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]
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- ii) Fluid mechanics [2 marks]
- iii) Reynolds number [2 marks]
- b. Calculate the Reynolds number if a liquid of viscosity 0.5 Ns/m² and relative density of 500 kg/m³ 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/m² and relative density of 900kg/m³ 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 XX¹ is 315cm². The area of pipe at section YY¹ is twice the area of section XX¹. The velocity at section XX¹ is 4.5m/s. Find the velocity at section YY¹. 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, $T_1 = 400^\circ$ 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 m². [9 marks]

Given data:

 $h_1 = 3278.9 \text{ kJ/kg}$ $T_2 = 300^{\circ} \text{ C}$

 $v_2 = 26.445 \text{ m}^3/\text{kg}$

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:

 $h_1 = 3278.9 \text{ kJ/kg}$

 $h_f = 191.83 \text{ kJ/kg}$

 $h_{fg} = 2392.8 \text{ kJ/kg}$

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

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