TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
Diploma in Marine Engineering (Y2S1)
EMR 2207 : Thermo-Fluids I (Paper 2)
SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: SEPTEMBER 2018
TIME: 2 HOURS
DATE: Sep 2018

Instruction to Candidates:

You should have the following for this examination

- *Examination Pass & Student ID Card*
- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt any **THREE** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE

a) Derive an expression for the total pressure force on a surface immersed in liquid.

b) Find the net hydrostatic force per unit width on rectangular panel AB in **Fig. Q1** and determine its line of action.

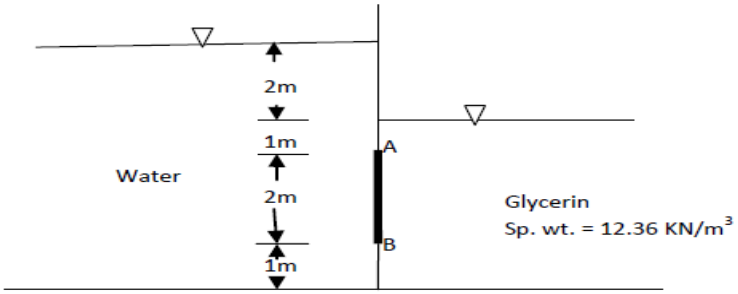

Fig. Q1

(20 marks)

Question TWO

a) A liquid of specific gravity 1.3 flows in a pipe at a rate of 800 L/s, from point 1 to point 2 which is 1 m above point 1. The diameters at section 1 and 2 are 0.6 m and 0.3 m respectively. If the pressure at section 1 is 10 bar, determine the pressure at section 2.

b) A tank contains oil of specific gravity 0.8 to a depth of 2.8m.It discharges through a 20mm diameter straight pipe at a point 8m below the bottom of the tank. Calculate

   i. The discharge in litres per second.

   ii. Oil pressure at a pint halfway along the pipe.

(20 marks)

Question THREE

a) The working fluid, in a steady flow process flows at a rate of 220 kg/min. The fluid rejects 100 kJ/s passing through the system. The conditions of the fluid at inlet and outlet are given as: c_1 = 320 m/s, P_1 = 6.0 bar, U_1 = 2000 kJ/kg, V_1 = 0.36 m^3/kg and c_2 = 140 m/s, P_2 = 1.2 bar, U_2 = 1400 kJ/kg, V_2 = 1.3 m^3/kg. The suffix 1 indicates the condition at inlet and 2 indicates at outlet of the system. The change in potential energy may be neglected. Determine the power capacity of the system in MW.

b) A cylinder contains 0.45 m^3 of a gas at 1 × 10^5 N/m^2 and 80 °C. The gas is compressed to a volume of 0.13 m^3, the final pressure being 5 × 10^5 N/m^2. Taking γ = 1.4, R = 294.2 J/kg·°C, determine

   i. The mass of gas.

   ii. The value of index 'n' for compression.

   iii. The increase in internal energy of the gas.

   iv. The heat received or rejected by the gas during compression.

(20 marks)

Question FOUR

a) A fluid at a pressure of 3 bar, and with specific volume of 0.18 m^3/kg, contained in a cylinder behind a piston expands reversibly to a pressure of 0.6 bar according to a law, $p = c/v^2$ where c is a constant. Calculate the work done by the fluid on the piston.

b) An air tank is equipped with a pressure relief valve so that the pressure does not exceed 220 kN/m^2 gauge. The initial temperature and pressure are 23 °C and 200 kN/m^2. The temperature is then increased to 83 °C. If the mass of air is 0.11 kg, determine

   i. The mass of air that will escape.

   ii. The pressure in the tank when temperature returns to 23 °C.

(20 marks)

Question FIVE

a) The following equation gives the internal energy of a certain substance $u = 3.64\,pv + 90$, where u is in kJ/kg, p is in kPa and v is in m^3/kg. A system composed of 3.5 kg of this substance expands from an initial pressure of 500 kPa and a volume of 0.25 m^3 to a final pressure 100 kPa in a process in which pressure and volume are related by $pv^{1.25}$ = constant.

i. If the expansion is reversible, find Q, ΔU and W for the process.

ii. In another process, the same system expands according to the same pressure-volume relationship as in part (*i*), and from the same initial state to the same final state as in part (*i*), but the heat transfer in this case is 32 kJ. Find the work transfer for this process.

iii. Explain the difference in work transfer in parts (*i*) and (*ii*).

b) The properties of a system, during a reversible constant pressure non-flow process at P = 1.6 bar, changed from V_1= 0.3 m^3/kg, T_1 = 20 °C to V_2 = 0.55 m^3/kg, T_2 = 260 °C. The specific heat of the fluid is given by $C_p = (1.5 + 75/T + 45)$ kJ/Kg·°C where T is in °C. Determine

i. Heat added/kg.

ii. Work done/kg.

iii. Change in internal energy/kg.

iv. Change in enthalpy/kg.

(20 Marks)