Chapter # 5

Problem # 5-2

One-dimensional steady-state convection diffusion equation without source term, whereas boundary conditions are $x=0$, $\phi=\phi_0$, $x=L$, $\phi=\phi_L$。Taking 10 to 20 nodes for range $x/L=0\sim1$, using the following 4 methods: Central difference, first order upwind , Hybrid scheme and QUICK scheme, then draw the plot between $(\phi-\phi_0)/(\phi_L-\phi_0)$ and x/L using three values of Peclet number i.e. $P_\Delta=1,5,10$ and compare the results with exact values.

(Note: take care the difference between gird Peclet number, P_Δ, whole Peclet number and $P_\Delta=\dfrac{\rho uL}{\Gamma}$)

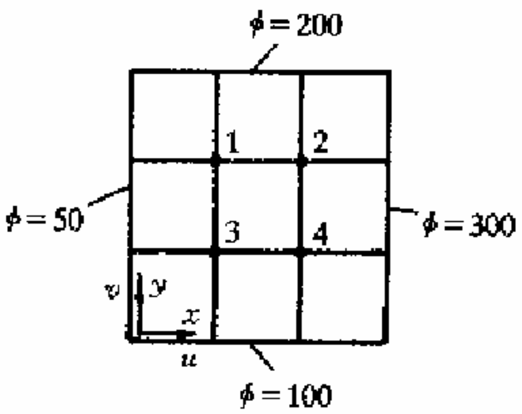
Problem # 5-3

For one-dimensional unsteady convection - diffusion equation

$\dfrac{\partial(\rho\phi)}{\partial(t)}=-\dfrac{\partial(\rho u\phi)}{\partial x}+\dfrac{\partial}{\partial x}\left(\Gamma\dfrac{\partial\phi}{\partial x}\right)$, using power law scheme for the discretization and find the values of followings constants a_E, a_W, a_P^0 and a_P : $\Delta t=0.05$, where $\rho u=1$, $P_\Delta=0.1, 10$。All units are the same.

Problem # 5-5

Consider a two-dimensional steady-state convection diffusion equation, where $\rho u=5$, $\rho v=3$, $\Gamma=0.5$, the boundary values are shown in figure given below, also $\Delta x=\Delta y=0.2$。By using (a) first order upwind scheme ; (2) hybrid scheme ; (3) power law scheme ; (4) second-order upwind scheme, try to get the values of ϕ at four nodes (1,2,3,4).



Problem # 5-7

Discretize the equation (5-1) for uniform grid and $u > 0$ by using the QUICK scheme and get the discretization equation. Then use the sign preservation rule as in section 5.7 to analyze the stability of this scheme.

Problem # 5-9

Define the third-order upwind scheme using the interface function interpolation method and verify the consistence in form with the definition of derivative expression for given nodes.