Menoufiya University
Faculty of Engineering
Shebin El-Kom
2th Semester
Academic Year: 2014-2015

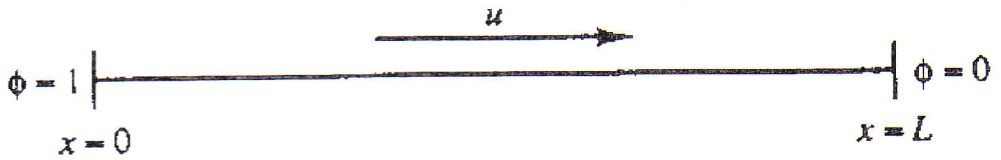
Minufiya University

Post Graduate: Master
Department: *Mechanical Power*
Subject: Computational Fluid Dynamics
(MPE620)
Time Allowed: 3 hrs
Date: 10 /06/2015

Note: Assume any data required , state your assumption clearly. Answer all the following Questions

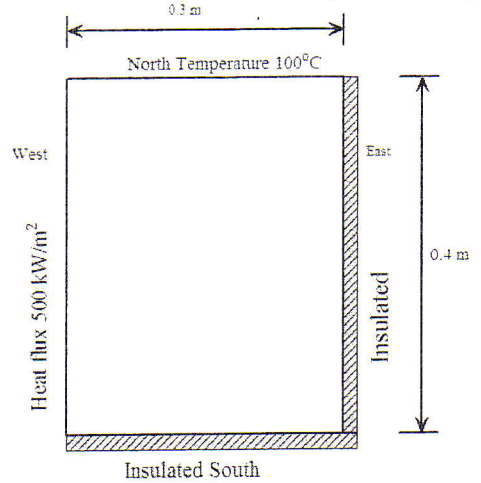
Question (1) (25 Marks)

A property □ is transported by means of convection and diffusion through the one – dimensional domain sketched in the figure. The governing equation is $\frac{d\rho u\phi}{dx}=\frac{d}{dx}\left(\Gamma(\frac{d\phi}{dx})\right)$ the boundary conditions are $\phi_o=1.0$ at x=0 and $\phi_L=0.0$ at x=L. Using five equally spaced cells and the upwind differencing scheme, calculate the distribution of □ 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, $\Gamma=0.1$ kg/m.s.



Question (2) (25 Marks)

In figure a two- dimensional plate of thickness 1cm is shown. The governing equation is $\frac{\partial}{\partial x}\left(k(\frac{\partial T}{\partial x})\right)+\frac{\partial}{\partial y}\left(k(\frac{\partial T}{\partial y})\right)=0.0$. The thermal conductively of a 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 at nodes



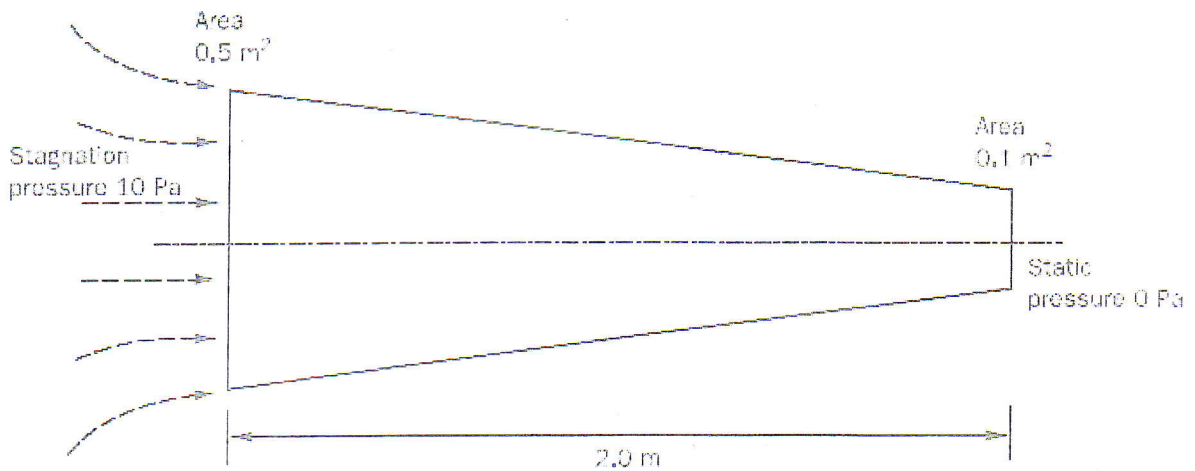
Question (3) (25 Marks)

3-a) The original x-momentum can be written with η as the independent variable and f is the dependent variable as $2\frac{\partial^3 f}{\partial \eta^3}+f\frac{\partial^2 f}{\partial \eta^2}=0$ upon simplifications. Calculate the value of f over the range η = 0 to 5 using a step size of 1 with $f(0)=f'(0)=0$ and $f''(0)=0.3321$ (15 marks)

3-b) Drive an expression for pressure correction equation using SIMPLE algorithm and draw a flowchart for the solution of Navier-Stokes equations using this algorithm (10 Marks)

Question (4) (25 Marks)

A planar two-dimensional nozzle is shown in figure below. The flow is steady and frictionless and the density of the fluid is constant. Use the backward-staggered grid with five pressure nodes and four velocity nodes. The stagnation pressure is given at the inlet and the static pressure is specified at the exit. Using the SIMPLE algorithm, write down the discretised momentum and pressure correction equations and solve for the unknown pressures and velocities. Check whether the computed velocity field satisfies continuity



GOOD LUCK

Dr. Samy M. El-Behery & Dr. Ismail M. Sakr