Bachelor level/ B.E. Hydropower/ II Semester

Full Marks: 50

Pass Marks: 25

Time: 3 hours

Subject: Fundamentals of Thermodynamics & Heat Transfer (ME421/ME104)

- *Attempt all the questions*
- *Figures in the margin indicate full marks.*
- *Assume suitable values, with a stipulation, if necessary.*
- *Candidates are required to answer the questions in their own words as far as possible.*

1. Define the terms; system, surrounding and universe. Describe open and closed system with examples. **[2+2]**

2. Derive the mathematical expression of displacement work and simplify it for polytropic process. **[2+2]**

3. Define the term moisture content, superheated vapor, saturated pressure and saturated liquid with the help of illustrative diagram. **[4]**

4. Derive an expression for steady state heat transfer through a composite plane wall consisting of three different materials. **[4]**

5. Explain the working principle of an ideal Brayton cycle, Sketch the cycle on P-v and T-v diagrams and derive an expression for its efficiency. **[2+2+3]**

6. Three pressure gauges are connected to a container consisting of two compartments as shown in **Figure1**. If the local barometer reads 750 mm of Hg and pressure gauges **A** and **B** read 400 kPa and 300 kPa respectively. Determine the absolute pressure in each compartment and reading of pressure gauge C (Take ρ_{HG} =13600 kg/m³ and g= 9.81 m/s) **[2+2]**

7. Piston cylinder has a diameter of 0.2m with an outside atmospheric pressure of 200kPa. Determine the piston mass that will create an inside pressure of 500kPa. Take g= 9.8 m/s². **[3]**

8. A rigid vessel having a volume of 0.4m³ contains 2kg of liquid water and water vapor mixture in equilibrium at pressure of 250kPa. Calculate **[1+1+1+1+1]**
   i. The volume and mass of liquid
   ii. The volume and mass of vapor
   iii. Temperature
   iv. Enthalpy
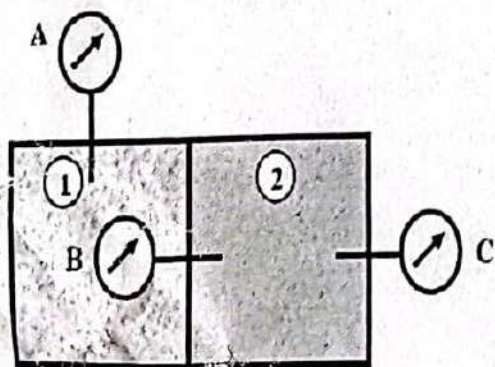   v. If it is heated until its pressure reached to 350kPa, what will be its quality?

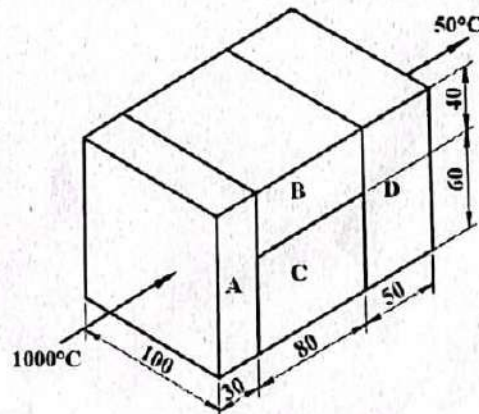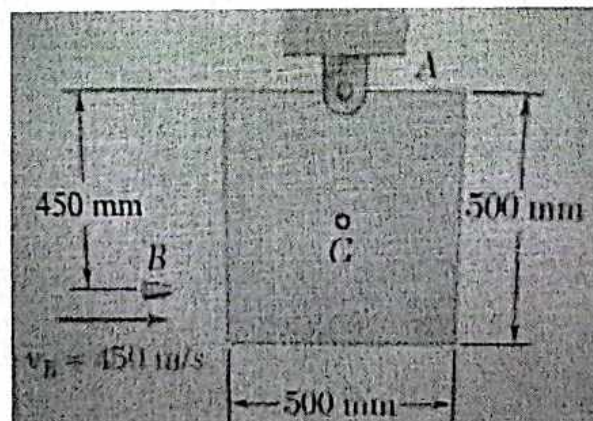Figure1

Figure2

6. In a game of billiards, ball A is given an initial velocity Vo = 3 m/s along line DA parallel to the axis of the table. It hits ball B and then ball C, which are both at rest. Knowing that A and C hit the sides of the table squarely at points G and E respectively, and B hits the side obliquely at F, and assuming frictionless surfaces and perfectly elastic impacts, determine the velocity Vc with which the ball C hits the side of the table at E. **(6)**
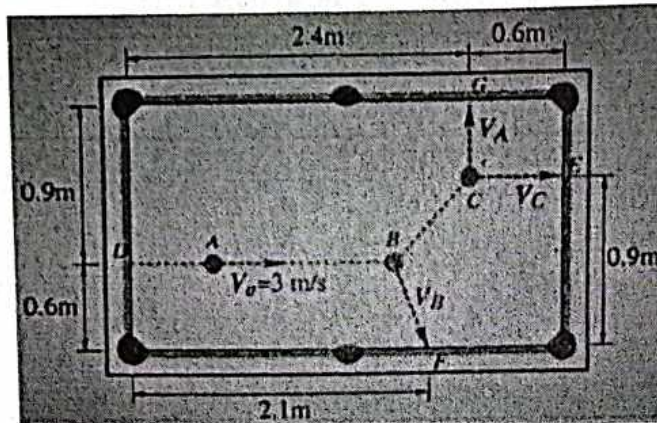
7. Describe about translation and rotational motion of rigid bodies. In the engine system shown, the crank AB has a constant clockwise angular velocity of 2000rpm. For the crank position indicated, determine: (a) the angular velocity of the connecting rod BD (b) the velocity of position P. **(2+6)**
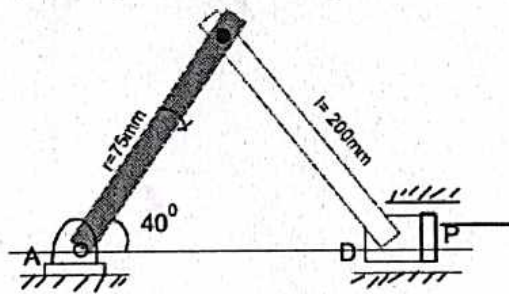
8. Explain D'Alembert's principle and prove that the equation of motion for a rigid body. **(4)**
9. Explain Principle of work and energy for a rigid body. **(2)**
10. A 20 gm bullet 'B' is fired with a horizontal velocity of 450 m/s into the side of a 10 kg square panel suspended from a hinge at 'A'. Knowing that the panel is initially at rest, determine: a) The angular velocity of the panel immediately after the bullet becomes embedded. b) The impulsive reaction at 'A' assuming that the bullet becomes embedded in 0.0008 sec. **(6)**

The End