

Homework4-Numerical Heat Transfer

习题 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 $x/L = 0 \sim 1$, 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 grid Peclet number, P_Δ , whole Peclet number

and $P_\Delta = \frac{\rho u L}{\Gamma}$).

习题 5-3

For one-dimensional unsteady convection - diffusion equation

$$\frac{\partial(\rho\phi)}{\partial(t)} = -\frac{\partial(\rho u\phi)}{\partial x} + \frac{\partial}{\partial x} \left(\Gamma \frac{\partial\phi}{\partial x} \right), \text{ using power law scheme for the discretization and find}$$

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.

习题 5-8

For 1-D diffusion-convection problem with source term, following conditions are given: $x = 0, \phi = 0, x = 1, \phi = 1; S = 0.5 - x$

By adopting (1) FUD, (2) QUICK for the convection term and CD for the diffusion term, calculate the values of ϕ at 10-20 uniformly distributed grids. Compare the numerical results with the analytical solution.

Hint: The analytical solution is

$$T = \frac{\exp(PeX) - 1}{\exp(Pe) - 1} - \frac{X^2}{2Pe} + \frac{X}{2Pe} \quad 0 \leq X \leq 1$$

$$T = \frac{\phi - \phi_0}{\phi_L - \phi_0} \quad X = \frac{x}{L}$$

习题 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. ↓

习题 5-11

Adopt the Fromm scheme for the convection term of 1-D diffusion-convection equation without source term . Analyze its stability by sign preservation principle and find its critical grid Peclet number.