INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR, HOW-3
M.E. (ME) 2nd Semester Final Examination, 2014.

Numerical Heat Transfer

(ME – 1007)

Time : 3 hours **Full Marks : 70**

Answer FOUR questions
The questions are of equal value

1 (a) State the method for linearization of the non-linear terms. Discuss in brief the tri-diagonal matrix algorithm.

(b) In one dimensional source free steady heat conduction situation, the temperatures at the inlet and exit sections of the computational domain are 115^0c and 320^0c respectively. Take three equal divisions throughout the domain. Length and cross section of the domain are 2.7 m and 10 cm^2 respectively. The thermal conductivity of the medium is 780 W/m-K. Estimate the temperatures at all nodes of the domain.

2 (a) Write the governing differential equations and discuss in brief the physical meaning of each term. State the benefits of discretization. Explain in brief the finite difference formulation during derivation of discretization equations.

(b) Estimate the magnitudes of $f'(x)$ and $f''(x)$ at the distance, i.e. x, of 0.22 and 0.45 with mesh increment of 0.01. The function is $\sin 2\pi x$. Also estimate the % of error in respect to exact solution.

3 (a) Deduce the discretized equations for four internal grid nodes and two near boundary grid nodes in case of one dimensional steady state convection and diffusion problem using upwind scheme. Also state the relevant coefficients.

(b) A property Φ is transported through convection and diffusion in a steady one dimensional domain of 0.9 m length. The domain is having three equally spaced cells. Estimate the distribution of Φ in all the nodes. The fluid is having velocity of 10 m/s, density of 1 kg/m^3 and diffusion coefficient of 0.9 kg/m-s. Magnitudes of Φ at entry and exit of the domain are 2.5 and 1.2 respectively. Use the upwind scheme.

4 (a) With the help of the relevant flow charts discuss in brief the SIMPLE algorithm for solving the 1-D steady and transient convection-diffusion problems.

(b) A steady heat conduction is taking place through a 15 cm thick plate in one direction. Thermal conductivity of the plate is 4.7 W/m-K. If the computational domain is having three equal divisions, estimate the temperatures of all nodes. The uniform heat generation of 1070 kW/m^3 is persisting in the plate. The temperatures at two faces of the plate are 200^0c and 425^0c respectively. The cross sectional area of the plate is 50 cm^2.

5 Write short notes on <u>any four</u> of the following:-

(a) Central differencing scheme

(b) Relaxation parameters

(c) Boundness and tranportiveness

(d) Power law scheme

(e) Prediction methodologies