Menoufiya University
Faculty of Engineering
Shebin El-Kom
Final Exam
Academic Year: 2015-2016

Post Graduate: Diploma
Department: Basic Engineering science
Subject: Computational Fluid Dynamics
Time Allowed: 3hrs
Date: 18/6/2016

Note: Assume any data required, state your assumption clearly.

Question (1) **(25 Marks)**

Solve the following equations using second order Runge Kutta Mothod

$$\frac{dy}{dx} = -2y + 5ze^{-x}$$

$$\frac{dz}{dx} = -\frac{yz^2}{2}$$

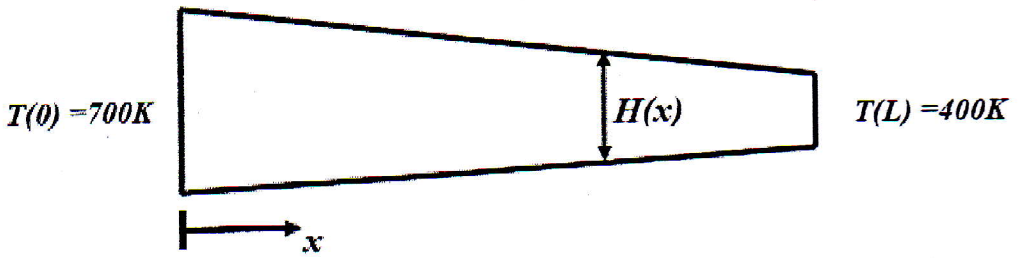
over the range x = 0 to 1 using a step size of 0.2 with y(0) = 2 and z(0) = 4.

Question (2) **(25 Marks)**

The heat transfer equation in trapezoidal fine shown in the next figure is given by

$$\frac{\partial}{\partial x}\left(kA(x)\frac{\partial T}{\partial x}\right) + hP(x)(T - T_{\infty}) = 0$$

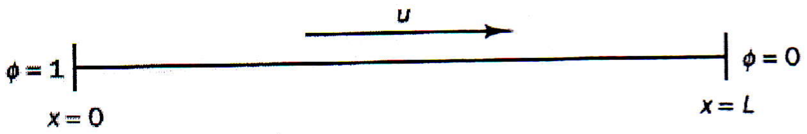
Where, ***k*** is the thermal conductivity, ***P(x)*** and ***A(x)*** are the perimeter and cross sectional area of the fin at any ***x***. given that: ***k*** = 19 W/m.K, T_{∞}=300K, ***h*** = 2 W/m^{2}K, the fin length is 50 cm and fin width (perpendicular to paper) is 15 cm, the find height is ***H(x)*** = 5-0.005***x*** cm. Calculate the temperature distribution along the fin using five grid points



Question (3) **(25 Marks)**

A property φ is transported by means of convection and diffusion through the one-dimensional domain sketched in the figure The governing equation is $\frac{d\rho u\varphi}{dx} = \frac{d}{dx}\left(\Gamma\left(\frac{d\varphi}{dx}\right)\right)$ the boundary conditions are φ_0 =1 at x = 0 and φ_L = 0 at x = L. Using five equally spaced cells and the central differencing scheme for convection and diffusion, calculate the distribution of φ as a function of x. The following data apply:

u = 0.1 m/s, length L = 1.0 m, ρ = 1.0 kg/m^3, Γ = 0.1 kg/m.s.



Question (4) **(25 Marks)**

In figure 1, a two-dimensional plate of thickness 1 cm is shown. The thermal conductivity of the plate material is k = 1000 W/m.K. The west boundary receives a steady heat flux of 500 kW/m^2 and the south and east boundaries are insulated. If the north boundary is maintained at a temperature of 100°C, use a uniform grid with Δx = Δy = 0.1 m to calculate the steady state temperature distribution. The two-dimensional steady state heat transfer in the plate is governed by

$$\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)+\frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right)=0\,.$$

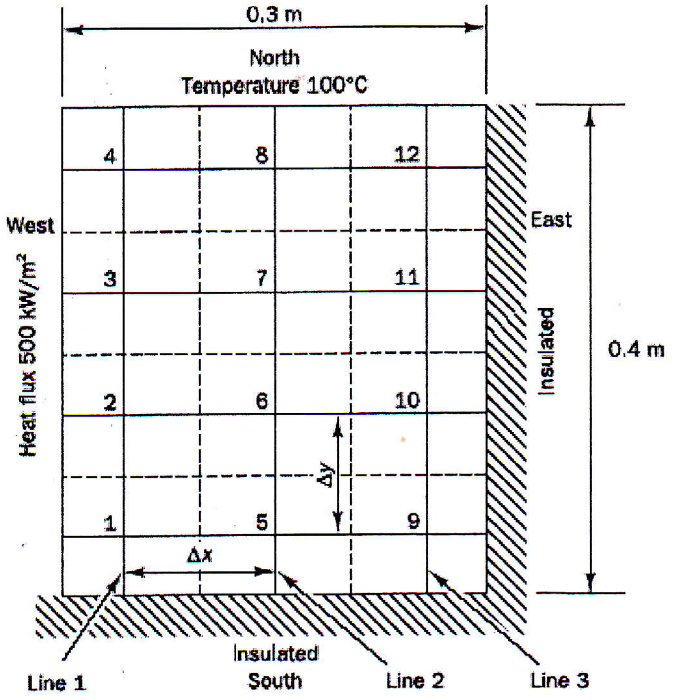
Answer the following:

a) Describe the solution of the aforementioned problem

b) Show in details how the boundary conditions of this problem can be implemented.

c) How TDMA can be used with problem?

d) Write computer program for this problem.



GOOD LUCK

Dr. Samy M. El-Behery