



DEPARTMENT OF MECHANICAL & INDUSTRIAL ENGINEERING

I SEMESTER B.TECH.

Mid-Term Exam

SUBJECT: BASIC MECHANICAL ENGINEERING SCIENCE (MIE 1072)

SCHEME OF EVALUATION

Time: 8.30-10.00 AM

Date: 26.09.2024

MAX. MARKS: 30

Type: DES

A6:

$$x = 0.5 \text{ --- (0.5 mark)}$$

$$\text{Heat supplied in the boiler} = h_Q - h_P$$

$$h_P = 125.61 \text{ kJ/kg --- (0.5 mark)}$$

$$h_Q = 1825.1 \text{ kJ/kg --- (0.5 mark)}$$

$$\text{Heat supplied in the boiler} = h_Q - h_P = 1825.1 - 125.61 = 1699.49 \text{ kJ/kg --- (0.5 mark)}$$

Condition of steam at exit of pipeline:

$$h_{Exit} = 0.8h_R$$

$$h_R = 3016.7 \text{ kJ/kg --- (0.5 mark)}$$

$$h_{Exit} = 2413.36 \text{ kJ/kg --- (0.5 mark)}$$

Since $h_{Exit} > h_f$ and $h_{Exit} < h_g$, the steam is wet. --- (0.5 mark)

$$x \text{ at exit} = 0.804 \text{ --- (0.5 mark)}$$

A7:

$$\theta = 3.2 \text{ radian --- (0.5 mark)}$$

$$\frac{T_1}{T_2} = 2.61 \text{ --- (0.5 mark)}$$

$$T_1 + T_2 = 1600 \text{ N --- (0.5 mark)}$$

$$T_1 = 1156.79 \text{ N --- (0.5 mark)}$$

$$T_2 = 443.21 \text{ N --- (0.5 mark)}$$

$$\text{Power Transmitted} = 1.87 \text{ kW --- (0.5 mark)}$$

A8:

$$\text{Length of open belt, } L = \Pi(r_1 + r_2) + [(r_1 - r_2)^2 / X] + 2X$$

$$5.571 = \Pi D + 0 + 2 \times 2; D = 0.5 \text{ m or } r_1 = r_2 = 0.25 \text{ m (0.5 mark)}$$

$$\text{Ratio of Tensions} = T_1 / T_2 = e^{\mu \Theta} = e^{0.3 \times 180 \times \pi / 180} = 2.57 \text{ (0.5 mark)}$$

$$T_1 + T_2 = 1000 \text{ N}$$

$$T_2 = 280.1 \text{ N (0.5 mark)}$$



and $T_1 = 719.9 \text{ N}$ (**0.5 mark**)

Power Transmitted = 26.39 kW (**01 mark**)

A9:

$$p = 2.7 \text{ bar}, T_{\text{sat}} = 130^\circ\text{C}, x = 0.85, h_f = 546.2 \frac{\text{kJ}}{\text{kg}}, h_{fg} = 2173.7 \frac{\text{kJ}}{\text{kg}}, h_g = 2719.9 \frac{\text{kJ}}{\text{kg}}, Q = 500 \frac{\text{kg}}{\text{day}}, T_1 = 25^\circ\text{C}, GCV_{\text{fuel}-1} = 25000 \frac{\text{kJ}}{\text{kg}}, GCV_{\text{fuel}-2} = 30000 \frac{\text{kJ}}{\text{kg}}, \eta = 75\%$$

$$h_w = 104.68 \frac{\text{kJ}}{\text{kg}} \text{ --- (0.5 marks)}$$

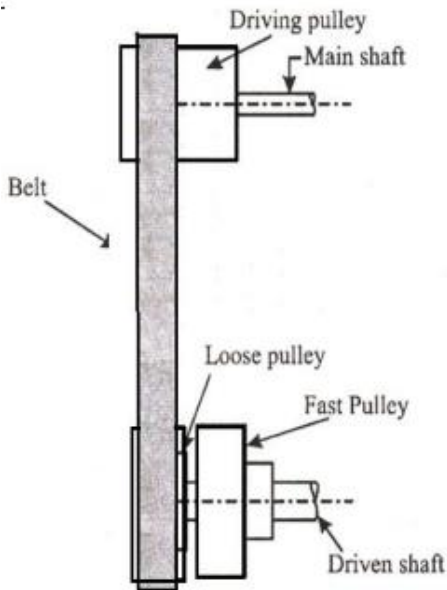
$$h_s = 2285.16 \text{ kJ/kg} \text{ --- (0.5 marks)}$$

$$m_{\text{fuel}-1} = 58.15 \text{ kg} \text{ --- (01 marks)}$$

$$m_{\text{fuel}-2} = 48.45 \text{ kg} \text{ --- (01 marks)}$$

A10:

Identification of the pulley as Fast and Loose Pulley (**01 mark**)



Sketch (**1.5 mark**)

- Deduct 0.5 mark if the sketch fails to depict a wider driving pulley
- Deduct 0.5 mark if the sketch shows too much gap between the fast and loose pulleys.

Explanation (**0.5 mark**)

A11:

$$\text{Given } Q = 4000 \frac{\text{kg}}{\text{h}}, T_{\text{sat}} = 188^\circ\text{C}, T_w = 30^\circ\text{C}, m_f = 2000 \frac{\text{kg}}{\text{h}}, CV_{\text{fuel}} = 25000 \frac{\text{kJ}}{\text{kg}}$$

$$\text{At } 12 \text{ bar}, h_f = 798.4 \frac{\text{kJ}}{\text{kg}}, h_{fg} = 1984.3 \frac{\text{kJ}}{\text{kg}}, h_g = 2782.7 \text{ kJ/kg}$$



Efficiency of boiler without accessory:

$$h_s = 2584.27 \text{ kJ/kg} \text{ --- (0.5 marks)}$$

$$h_w = 125.61 \frac{\text{kJ}}{\text{kg}} \text{ --- (0.5 marks)}$$

$$\eta = 19.67\% \text{ --- (0.5 marks)}$$

Efficiency of boiler with economiser:

$$\therefore h_w = 355.895 \frac{\text{kJ}}{\text{kg}} \text{ --- (0.5 marks)}$$

$$\text{Mass of coal consumption} = 1760 \text{ kJ/kg} \text{ --- (0.5 marks)}$$

$$\eta = 20.25\% \text{ --- (0.5 marks)}$$

A12:

Suggesting the boiler type as a Fire Tube Boiler --- (01 mark)

Justification (Any one point --- 01 mark)

- Fire tube boilers do not require water treatment
- Fire tube boilers are suitable for locomotives with in-built furnace

A13:

- a) Boiler mountings are required for safe operation of the boilers. They are mounted directly on the boiler drum and hence form an integral part of the boiler. --- (01 mark)
- b) To prevent reverse flow of water from the boiler drum to the reservoir due to difference in pressure when the feed pump fails/stops functioning. --- (01 mark)

A14:

Friction in belt drives ensure that there is no slipping of belt from the pulley surface ensuring minimum loss of power during its transmission. --- (01 marks)

Explanation to slip --- (01 marks)