Reg. No.

End Sem. QP (2018)

M.Tech

BRG

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

I SEMESTER M.TECH. (BIOTECHNOLOGY)
END SEMESTER EXAMINATIONS, NOVEMBER 2018
SUBJECT: TRANSPORT PHENOMENA IN BIOPROCESSING [BIO 5123]
REVISED CREDIT SYSTEM

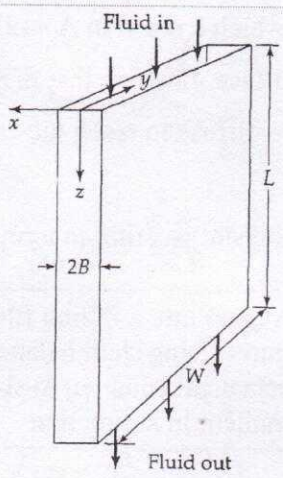
Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A.



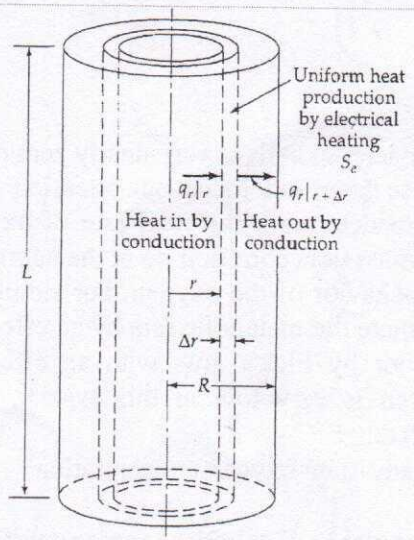
A newtanian fluid is in laminar flow in a narrow slit formed by two parallel walls a distance 2B apart. It is understood that B<<W, so that edge effect are unimportant. Make a differential momentum balance, and obtain the expression for momentum flux and velocity distribution

6

1B. Compare Momentum transfer, Heat transfer and mass transfer with basic equations and explain momentum diffusivity, thermal diffusivity and mass diffusivity with proper equations

4

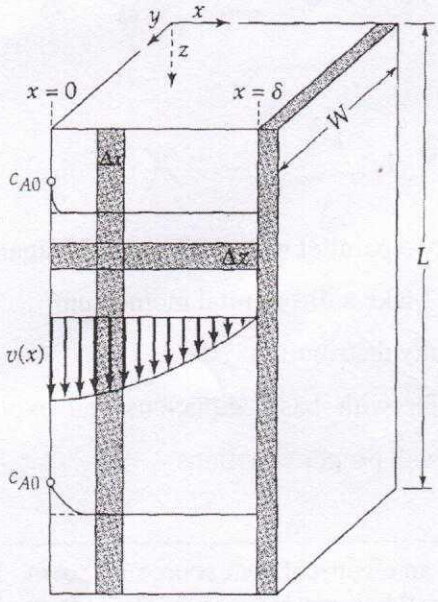
2A.



Heat conduction with an electrical heat source is shown in the figure. Using shell balance technique, Develop a mathematical equation which gives the temperature profile from the center of the wire to the surface of the wire.

- Where is the maximum temperature rise? Show in terms of equation
- Develop an equation for average temperature rise
- Develop an equation to show heat outflow at the surface for a length L of wire

8

2B.	Explain free convection and forced convection in heat transfer	**2**
3A.	Using Buckingham Pi theorem show that power required for an impeller of the reactor without baffles in dimensionless number and also show that it is a function of other dimensionless numbers	**8**
3B.	Explain the significance of dimensionless numbers in transport processes	**2**
4A.	The space between two coaxial cylinders is filled with an incompressible fluid at constant temperature. The radii of the inner and outer wetted surfaces are kR & R, respectively. The angular velocities of rotation of the inner and outer cylinders are Ω_i & Ω_o. Determine the velocity distribution in the fluid.	**6**
4B.	Consider a catalytic heterogeneous chemical reaction in which a reaction A $\rightarrow$2B is carried out and assume reaction occurs instantaneously at the catalytic surface. Imagine that the catalytic particle is surrounded by a stagnant gas film through which A has to diffuse to reach the catalytic surface. Neglect the curvature of the particle. Obtain the expression for concentration profile of A in stagnant gas film in terms of mole fraction of A	**4**
5A.	 Absorption of A (gas) into a falling film of liquid B is shown in the figure. Using shell balance technique, Develop a mathematical equation to show the concentration gradient in x direction	**6**
5B.	Under suitable circumstances the rate of oxygen metabolism by bacterial cells is very nearly zero order with respect to oxygen concentration. We examine such a case here and focus our attention on a spherical aggregate of cells, which has a radius R. We wish to determine the total rate of oxygen uptake by the aggregate as a function of aggregate size, oxygen mass concentration ρo at the aggregate surface, the metabolic activity of the cells, and the diffusional behavior of the oxygen. For simplicity we consider the aggregate to be homogeneous. We then approximate the metabolic rate by an effective volumetric reaction rate r_{o2} = - K and the diffusional behavior by Fick's law, with an effective pseudobinary diffusivity $\mathbf{D_{O2}}$. Because the solubility of oxygen is very low in this system, both convective oxygen transport and transient effects may be neglected. • Show by means of a shell mass balance that the quasi-steady-state oxygen concentration profile is described by the differential equation • Show the oxygen mass concentration variation in different places of spherical aggregate of cells	**4**