TUGAS 12

Case Study; Group Work

The question number is the same as the group number

1. Figure 3.3 shows steady-state heat transfer in the rectangular fin (Ghoshdastidar, 1998). The base temperature of the fin is $T(0) = 0$ and the temperature at the fin tip is $T(1) = 1$.

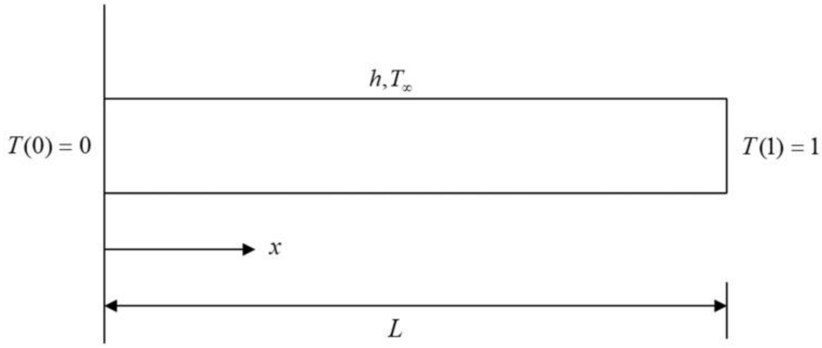

FIGURE 3.3 Steady-state heat transfer in rectangular fin.

h = fin heat transfer coefficient
L = fin length

The dimensionless form of the energy equation is

$$\frac{d}{dX}\left(k(T)\frac{dT}{dX}\right) = Q \tag{3.5}$$

$$T(0) = 0,\ T(1) = 1. \tag{3.6}$$

The temperature, T, is the dimensionless temperature and is a function of dimensionless length, X. The thermal conductivity of the fin is temperature dependent $k(T) = 1+T$, $Q=0$.

Q = energy generation rate.

2.

The illustration on reaction–diffusion considering spherical domain (Finlayson, 2006) is given by following differential equation:

$$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dc}{dr}\right)=\frac{\alpha' c}{1+Kc} \tag{3.9}$$

$$\text{or } -\frac{d^2c}{dr^2}=\frac{2}{r}\frac{dc}{dr}-\frac{\alpha' c}{1+Kc}. \tag{3.10}$$

The boundary conditions are

$$\frac{dc}{dr}(0)=0, c(1)=1 \tag{3.11}$$

where $\alpha = 5$ and $K = 2$.

3.

Figure 3.11 illustrates the pipe of radius R and length L over which pressure drop Δp occurs. The Newtonian fluid having viscosity μ is flowing through the pipe with velocity v. It is governed by the following differential equation (Bird et al., 2002):

$$\frac{d^2v}{dr^2} = -\frac{1}{\mu}\frac{\Delta p}{L} - \frac{1}{r}\frac{dv}{dr} \tag{3.14}$$

$$\frac{dv}{dr}(0) = 0, v(R) = 0 \tag{3.15}$$

where

$\Delta p = 28 \times 10^4$ Pa

$\mu = 492 \times 10^{-3}$ Pa s

$L = 488 \times 10^{-2}$ m

$R = 0.0025$ m.

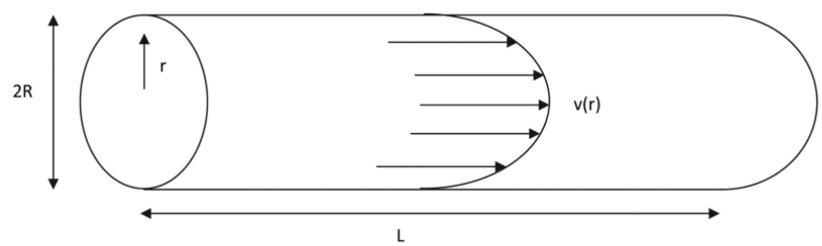

FIGURE 3.11 Newtonian fluid in a pipe.

4.

The non-Newtonian fluid having viscosity η (Bird et al., 1987) is flowing through the pipe with velocity v. It is governed by the following differential equation:

$$\frac{\text{Ä}}{r}\frac{d}{dr}\left(r\eta\frac{dv}{dr}\right)=-\frac{\Delta P}{L} or \frac{d}{dr}\left(\eta\frac{dv}{dr}\right)+\frac{\eta}{r}\frac{dv}{dr}=-\frac{P}{L} \tag{3.18}$$

$$\frac{dv}{dr}(0)=0, v(R)=0 \tag{3.19}$$

$$\eta=\frac{\eta_0}{\left[1+\left(\lambda\frac{dv}{dr}\right)^2\right]^{(1-n)/2}} \tag{3.20}$$

where

$\eta_0 = 0.492$

$\lambda = 0.1$

$n = 0.8$

$\Delta p = 2.8 \times 10^5$ Pa

$L = 488$ m

$R = 0.0025$ m.