Roll Number:_____

Thapar Institute of Engineering & Technology, Patiala
Department of Chemical/Civil Engineering

B. E. (Second Year): Semester-IV	Course Code: UES011
Mid Semester Test, March 15, 2018	Course Name: Thermo-Fluids
Time: 2 Hours, M. Marks: 50	Name of Faculty: VKS/SKA/VKB/SKS/RGU/ DNR/RB/AC/AGR

Note: **Attempt all questions, and all parts of a question at a place.**
Attempt the paper as per the portion you have studied up to mid semester examination i.e. Thermodynamics/Fluid Mechanics.
Write at the top of your answer sheet either Thermodynamics or Fluid Mechanics.
Assume missing data, if any, suitably.

THERMODYNAMICS

Q1. (a) A vessel of capacity of 0.05 m^3 contains mixture of saturated liquid and saturated steam at 245°C. If mass of the liquid present is 10 kg, determine the pressure, mass of vapor, volume of vapor and specific enthalpy? **(4)**

(b) A rigid tank with a volume of 2.5 m^3 contains 15 kg of saturated liquid–vapor mixture of water at 75°C. Now the water is slowly heated. Determine the temperature at which the liquid in the tank is completely vaporized. Also, show the process on a T-v diagram with respect to saturation lines. **(6)**

Q2. It is desired to compress one kmol of air from the initial state 100 kPa and 300 K to final state 1 MPa and 300 K using two different processes. The different processes are as following:

(a) Isothermal compression
(b) Adiabatic compression followed by cooling at constant volume

Calculate the work required for above two processes with use of suitable P-v diagrams.
(Given: $\gamma = 1.4$, universal gas constant R = 8.314 J/mol-K) **(4+6)**

Q.3 (a) From a saturated liquid state at 200 kPa, 10 kg of water is heated to a temperature of 270°C at constant pressure. Determine the entropy change for the process and depict the process on a T-s diagram. **(5)**

(b) Air is compressed reversibly in a polytropic process from 1 bar and 30°C to 3 bars. The polytropic index is 1.2. Determine the change in specific entropy of the air. Take C_p and C_v of air as 1.005 and 0.718 kJ/kg-K respectively. **(5)**

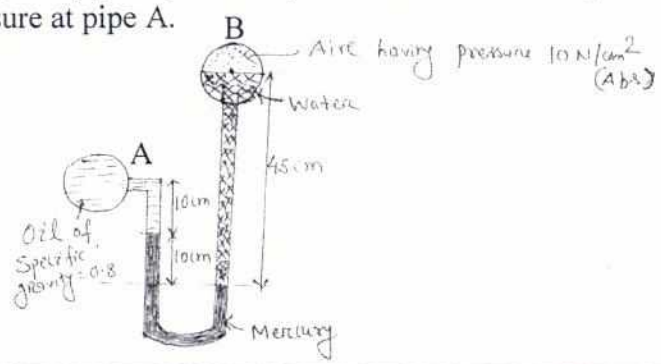
Q.4 An adiabatic duct receives air at 900 km/h, –5°C, 50 kPa. Air leaves at a velocity of 80 m/s. If the outlet flow area is reduced to 80% of the inlet area, find the temperature and pressure at the outlet. Take C_p of air as 1.004 kJ/kg °C. **(5+5)**

Q.5 A heat pump heats a house in winter and it can also be used to cool the house in summer, if operated in the reverse mode. The interior temperature should be 20°C in the winter and 25°C in the summer. Heat leakage through the walls and ceilings is estimated to be 2400 kJ per hour per degree temperature difference between the inside and outside.

(a) If the winter outside temperature is 0°C, what is the minimum power required to drive the heat pump? **(5)**
(b) For the same power as in part (a), what is the maximum outside summer temperature for which the house can be maintained at 25°C? **(5)**

FLUID MECHANICS

Note: ***Attempt all questions and all parts of a question at same place***
Assume missing data, if any, suitably

Q.1 (a)	Derive an expression for continuity equation in the differential form for Cartesian coordinates.	(07)
(b)	Derive the expression for the total pressure and centre of pressure for completely submerged inclined plane surface.	(10)
Q.2 (a)	Two plates are placed at a distance of 0.2 mm apart. The lower plate is fixed while the upper plate having surface area of 1.25 m^2 is pulled at 0.25 m/s. Determine the force and power required to maintain this speed. The viscosity of fluid is 0.15 Pa.s.	(04)
(b)	A differential mercury manometer is connected in the two pipes A and B as shown in Fig. At pipe B, the air pressure is 10 N/cm^2 (Absolute). Find the absolute pressure at pipe A. 	(05)
Q.3 (a)	A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of oil of specific gravity 0.8. The discharge of oil through venturimeter is 60 litre/sec. Find the reading of the oil and mercury differential manometer. Coefficient of discharge of venturimeter is 0.98.	(06)
(b)	A converging pipe bend with its centerline in a horizontal plane change the direction of pipeline by 60^0 in a clockwise direction and reduce the pipeline diameter from 30 cm to 20 cm in the direction of flow. If the pressure at the entrance to bend is 140 kN/m^2 and the flow of water through the pipeline is 0.1 m^3/s. Determine the magnitude and direction of force on the bend due to moving water.	(06)
Q.4 (a)	Glycerine of specific gravity 1.26 and dynamic viscosity 0.9 Pa.s, is pumped at the rate of 20 litre/s through a straight pipe of diameter 100 mm and inclined upward at 15^0 to the horizontal. The inclined length of pipe is 45 m. The gauge pressure at the inlet is 590 kPa. Find the gauge pressure at the outlet. Consider only friction loss.	(06)
(b)	The velocity distribution in the boundary layer over a high spillway face is in the following form where u, is velocity of flow at any point, U is free stream velocity, and δ is boundary layer thickness. $\frac{u}{U}=\left(\frac{y}{\delta}\right)^{0.22}$ Find the displacement thickness and the momentum thickness.	(06)