

The Open University of Sri Lanka

Faculty of Engineering Technology



Study Programme : Bachelor of Science Honours in Engineering
 Name of the Examination : Final Examination
Course Code and Title : DMX3401 Fluid Mechanics and Thermodynamics
 Academic Year : 2023/24
 Date : 20th February 2025
 Time : 0930-1230 hrs
 Duration : **3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. Answer all **five (05)** Questions. All questions carry equal marks.
3. This is a Closed Book Test (CBT).
4. Answers should be in clear handwriting.
5. Do not use Red colour pen.
6. Take the specific gas constant (R) for air as 0.287 kJ/kg.K .
7. Density of Water is 1000 kg/m^3
8. For air $C_v = 0.718 \text{ kJ/kg.K}$ and $C_p = 1.005 \text{ kJ/kg.K}$
9. Take acceleration due to gravity as 9.81 ms^{-2} .

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- Q1 (a) State the steady flow energy equation and explain all the terms. (6 marks)
- (b) A horizontal axial compressor provides a steady flow of air. The air enters the compressor at a velocity of 5 m/s, a temperature of 15°C and a pressure of 1 bar. The air leaves the compressor at a velocity of 85 m/s and a temperature of 115°C . The outer surfaces of the compressor are exposed to the atmosphere and as a result, there is a heat loss of 6 kJ/kg of air as it passes through the compressor. The mass flow rate is 4 kg/s. Calculate: (14 marks)
- (a) The change in enthalpy per kg of air
 - (b) The change in kinetic energy per kg of air
 - (c) The work done per kg of air
 - (d) The power required to drive the compressor
 - (e) The air density at entry
 - (f) The cross-sectional flow area of the entry pipe.
- Take $R = 0.287 \text{ kJ/kg K}$ and $c_p = 1.005 \text{ kJ/kg K}$

Q2 (a) Show that the thermal efficiency of OTTO cycle is given by

(5 marks)

$$1 - \frac{1}{r^{\gamma-1}}$$

Where r is the compression ratio and γ is the ratio of specific heat capacities

- (b) A spark-ignition engine is proposed to have a compression ratio of 10 while operating with a low temperature of 200°C and a low pressure of 200 kPa. If the work output is to be 1000 kJ/kg, calculate the maximum possible thermal efficiency and compare with that of a Carnot cycle.

(15 marks)

Q3 (a) Define the term “meta centric height”

(5 marks)

- (b) A barge with a flat bottom and square cross section has 183cm height below the water line, floating in an upright position as shown in figure Q3. The centre of gravity of the barge is on the axis of symmetry and 30cm above the water surface. Show that the barge is in stable equilibrium position.

(15 marks)

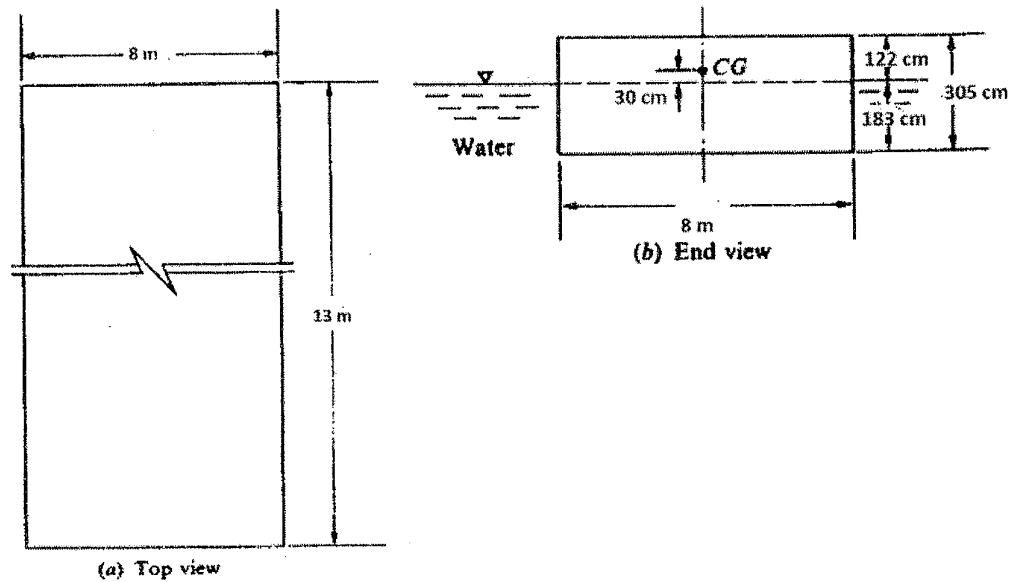


Figure Q3

- Q4 (a) Define the two terms "gauge pressure" and "absolute pressure". (5 marks)
- (b) A differential Mercury manometer attached to two tanks, as shown in figure Q4. The specific gravities of SAE 30 oil, Carbon Tetrachloride and Mercury are 0.89, 1.59 and 13.6 respectively. Find the pressure difference between Chamber A and Chamber B. (15 marks)

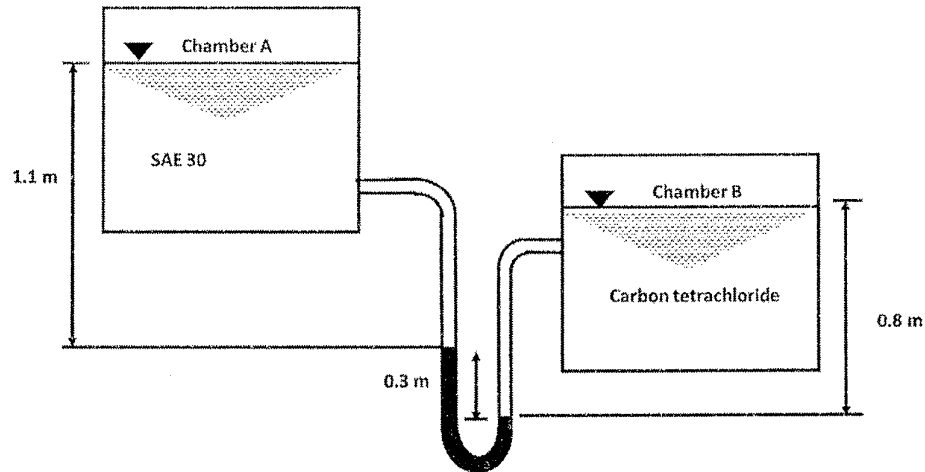


Figure Q4

- Q5 (a) Explain the significance of centre of pressure for a plane surface submerged in a liquid. (5 marks)
- (b) Find the minimum depth of z for which the gate shown in figure Q5, will open, if the gate is (15 marks)
- A square
 - Isosceles triangle, with base equal to height.

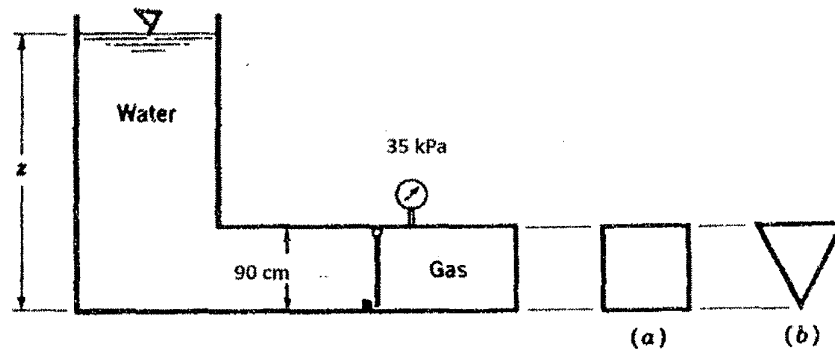


Figure Q5

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