Menoufiya University Faculty of Engineering Shebin El-Kom Final Exam Academic Year: 2014-2015	Minufiya University	Post Graduate: Diploma Department: Basic Engineering science Subject: Computational Fluid Dynamics Time Allowed: 3hrs Date: 12/1/2015

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

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

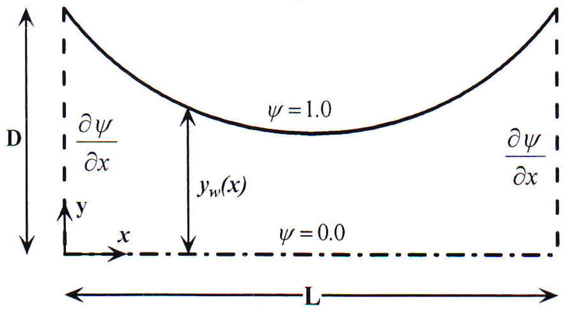
Solve the following equation using Runge Kutta Mothod

$\frac{d^2y}{dt^2}+0.5\frac{dy}{dt}+7y=0$ Where y(0) =4 and $\left.\frac{dy}{dt}\right|_{x=0}=2$ from t = 0 to 5 using step 1.

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

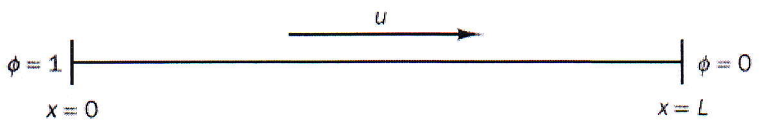
The ideal incompressible flow in a convergent-divergent nozzle can be described by $\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=0$, where ψ is the stream function. Due to flow symmetry, only the upper half of the nozzle needs to be solved, see the figure. The nozzle wall can be represented by $y_w(x)=D-\frac{D}{2}\sin(\pi\frac{L-x}{L})$. The velocity distribution through the nozzle can be calculated from $u=\frac{\partial\psi}{\partial y}$ and $v=-\frac{\partial\psi}{\partial x}$, where u and v are the horizontal and vertical velocity component, respectively. Using the boundary conditions shown in the figure, answer the following:

a. Describe the solution procedure of this problem using finite difference method
b. Write a computer program for the solution procedure described in a.
c. Show how the velocity distribution can be obtained numerically.



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 $\varphi_L = 0$ 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)**

Drive an expression for pressure correction equation using SIMPLE algorithm and draw a flowchart for the solution of Navier-Stokes equations using this algorithm

GOOD LUCK

Dr. Samy M. El-Behery