Form A: Paper-setting Blank

Ref. No. Ex/PG/PE/T/128B/2017

M.E. POWER ENGG. 1ST YEAR 2ND SEMESTER EXAMINATION, 20017

SUBJECT: ***Computational Heat Transfer & Fluid Flow***

Time: Three Hours **Full Marks 100**

Attempt Any FOUR questions.

No. of Questions		Marks
1.a)	Briefly discuss the advantages of and disadvantages of numerical methods over other methods of solving a fluid flow problem.	5
b)	State why 'direct method' is not encouraged by the researchers in solving a set of discretised governing equations related to fluid flow problem? 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 Thomas Algorithm, where T_1 and T_N are known and a, b, c and d are constants.	5+10
c)	What do you mean by 'boundary value problem' and 'initial value problem'? Discuss briefly with examples.	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.	10+3
3.a)	Explain how staggered grids are used to overcome the difficulties in solving a 2D pressure-velocity coupled steady flow problem?	10
b)	With an example, explain 'false diffusion'. A 2-D purely convection equation is discretised following upwind scheme. Show mathematically that 'false diffusion' decreases with grid refinement.	15

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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.	**25**
5.a)	Explain how staggered grids are used to overcome the difficulties in solving a 2D pressure-velocity coupled steady flow problem?	**10**
b)	Briefly describe the central difference scheme and upwind scheme to solve a one dimensional convection diffusion equation. Briefly describe merits and demerits of both the scheme.	**10 + 5**
6.	Starting from generalized discretised equation show how a 2-D fluid flow problem can be solved using SIMPLE algorithm.	**25**