Roll Number:_____

Thapar Institute of Engineering and Technology, Patiala

Department of Chemical/Civil Engineering

B. E. (Second Year): Semester-III	Course Code: UES-011
End Semester Examination,	Course Name: Thermo-Fluids
Dec 11, 2017 (Monday)	
Time: 3 Hours, M. Marks: 100	Name of Faculty: GCH/HPB/SJS/SMB/NS/PMS/DNR/JPK

Note: **Attempt all questions, and all parts of a question at a place.**
Attempt the paper as per the portion you have studied AFTER mid semester examination i.e. Thermodynamics (Part A)/Fluid Mechanics (Part B). All the Figures related to PART A as well as PART B are given at the end.
Write at the top of your answer sheet either Thermodynamics or Fluid Mechanics.
Assume missing data, if any, suitably.
Steam Table is allowed.

PART A
(THERMODYNAMICS)

Q.1 (a) A piston–cylinder device initially contains 50 L of liquid water at 40°C and 200 kPa. Heat is transferred to the water at constant pressure until the entire liquid is vaporized. **10**

(a) What is the initial state of water?

(b) Show the process on a T-v diagram with respect to saturation lines.

(c) What is the final temperature?

(d) Calculate the mass of the water and total enthalpy change by approximating initial state as saturated liquid?

Q.1 (b) A 1.8 m^3 of rigid tank contains steam at 220°C. One third of the volume is in the liquid phase and the rest is in the vapor phase. Determine (a) the pressure of the steam, (b) the quality of the saturated mixture, and (c) the density of the mixture? **10**

Q.2 (a) A mass of 5 kg of saturated liquid vapor mixture of water is contained in a piston cylinder device at 125 kPa. Initially, 2 kg of the water is in the liquid phase and the rest is in the vapor phase. Heat is now transferred to the water, and the piston, which is resting on a set of stops, starts moving when the pressure inside reaches 300 kPa. Heat transfer continues until the total volume increases by 20%. Determine (i) the initial and final temperatures, (ii) the mass of liquid water when the piston first starts moving, and (iii) the work done during this process. Also show the process on P-v diagram? **14**

Q.2 (b) A gas is compressed from an initial volume of 0.42 m^3 to a final volume of 0.12 m^3. During the quasi-equilibrium process, the pressure changes with volume according to the relation P= aV+ b, where a= -1200 kPa/m^3 and b= 600 kPa. Calculate the work done during this process by plotting the process on a P-V diagram and finding the area under the curve? **6**

Q.3 (a) A gas turbine receives gases from the combustion chamber at 7 bar and 700 °C with a velocity of 10 m/s. The gases leaves the turbine at 1 bar with a velocity of 50 m/s. Assuming the adiabatic and reversible process of an ideal gas, calculate the power output of the turbine per unit mass of flow rate? Take Cp=1100 J/(kg.K) and γ = 1.3. **10**

Q.3 (b) At steady flow condition, water vapor at 100 kPa and 150°C enters a subsonic diffuser with a velocity of 150 m/s. The inlet diameter is 10 cm. The fluid leaves the diffuser at 200 kPa with a velocity of 55 m/s and 1.6 kJ/kg of heat is transferred to surroundings. Determine (a) the final temperature, (b) the mass flow rate, and (c) the exit diameter? **10**

Q.4 (a) Five hundred kg of fruits at 20 °C are stored in a cold storage. The cold storage is maintained at –5 °C and the fruits get cooled to the storage temperature in 10 hours. The latent heat of freezing is 105 kJ/kg and specific heat of fruits is 1.26 kJ/(kg.K). Find the refrigeration capacity of the plant in tonne of refrigeration (TR)? Take, 1 TR = 210 kJ/min. **10**

Q4 (b) A reversible engine, as shown in Figure 1, is supplied with heat from two constant temperature sources at 900 K and 600 K, and rejects the heat to a constant temperature at 300 K. The engine develops work equivalent to 103 kJ/s and rejects heat at the rate of 56 kJ/s. Estimate the a) heat supplied by each source, and b) the thermal efficiency of the engine? **10**

Q.5 (a) Water is flowing at rate of 500 litres/min in a 10 cm diameter pipe. At a section, the pipe suddenly expands to a 15 cm diameter. If the pressure just upstream of the expansion is 22 kN/m^2, calculate the pressure just after the expansion. The pipe is horizontal in the expansion region. **10**

Q.5 (b) Calculate the displacement thickness and momentum thickness for the velocity distribution given below. **10**

$$\frac{u}{U} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

PART B
(FLUIDMECHANICS)

Q.1(a) State and prove Bernoulli's theorem. **8**

Q.1(b) Derive the head loss due to friction in a horizontal pipe for laminar flow. **12**

Q.2 (a) The expression for the velocity component u and w is given.

$u = 2x^2 + 2xy; w = z^3 - 4xz - 2yz$

Determine the expression for velocity component v so that it will represent a possible case of three dimensional incompressible fluid flow. **8**

Q.2 (b) A rectangular gate of size 3.6 m × 1.5 m wide is hinged at a point 0.15 m below the centre of gravity of gate as shown in figure 2. The total depth of water is 6.0 m. What horizontal force must be applied at the bottom of the gate to keep the gate closed? **12**

Q.3 (a) Gasoline of specific gravity 0.8 is flowing upwards in a vertical pipe line which tapers from 200 mm to 100 mm diameter. A gasoline mercury differential manometer is connected to the pipe to measure the rate of flow. The distance between the manometer tapings is 1 m and difference of level of mercury in both the limb of U-tube differential manometer is 500 mm. Calculate the pressure head difference between two point in terms of gasoline and also calculate the rate of flow. **10**

Q.3 (b) A pipeline 0.6 m diameter carrying oil of specific gravity 0.85 at the flow rate of 1.8 m^3/s has a bend of 90^0 in the horizontal plane. The pressure at the entrance to the bend is 1.5 bar and the loss of head in the bend is 2 m of oil. Find the magnitude and direction of force exerted by the oil on the bend. **10**

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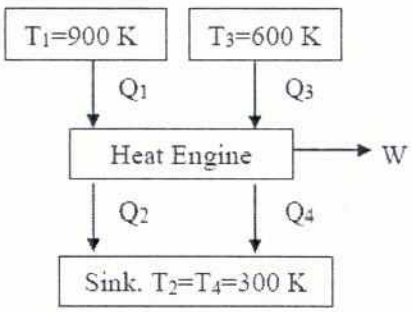

Figure 1

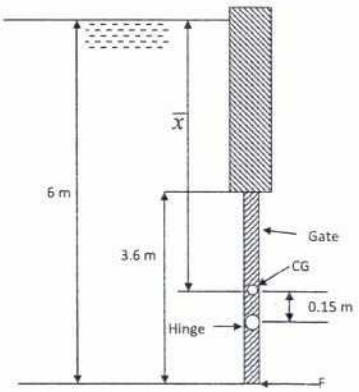

Figure 2