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B. M. S. College of Engineering, Bengaluru - 560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: V**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH5DCTRP **Max Marks: 100**
Course: Transport Phenomena **Date: 13.09.2023**

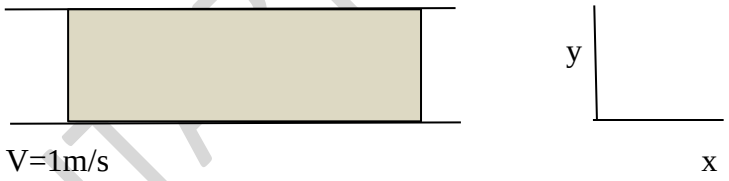
Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1. a) Define Newton's law of viscosity and discuss any 3 models to describe non-Newtonian fluids. **10**

   b) Describe the mechanism of Fourier's law of heat conduction with neat sketch. **06**

   c) Compute the steady state momentum flux τ_{yx} in N/m^2 when the lower plate is velocity v as shown in the figure is 1 m/s in positive x direction, the plate separation Y is 0.001 m and μ= 0.7cP. **04**



UNIT - II

2. a) Derive an expression to find the following when the flow is taking place in a circular tube with constant viscosity **14**
   i. Shear stress profile
   ii. Velocity profile
   iii. Ratio of maximum to average velocity
   State the assumptions made

   b) Oil is flowing in laminar region in a 1.27 cm dia tube at the rate of 35.72 L/min. The oil viscosity is 150 mPa.s and its specific gravity is 0.960. Calculate **06**
   i) Pressure drop per meter of pipe length
   ii) The wall stress

OR

3. a) Derive an expression to find the average velocity for the flow of falling film with constant viscosity. **12**

   b) Pure water at 25°C is flowing down though a wetted column at the rate of 0.124 m^3/s. Calculate the film thickness. Viscosity of water at 25°C is 1cP and density is 1000 kg/m^3. **05**

   c) Enlist all the boundary conditions while deriving the velocity and shear profile equations. **03**

UNIT - III

4. a) Derive an expression to find the temperature distribution of an incompressible fluid by considering the viscous heat source **10**

b) The copper wire of 0.1cm diameter is insulated uniformly with the plastic to an outside diameter of 0.31cm and is exposed to surroundings at 40°C. The heat transfer co-efficient from the outer surface of the plastic to the surrounding is 8.5 W/m^2 K. What is the maximum steady state current the wire can carry without heating any part of the plastic above its operating limit, 94°C? **10**

DATA:

	K (W/m K)	Kc (1/ohm cm)
Copper	380.82	$5.1*10^5$
Plastic	0.346	0

OR

5. a) Derive an expression to find the temperature distribution in a spherical nuclear source surrounded by aluminum cladding. **12**

b) A furnace wall consists of three layers. First is a layer of refractory brick, second layer of insulating brick, and steel plate as third layer for mechanical protection. The steel plate is 6.3 mm. thick. Calculate the thickness of each layer of brick to give minimum total wall thickness if the heat loss through the wall is to 15.77 kW/m^2. Assuming that the layers are in excellent thermal contact. Temperature of refractory brick layer, insulating brick layer and steel plate layers are 2500 °F, 2000 °F and 100 °F **08**

Data given

Material	Maximum allowable temperature	Thermal conductivity (W/m K)	
		at 100 °F	at 2000 °F
Refractory brick	2600°F	3.12	6.23
Insulating brick	2000°F	1.56	3.12
Steel plate	-	45.14	-

UNIT-IV

6. a) Derive an expression for the molar flux, for the diffusion with heterogeneous chemical reaction $2A \rightarrow A_2$ taking place in a catalytic reactor of cross section area S and Length L. **10**

b) Chloropicric acid is kept in an Arnold cell & liquid is evaporating in the stagnant air at 25ºC. Determine the rate of evaporation from the following data: **10**

i) Total Pressure = 770 mmHg
ii) Diffusivity = 8.8×10^{-6} m^2/s
iii) Vapor pressure = 23.8 mmHg
iv) Distance of liquid level to top of tube = 11.14 cm
v) Molecular weight = 164.35
vi) Density = 1650 kg/cubic meter
vii) Surface area = 2.29 cm^2

UNIT - V

7.	a)	Define Newton's 2nd law of motion and derive Navier-Stokes equation of motion.	**12**
	b)	Explain the Reynolds analogy between momentum and heat transfer.	**08**

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