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Question Paper Code : 72126

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Seventh/Eighth Semester

Mechanical Engineering

ME 6014 – COMPUTATIONAL FLUID DYNAMICS

(Common to Aeronautical Engineering, Manufacturing Engineering, Mechanical and Automation Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Classify partial differential equations.

2. Classify Boundary Conditions (BCs) and give an example for each B.C.

3. What is meant by grid independent solution?

4. What is the stability criterion for explicit and semi-implicit schemes?

5. What is the scheme used for Peclet number more than two? Why?

6. What is transportiveness?

7. What are the advantages of staggered grid?

8. What are the non-linearities present in the momentum equation?

9. What is the mixing length for jets and wakes?

10. What is viscous sublayer?

PART B — (5 × 16 = 80 marks)

11. (a) Derive the continuity and X – momentum equations for a 3D compressible flow.

Or

(b) Consider heat transfer in the boundary layer over a flat plate. The flow is steady, two – dimensional incompressible laminar flow over a flat plate. Far stream velocity of the flow is uniform and parallel to the plate. Write the governing (partial differential) equations for flow and heat balance. Give the appropriate boundary conditions. Identity whether the equation is linear, parabolic or elliptic.

12. (a) A rectangular fin of length 2 cm, thickness 2 mm, and breadth 20 cm is attached to a plane wall. The wall temperature T_w = 200°C and ambient temperature T_∞ = 25°C. For the fin material, k = 45 W/(m.K) and the operating h = 15 W/(m².K) determine the steady state temperature distribution in the fin using Finite volume method by taking 5 equal control volumes. Assume the fin tip is insulated.

Or

(b) An slab of aluminium, L = 5 cm thick is initially at a uniform temperature of 200°C. Suddenly one of its surfaces is brought to 70°C while the other surface is kept insulated. By using explicit scheme and mesh size Δx = 1 cm, calculate the transient temperature distribution of the slab at time t = 10 sec. Use finite volume method. Take ρ = 2700 kg/m³ c = 0.9 kJ/kg-K and k = 215 W/mK. Consider 5 equal control volumes.

13. (a) Derive the discretized equations for a 1 D convection diffusion for interior nodes using upwind schemes for convection terms. Take 5 equal control volumes.

Or

(b) Derive the discretized equations for a 1 D convection – diffusion for the boundary nodes using QUICK scheme. Take 5 equal control volumes.

14. (a) Derive the equations for convective flux per unit mass F and the diffusive conductance at v- control volume faces, using staggered grid.

Or

(b) Derive the pressure correction and velocity correction equations of SIMPLE algorithm using finite volume method.

15. (a) Discuss the governing equations for mean flow kinetic energy K and turbulent kinetic energy k. Explain the various terms.

Or

(b) Discuss any one of low Reynolds number turbulence models. Discuss the various constants and functions used for predicting near wall behavior.

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