

**UNIVERSITY COLLEGE TATI (UC TATI)****FINAL EXAMINATION QUESTION BOOKLET**

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| COURSE CODE | : BME 2143 |
| COURSE | : THERMO FLUID |
| SEMESTER/SESSION | : 2- 2023/2024 |
| DURATION | : 3 HOURS |

Instructions:

1. This booklet contains **FOUR (4)** questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write and Sketch legibly wherever required.
4. Question booklet need to be returned after session ends.
5. If in doubt, raise your hand and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 8 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

Superheated steam in **Figure 1** enters a nozzle at 450°C and 800 kPa with a velocity of 10 m/s , and leaves at 350°C and 200 kPa while losing heat at a rate of 25 kJ . For an inlet area of 800 cm^2 . Potential energy change is negligible.

- i. **Show** the value of enthalpy steam properties at inlet and outlet (15 marks)
- ii. Given that the specific volume (v) = $0.3844\text{ m}^3/\text{kg}$, **compute** the mass flow rate of the steam (5 marks)
- iii. **Compute** The exit velocity of the steam (7 marks)

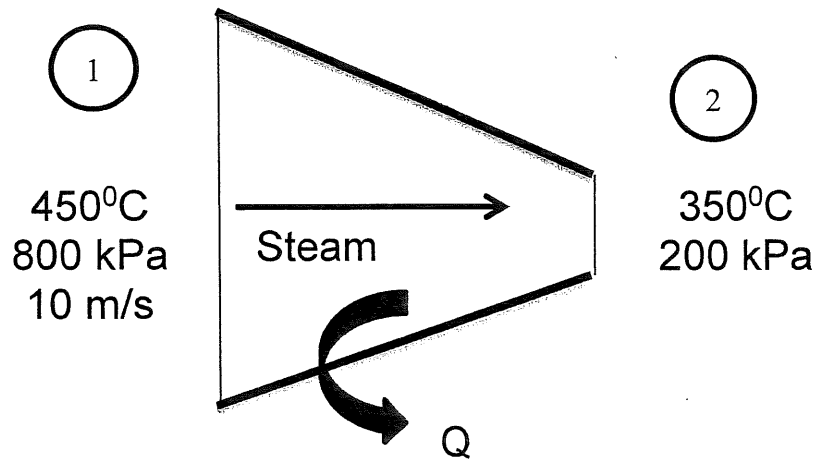


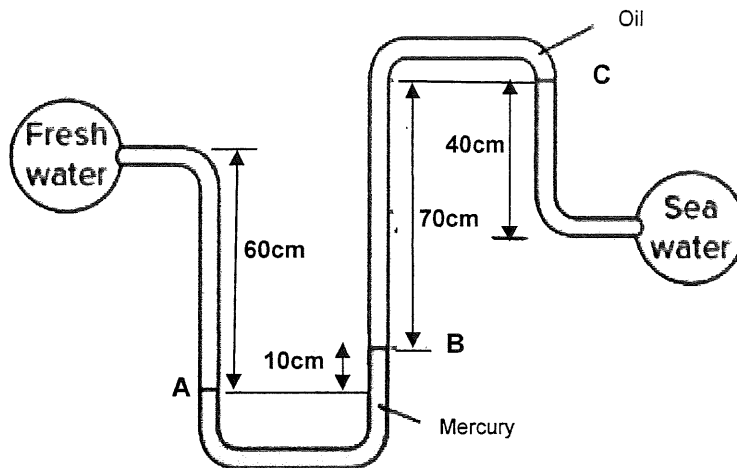
Figure 1

QUESTION 2

- a. **Illustrate** the simplistic representation of heat pump (3 marks)
- b. **Describe** the Zeroth Law of Thermodynamics (2 marks)
- c. The system has 1400 J of internal energy. 190 kJ of heat is added to a system, and the net amount of work done by the system is 3000 J. **Compute** the final internal energy of the system. (3 marks)
- d. A household refrigerator with Coefficient of Performance (COP) : 2.03 removes heat from the refrigerated space at a rate of 160 kJ/min.
- Illustrate** the simplistic representation of refrigerator (3 marks)
 - Compute** the rate of heat transfer to the kitchen in kJ/min (2 marks)
 - Compute** the electric power consumption of the refrigerator in kJ/min (2 marks)
- e. A steam power plant with a power output of 600 MW is cooled by a nearby lake. The thermal efficiency of this plant is 85%.
- Illustrate** the simplistic representation of steam plant (3 marks)
 - Compute** the heat transfer rate from a furnace in MW (2 marks)
 - Compute** the rate of heat rejected nearby lake in MW (2 marks)

QUESTION 3

- a. Freshwater and seawater flowing in parallel horizontal pipelines are connected to each other by a double U-tube manometer, as shown in **Figure 2**.
- i. **Determine** the pressure difference between the two pipelines. (8 marks)
 - ii. **Criticise** the value of fresh water pressure in pipe compare to pressure of sea water in pipe. (2 marks)



Density :

Sea Water = S.G 1.035

Oil = Specific Gravity 0.72

Fresh Water = 1000 kg/m³

Mercury = 13,600 kg/m³

Figure 2

- b. In a hydroelectric power plant (**Figure 3**), 65 m³/s of water flows from an elevation of 90 m to a turbine, where electric power is generated. If the mechanical power output of the turbine is 48,000 kW and the electric power generation is 53,600 Hp, Neglect losses in the pipes.

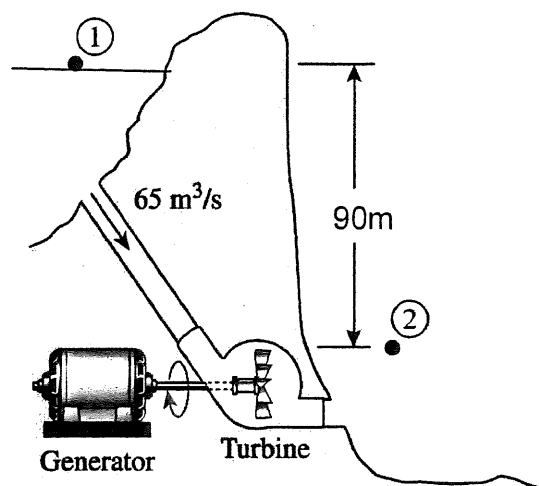


Figure 3

Compute

- i. the turbine efficiency (4 marks)
- ii. the generator efficiency (4 marks)
- iii. the combined turbine-generator efficiency of this plant. (5 marks)

QUESTION 4

a. A rectangular gate AB hinged along A to support the water pressure as shown in **Figure 4**. The gate width is 4 m. **Solve:**

- i. The location of centroid of gate from surface. (3 marks)
- ii. The location of center of pressure from surface. (10 marks)
- iii. The resultant hydrostatic force exerted on the gate AB. (3 marks)
- iv. The moment to be applied on the shaft at A if the gate needs to open. (6 marks)

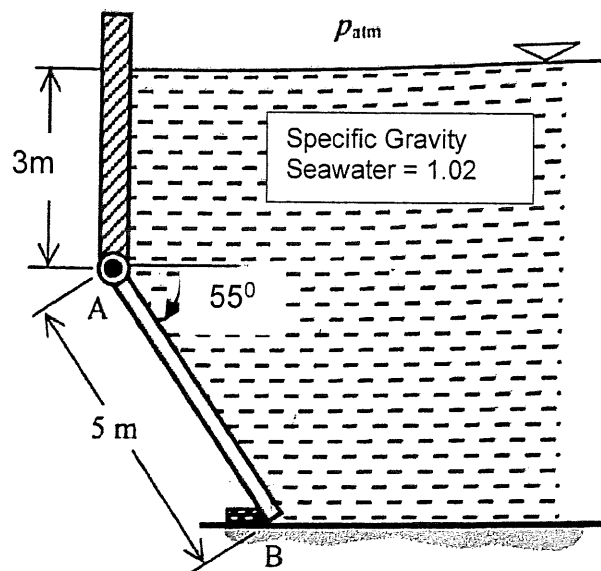


Figure 4

- b. If the sea water was replaced with fluid (specific gravity = 0.75), **solve**
- i. The resultant hydrostatic force exerted on the gate AB. (3 marks)
 - ii. The moment to be applied on the shaft at A if the gate needs to open. (3 marks)

-----End of question-----

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| Criteria | Marks |
|--|-------|
| All questions answered will be marked according to answer schema | / 100 |

FORMULA

$$A = \pi r^2$$

$$\text{Pressure} = \rho gh$$

$$\dot{E}_{in} = \dot{E}_{out}$$

$$\dot{m} = \frac{1}{v} VA$$

$$pe = \dot{m}gz$$

$$ke = \frac{\dot{m}v^2}{2}$$

$$pv = RT$$

$$\mu, COP = \frac{\text{Desired output}}{\text{Required input}}$$

$$P + \frac{\rho v^2}{2} + \rho gz = C$$

$$F_R = \rho gh_c A$$

$$h_p = h_c + \frac{I}{Ah_c}$$

$$S.G = \frac{\rho_{fluid}}{\rho_{water}}$$

Area Moment of inertia.

Table: Area inertia properties for some common cross sections

| | |
|--|--|
| | $A = bh$ $I_{xx} = \frac{bh^3}{12} \quad I_C = \frac{bh}{12}(b^2 + h^2)$ $I_{yy} = \frac{b^3h}{12}$ |
| | $A = \frac{bh}{2}$ $I_{xx} = \frac{bh^3}{36} \quad I_C = \frac{bh}{36}(b^2 + h^2)$ $I_{yy} = \frac{b^3h}{36}$ |
| | $A = \frac{\pi d^2}{4}$ $I_{xx} = I_{yy} = \frac{\pi d^4}{64}$ $I_C = \frac{\pi d^4}{32}$ |
| | $A = \frac{\pi}{4}(d^2 - d_i^2)$ $I_{xx} = I_{yy} = \frac{\pi}{64}(d^4 - d_i^4)$ $I_C = \frac{\pi}{32}(d^4 - d_i^4)$ |
| | $A = \frac{\pi r^2}{2}$ $I_{xx} = I_{yy} = \frac{\pi r^4}{8}$ $y_C = \frac{4r}{3\pi}$ |