Form A: Paper-setting Blank

Ref. No. Ex/PG/PE/T/128B2018

M.E. POWER ENGG. 1ST YEAR 2ND SEMESTER EXAMINATION, 2018

SUBJECT: Computational Heat Transfer & Fluid Flow

Time: Three Hours | **Full Marks 100**

Attempt Any FOUR questions.

1.a)	Explain how classification of linear 2nd order differential equation is carried out into hyperbolic parabolic and elliptic types? Give example in each case. What do you mean by 'boundary value problem' and 'initial value problem'? Give example.	12
b)	What do you mean by consistency and stability of a numerical scheme? Why it is essential to analyze the stability of a particular numerical scheme?	8
c)	Hyperbolic problems are also initial boundary value problem- explain.	5
2. (a)	State the different kind of boundary conditions that are encountered in a heat conduction problem. Discuss how temperature at the boundary can be obtained by control volume method (use half control volume) when boundary heat flux is specified via heat transfer coefficient and the temperature of the surrounding fluid.	12
(b)	Consider unsteady one dimensional heat conduction equation with no source term. Disretise it using control volume approach (control volumes are equal and thermal conductivity is constant) and show that for fully explicit scheme $\Delta t < \frac{\rho c(\Delta x)^2}{2k}$ should be satisfied for stability of the scheme. Briefly state its difference with fully implicit scheme.	13
3 a)	Discuss how equations $a_i T_i = b_i T_{i+1} + c_i T_{i-1} + d_i$ ($N \geq i \geq 1$) can be solved by TDMA, when T_1 and T_N are known. (*a*, *b*, *c* and *d* are constants).	12
b)	How a set of algebric equations can be solved by direct method and Gauss-Siedel method? Discuss why these methods are discouraged to solve a fluid flow problem. In this context describe the Scarborough criterion.	13

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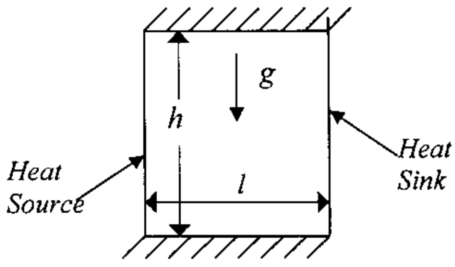
4	Show that for 1D convection diffusion equation $\frac{d}{dx}(\rho u\phi) = \frac{d}{dx}(\Gamma\frac{d\phi}{dx})$, the exponential scheme yields the following discretised equation. $a_P\phi_P = a_E\phi_E + a_W\phi_W$, where $a_E = \frac{F_e}{Exp(F_e / D_e) - 1}$, $a_W = \frac{F_w Exp(F_w / D_w)}{Exp(F_w / D_w) - 1}$ and $a_P = a_E + a_W + (F_e - F_w)$. Hence briefly discuss the hybrid scheme as a simplification of exponential scheme. How the difficulties of central difference scheme and the upwind scheme can be eliminated using this scheme?	**10**
5.	The figure shows a 2-D cavity of height h and length l filled with air. The LHS wall is an isothermal heat source while the RHS wall is an isothermal heat sink. Top and bottom walls are insulated as shown by hatched lines in the Figure 1. Considering laminar natural convection, develop the continuity, momentum and energy equations with boundary conditions. Also show the non-dimensional form of the equations and boundary conditions using suitable scale. (Incorporate the density variation in the body force term using Bossinesq approximation.)  *Figure 1*	**25**
6.	Starting from generalized discretised equation show how a 2-D fluid flow problem can be solved using SIMPLER algorithm.	**25**