UNIVERSITY COLLEGE
TATI

TATI UNIVERSITY COLLEGE (TATIUC)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BCE 2114
COURSE	: TRANSPORT PROCESS
SEMESTER/SESSION	: SEM1-2022/2023
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. You are allowed to bring with you one hand written sheet of A4 for the equations you may need.
4. Write legibly and draw sketches wherever required.
5. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 5 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1 (14 MARKS)

a) Differentiate between the following terms (Illustrate your answers with appropriate sketches and related equations if needed):

i. Unit operation & transport processes (2 marks)

ii. Thermal conductivity & heat capacity (2 marks)

iii. Gravitational constant g & g_c (2 marks)

b) A gaseous mixture contains 0.04 kg of N_2, 0.06 kg of O_2, and 0.09 kg of CO_2. Calculate the followings:

i. Mass fraction for the mixture (2 marks)

ii. Mole fraction of the mixture (3 marks)

iii. The average molecular weight of the mixture (3 marks)

(M.W; N=14, O=16, and C=12)

QUESTION 2 (30 MARKS)

a) Differentiate between the following terms (Illustrate your answers with appropriate sketches and related equations if needed):

i. Driving force for momentum (3 marks)

ii. Resistance for momentum (3 marks)

iii. Laminar & turbulent flow (6 marks)

b) Hot water at 50 °C is being discharge from a storage tank at the rate of (6.3 L/s). The process flow diagram and conditions are the same as shown in Figure 1. Assume all steel pipes of schedule 40. The 20-ft-long outlet pipe from the storage tank is 1.5-in pipe. The length of 2-in 185 ft. Calculate the followings:

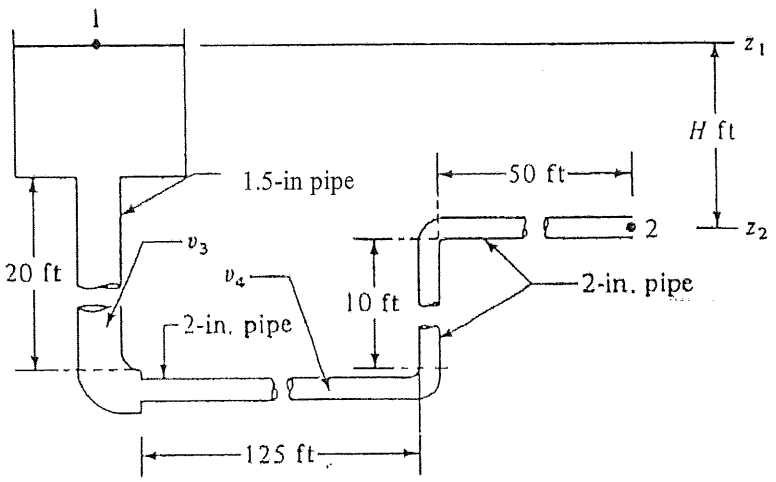

Figure 1

i. All friction losses (ΣF) in SI units. (10 marks)

ii. Determine H in Figure 1 in ft. (8 marks)

QUESTION 3 (28 MARKS)

a) Differentiate between the following terms (Illustrate your answers with appropriate sketches and related equations if needed):

i. Conduction, convection, radiation (2 marks)
ii. Driving force for heat transfer (2 marks)
iii. Resistance heat transfer (2 marks)

b)

Co-current flow in a 2-4 heat exchanger is 5.56 lb_m/s of water in which temperature has to be raised from 294.3 °K to 327.6 °K. The hot fluid entering at 388.8 °K and leaving at 322.1 °K. The outside surface area of the tubes in the exchanger is A_0 = 100 ft^2, calculate the followings: (Assume C_p for water =4.181 kJ/Kg.°K)

i. The mean temperature difference ΔT_{lm} in the exchanger (6 marks)
ii. The overall heat-transfer coefficient U_0 if the flow is co-current (6 marks)

C) In countries where apple grows, the freezing of the oranges on the trees during cold nights is economically important. If the oranges are initially at a temperature of 21.1°C. Assume the oranges are 0.102 m in diameter and the convective coefficient is estimated as 11.4 $W/m^2.K$. The thermal conductivity k is 0.431 W/m.K and α is 4.65 x 10^{-4} m^2/h Neglect any latent heat effects.

Calculate:

The center temperature of the orange if exposed to air at -3.9°C for 6 h. (10 marks)

QUESTION4 (28 MARKS)

a) The solute HCl (A) is diffusing through a thin film of water (B) 2.0 mm thick at 283 K. The concentration of HCl at point 1 at one boundary of the film is 12.0 wt % HCl (density ρ_1 = 1060.7 kg/m^3), and at the other boundary at point 2 it is 6.0 wt % HCl (ρ_2 = 1030.3 kg/m^3). The diffusion coefficient of HCl in water is 2.5 x 10^{-9} m^2/s. Assuming steady state and one boundary impermeable to water, calculate the followings;

(5 marks)

i. Average mole fraction of water (X_{BM}) (5 marks)
ii. Average concentration (C_{av}) (5 marks)
iii. The flux of HCl (N_A) in kgmol/s.m^2.

b) A wet cylinder of agar at 278K containing a uniform concentration of urea of 0.1 kg mol / m^3 has a diameter of 30.48 mm and is 38.1 mm long with flat, parallel ends. The diffusivity is 4.72x10^{-10} m^2/s. Calculate the concentration at the midpoint of the cylinder after 100 h for the following cases if the cylinder is suddenly immersed in turbulent pure water for the following 2 cases.

i. Diffusion occurs radially only (6 marks)

ii. Diffusion occurs radially and axially. (7 marks)

----------End of questions ----------