A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 97902

B.E./B.Tech. DEGREE EXAMINATION, NOV 2023

Seventh Semester

Chemical Engineering

19UCH702 - TRANSPORT PHENOMENA

(Regulations 2019)

Duration: Three hours Maximum: 100 Marks

Answer All Questions

PART A - (10 x 1 = 10 Marks)

1. A vector field with a vanishing curl is called a CO1- U

   (a) Irrotational (b) Solenoidal (c) Rotational (d) Cycloidal

2. The source term in the momentum equation is CO1-U

   (a) Pressure force (b) Body forces (c) Viscous force (d) Acceleration

3. Identify the maximum potential energy in a roller coaster is a CO2- U

   (a)The top of the steep climb (b) somewhere during the climb

   (c) somewhere during the descent (d)The lowest point after the climb

4. Identify the diffusive fluxes in the inlet boundary conditions is CO2-U

   (a) Are specified (b)Can be calculated

   (c)Are not necessary (d) Should be approximated

5. What is separation effected by in non-porous membranes? CO1-U

   (a) Differences In solubility in the membrane

   (b) Rate of species diffusion through the pores

   (c) Amount of feed to the membranes

   (d) Number of membranes used

6. For solids and liquids, specific heat is CO1-U

   (a) Depends on the process (b) Its independent of the process

   (c) May or may not depend on the process (d) None of the mentioned

7. A reaction occurs in a vessel such that its mass does not change but its temperature is increased, then the system is which of the following? CO1-U

(a) Steady-state (b) Unsteady-state

(c) Cannot say (d) None of the mentioned

8. The ratio of number of moles of species A to the total number of moles of the mixture is known as CO1-U

(a) Mole fraction (b) Mass fraction (c) Partial pressure (d) Mass density

9. $CO_{2(g)} + C_{(s)} \rightleftharpoons 2CO_{(g)}$ is an example for a CO1-U

(a) Homogeneous equilibrium

(b) Heterogeneous equilibrium

(c) Neither homogeneous nor heterogeneous

(d) Both homogeneous and heterogeneous

10. Which way is heat transfer believed to take place in a long, hollow cylinder that is kept at consistent but varied temperatures on its inner and outer surfaces? CO1-U

(a) Unpredictable (b) Radial only

(c) No heat transfer takes place (d) Axial only

PART – B (5 x 2= 10Marks)

11. What is an example of transport phenomena? CO1-U

12. Compute the momentum flux for a system with lower plate having velocity of 1m/sec.distance between the two plates is 1mm & viscosity is 1cp CO2-App

13. What is the analogy between heat and momentum transfer? CO1-U

14. How do you differentiate homogeneous and heterogeneous reactions? CO2-AP

15. What is transport of molecules across a selectively permeable membrane? CO1-U

PART – C (5 x 16= 80Marks)

16. (a) The lower plate is being pulled at a relative velocity of 0.4m/s greater than top plate. The fluid used is at 24 ºC, Viscosity = $0.4x10^{-2}$ N.s/m^2. CO2-App (16)

(i) How far apart should two plates be placed so that shear stress = 0.3N/m^2.

(ii) If oil of viscosity = $2x10^{-2}$ N/m^2 is used & plates are kept separated at a distance calculated in part (a) & velocity is same as in part(a), what is shear stress & shear rate?

Or

(b) Compute mean molecular velocity cm sec^{-1} and mean free path of oxygen at 1 atm and 378.4 K Assume d =5.0 °A. What is the ratio of mean free path to molecular diameter in this situation? CO2-App (16)

17. (a) Estimate viscosity of saturated liquid water at 0 & 100 ºC (to convert value at centipoise). CO2- App (16)

$N=6.023 \times 10^{23}$ $gm.mole^{-1}$

$V=18cm^3$ $gm.mole^{-1}$

$h= 6.624 \times 10^{-27}$ $gm.cm^2.sec^{-1}$

Or

(b) The distance between two plates is 4 inch. The fluid is methanol at 328K having a viscosity of 0.27 kg/m.sec. Initial Velocity, v_1= 13ft/min & Final Velocity, v_2= -53ft/min. CO2- App (16)

a) Calculate stress on each plate.

b) The fluid velocity at ½ inch intervals from each plate.

18. (a) (i) A plastic panel of area A is 929 cm^2 & thickness y is 0.64 cm was found to conduct heat at rate of 3.0 watts at steady state with temperature of T_0 is 24ºC & T_1= 26ºC on the two main surfaces. What is the thermal conductivity of plastic at 25ºC? CO2- App (16)

(ii) A thick- walled cylindrical tubing of hard rubber having an inside radius of 0.005 m & outside radius of a 0.02 m is being used as a temporary cooling coil in a bath. Ice water is flowing rapidly inside & inside wall temperature is 274.9 K. The outside surface temperature is 297.1K. A total of 14.65 W heats must be removed from bath by cooling coil how many m of tubing are needed? Thermal Conductivity is 0.151w/m.K

Or

(b) Calculate the thermal conductivity of formaldehyde (CH_2O) & methane (CH_4) at 278 K & 1atm pressure stigma for CH_2O is 2.78 °A then a constant pressure at vector level for CH_2O is 8.43 cal/g.mole.K, lennard-jones intermolecular potential model is 2.018 & resistance for CH_2O is 3.879 for viscosity of CH_4 at stigma is 2.744 °A then a constant pressure at vector level for CH_4 is 6.45 cal/gmole.K & lennard-jones intermolecular potential model is 1.165& resistance for CH_4 is 1.348? CO2- App (16)

19. (a) A value of DAB is 0.225cm^2/s has been found for the system CO2 -air at 108ºF & 1atm.calculate DAB at 295ºF by following methods. CO2-App (16)

(a) Slattery Equation

(b) Chapman-Enskog Theoretical Equation

Data

(Total pressure of compound A)108ºF=1.074

(Total pressure of compound B)295ºF=0.347

Or

(b) (i) Estimate DAB for a dilute solution in propane at 27ºC. CO2- App (16)

Data

U=0.507cp

VA^ =160cc/gmole

Association Parameter for Solvent 'B'=3.0 for propane

MB = 87.33 for propane

T = 373K

(ii) The value of DAB for a dilute solution of ethanol in water at 27ºC is 1.56 x 10^{-5} cm^2/s. calculate DAB for the same solution at 150ºC. (u_1 at 27ºC =1.41cp & u_2 at 150ºC = 0.248cp.)

20. (a) Based on analogy a large tank filled with a mixture of Methane & air is connected with second tank filled with a different composition of methane &air. Both tanks are at 100 KN/m^2 & 0ºC. CO2- App (16)

The connection between tanks is a tube of Inner Diameter is 2x10^{-3} m & length of 0.15 m calculate steady rate of transport of Methane through tube when concentration of methane is 90% (mole) in one tank 5% (mole) in other, DAB is 1.57 x 10^{-5} m^2/s (at 0ºC & 100 KN/m^2) Assume that transport is by molecular diffusion, (5% will be a residue).

Or

(b) Derive an expression for a closed path method. CO2- App (16)