UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	:	BME 2143
COURSE	:	THERMO FLUID
SEMESTER/SESSION	:	1– 2022/2023
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 9 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a. **Find** the final temperature if 100 J is added to 20.0 g of Aluminum at 25°C. The specific heat capacity for Aluminum is 0.902 J/(g°C) (2 marks)

b. **Describe** the First Law of Thermodynamics (2 marks)

c. **Explain** the isothermal process (2 marks)

d. **Explain** the isobaric process (2 marks)

e. **Explain** the meaning of "PROPERTIES" of a system in thermodynamic.(2 marks)

f. **Describe** specific gravity related to density (2 marks)

g. Water is being heated in a closed pan on top of a range while being stirred by a paddle wheel illustrate in **Figure 1**. During the process, 30 kJ of heat is transferred to the water, and 5 kJ of heat is lost to the surrounding air. The paddle-wheel work amounts to 500 Nm. **Find** the final energy of the system if its initial energy is 10 kJ. (3 marks)

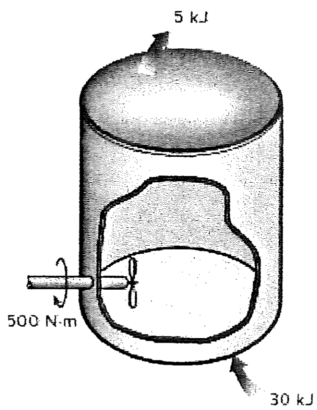

Figure 1

h. A gas is contained in a vertical, frictionless piston– cylinder device. The piston has a mass of 3.2 kg and a cross-sectional area of 35 cm^2. A compressed spring above the piston exerts a force of 150 N on the piston shown in **Figure 2**. If the atmospheric pressure is 95 kPa, **solve** the pressure inside the cylinder.

(5 marks)

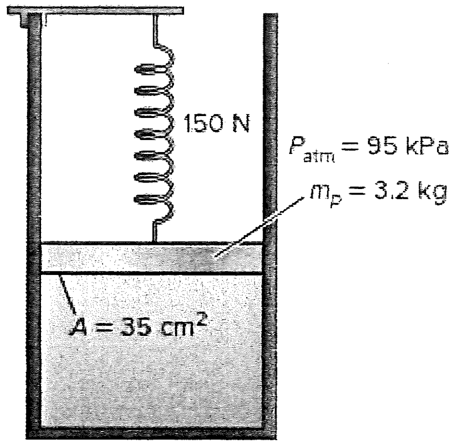

Figure 2

i. **Compute** the absolute pressure, P1 of the manometer shown in **Figure 3** in kPa. The local atmospheric pressure is 103 kPa.

(5 marks)

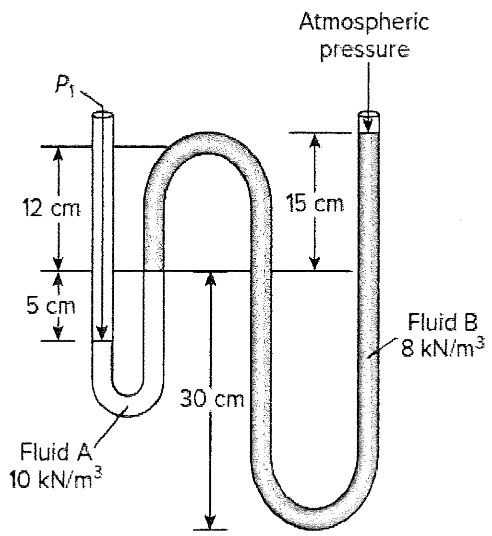

Figure 3

QUESTION 2

a. A household refrigerator with Coefficient of Performance (COP) 2.03 removes heat from the refrigerated space at a rate of 160 kJ/min.

  i. **Illustrate** the simplistic representation of refrigerator (2 marks)
  ii. **Compute** the rate of heat transfer to the kitchen in kJ/min (2 marks)
  iii. **Compute** the electric power consumption of the refrigerator in kJ/min (2 marks)

b. A completely reversible heat pump produces heat at a rate of 300 kW to warm a house maintained at 24°C. The exterior air, which is at 7°C, serves as the source as illustrate in **Figure 4**.

  i. **Compute** the Coefficient of performance (COP) (3 marks)
  ii. **Compute** the work done to the system. (3 marks)
  iii. **Compute** the heat (QL) need to feed to the system. (3 marks)

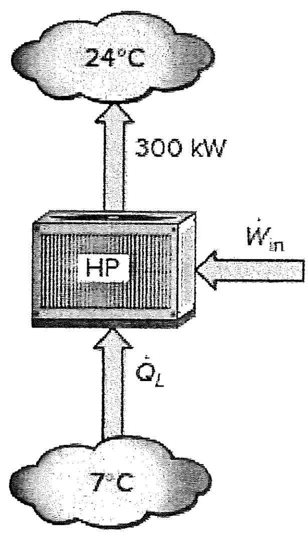

Figure 4

c. In a hydroelectric power plant (**Figure 5**), 65 m^3/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. **Compute**

i. the turbine efficiency (3 marks)

ii. the generator efficiency (3 marks)

iii. the combined turbine–generator efficiency of this plant. (4 marks)

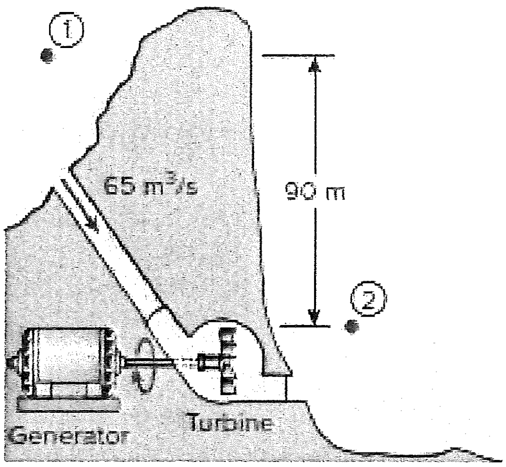

Figure 5

QUESTION 3

Steam in **Figure 6** enters a nozzle at 400°C and 800 kPa with a velocity of 10 m/s, and leaves at 300°C and 200 kPa while losing heat at a rate of 25 kW. For an inlet area of 800 cm. Potential energy change is negligible.

i. **Compute** the value of steam properties at inlet and outlet (13 marks)

ii. **Compute** Mass flow rate of the steam (5 marks)

iii. **Compute** The exit velocity of the steam (7 marks)

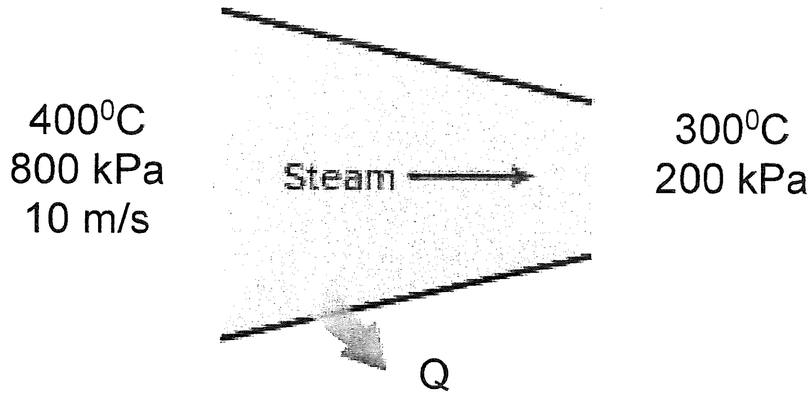

Figure 6

QUESTION 4

a. A water channel with a 15 m long quarter-circular section CD of radius 3 m is designed. **Solve** the resultant hydrostatic force exerted on the gate CD as shown in **Figure 7**. (15 marks)

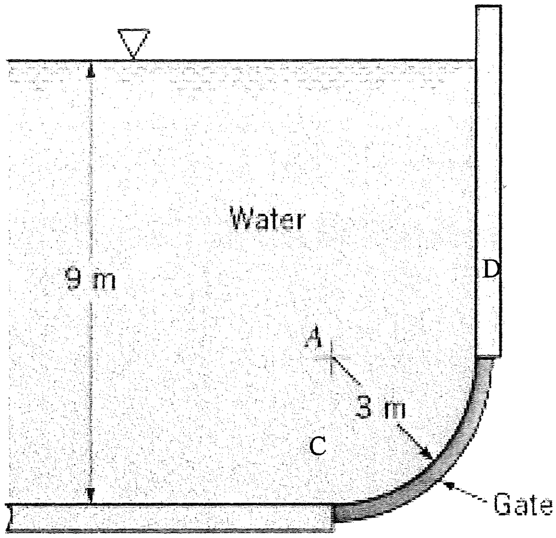

Figure 7

b. A 3 m high, 6 m wide rectangular gate is hinged at the top edge at A and is restrained by a fixed ridge at B as shown in **Figure 8**.

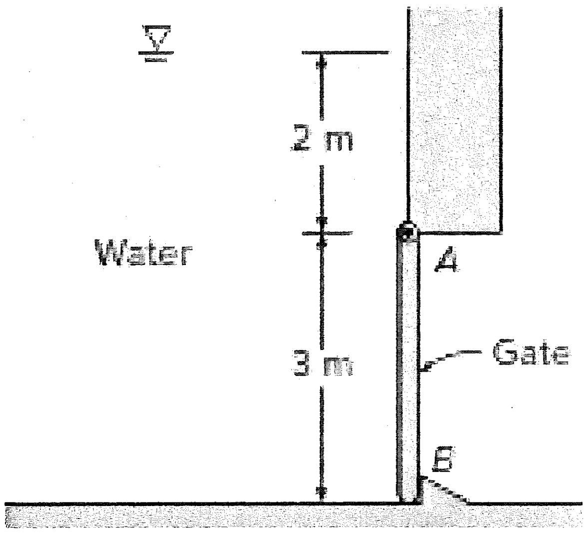

Figure 8

i. **Compute** the hydrostatic force exerted on the gate by the 5 m high water

(5 marks)

ii. **Compute** the location of the pressure center from the water surface.

(5 marks)

---**End of questions**-------------------------------------

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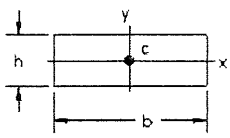
Criteria	**Marks**
All questions answered will be marked according to answer schema	/ 100

FORMULA

$A = \pi r^2$ $Pressure = \rho g h$ $\dot{E}_{in} = \dot{E}_{out}$ $\dot{m} = \frac{1}{v} VA$ $PE = \dot{m} g h$ $KE = \frac{\dot{m} v^2}{2}$ $pv = RT$ $\mu, COP = \frac{Desired\ output}{Required\ input}$	$P + \frac{\rho v^2}{2} + \rho g h = C$ $F_R = \rho g h_c A$ $h_p = h_c + \frac{I}{A h_c}$ $S.G = \frac{\rho_{fluid}}{\rho_{water}}$

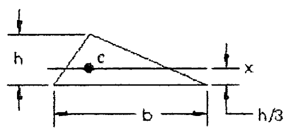
Moment of inertia.



$A = bh$

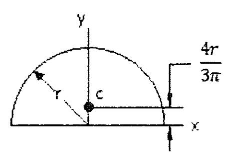
$I_x = \frac{1}{12} bh^3$

$I_y = \frac{1}{12} hb^3$



$A = \frac{1}{2} bh$

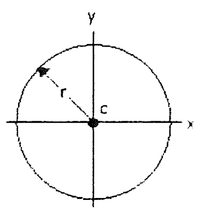
$I_x = \frac{1}{36} bh^3$



$A = \frac{\pi r^2}{2}$

$I_x = \frac{1}{8} \pi r^4$

$I_y = \frac{1}{8} \pi r^4$



$A = \pi r^2$

$I_x = \frac{1}{4} \pi r^4$

$I_y = \frac{1}{4} \pi r^4$