and its components. How do these components work together to achieve precise and flexible movements?