MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL AND PROCESSING ENGINEERING

FLUID FLOW, THERMOFLUIDS

CODE: HCHE 223/HMIE 225

SESSIONAL EXAMINATIONS

APRIL 2021

DURATION: 3 HOURS

EXAMINER: MR C.K. SIMENDE

INSTRUCTIONS

1. Answer**any 4** questions.
2. Each question carries25 marks.
3. Total marks 100

QUESTION 1

a. Define the following terms as they are used in fluid flow and thermofluids:

i) Fluid statics [1 mark]

ii) Fluid mechanics [2 marks]

iii) Reynolds number [2 marks]

b. Calculate the Reynolds number if a liquid of viscosity 0.5 Ns/m^2 and relative density of 500 kg/m^3 through a 10 mm pipe flows with a velocity of 3 m/s. [4 marks]

c. A dam holds back the water in a lake. If the dam has a small hole 1.4 meters below the surface of the lake, at what speed does water exit the hole? [10 marks]

d. Outline the main industrial applications of Fluid mechanics [6 marks]

QUESTION 2

a. If a 25 litre volume of oil has a mass of 20 kilograms, determine the oil's:

i) Mass density [2 marks]

ii) Weight density [2 marks]

iii) Relative density [2 marks]

iv) Specific volume [2 marks]

b. Determine whether the flow is laminar or turbulent given that a fluid having a viscosity of 0.4Ns/m^2 and relative density of 900kg/m^3 flows through a pipe of 20mm diameter with a velocity of 2.5m/s. [7 marks]

c. Define the following types of flow with the aid of equation where possible:

i) Steady flow [2 marks]

ii) Unsteady flow [2 marks]

iii) Compressible flow [1 mark]

iv) Incompressible flow [1 mark]

v) Laminar flow [2 marks]

vi) Turbulent flow [2 marks]

QUESTION 3

a. With the aid of a clearly labeled diagram derive the Continuity Equation. [16 marks]

b. The area of a pipe at section XX^1 is $315cm^2$. The area of pipe at section YY^1 is twice the area of section XX^1. The velocity at section $XX^1$is 4.5m/s. Find the velocity at section YY^1. Also determine the flow rate through the pipe. [9 marks]

QUESTION 4

a. State and explain Bernoulli's Theorem [2 marks]

b. Outline the main assumptions used when deriving the Bernoulli's equation [4 marks]

c. With the aid of a clearly labeled diagram derive the Bernoulli's equation [9 marks]

d. Water is flowing through an inclined pipeline of diameter 20cm and 40cm at section A and B respectively.Section A and B are located at height of 2m and 2.5m respectively from ground level. The discharge through the pipe is 30l/s. If the pressure at A is 20kPa, find the pressure at point B. [10 marks]

QUESTION 5

a. Steam enters a converging-diverging nozzle operating at steady state with P_1 = 0.05 MPa, T_1 = 400° C and a velocity of 10 m/s. The steam flows through the nozzle with negligible heat transfer and no significant change in potential energy. At the exit, P_2 = 0.01 MPa and the velocity is 665 m/s. The mass flow rate is 2 kg/s. Determine the exit area of the nozzle, in m^2. [9 marks]

Given data:

h_1 = 3278.9 kJ/kg

T_2 = 300° C

v_2 = 26.445 m^3/kg

b. Steam enters a turbine at steady state with a mass flow rate of 4600 kg/h. The turbine develops a power output of 1000Kw. At the inlet the pressure is 0.05 MPa, the temperature is 400° C, and the velocity is 10 m/s. At the exit, the pressure is 10 kPa, the quality is 0.9 and the velocity is 50 m/s. Calculate the rate of heat transfer between the turbine and the surroundings in Kw. [10 marks]

Given data:

h_1 = 3278.9 kJ/kg

h_f = 191.83 kJ/kg

h_{fg} = 2392.8 kJ/kg

c. Define the following terms as used in the study of thermofluids:

i) Control volume [1 mark]
ii) Work flow [2 marks]
iii) Enthalpy [1 mark]
iv) Nozzle [1 mark]
v) Diffuser [1 mark]

END OF PAPER