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M.Tech. (ME) (Sem.–2nd)

## COMPUTATIONAL FLUID DYNAMICS

Subject Code : MME-504

Paper ID : [E0429]

Time : 3 Hrs. Max. Marks : 100

INSTRUCTION TO CANDIDATES :
1. Attempt any FIVE questions out of EIGHT questions.
2. Each question carry TWENTY marks.

1. a) What are different methods used for solving engineering problems? Write their relative merits and demerits. What are different steps involved in theoretical modelling of a physical problem?

   b) What are different governing equations used for solving the fluid mechanics and heat transfer problems? Write these equations in Cartesian co-ordinates. Also write different boundary conditions used for solving these governing equations.

2. a) Describe Finite Difference Method, Finite Element Method and Finite Volume Method. For what type of problems these methods are most suitable?

   b) Derive the finite difference expressions for a second order derivative with forward, backward and central difference approximations.

3. a) Distinguish between discretization and round-off errors. Compare them with suitable examples.

   b) Describe briefly: Consistency, Convergence and stability of a numerical solution.

4. A large plate of thickness L = 2 cm with constant thermal conductivity $k$ = 0.5 W/mK and uniform heat generation $q$ = 1000 kW/m$^3$. The opposite faces of the plate are maintained at uniform temperature of 100°C and 200°C. Assuming the dimensions in $y$ and $z$ directions to be so large that temperature gradient is significant in x the steady state temperature distribution using (FVM) and compare the results with analytical so

5. Explain the following methods with suitable exam and demerits:

   I) Explicit method

   II) Implicit method

   III) Semi-implicit method

6. a) What is the purpose of defining different d control volume method? Show that central di second order of accuracy.

   b) Verify the following difference approximation at the point $(i, j)$. Assume $\Delta x = \Delta y = h$

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}=\frac{T_{i+1,j-1}+T_{i+1,j+1}+T_{i-1,j-}}{2h^2}$$



7. a) Describe the SIMPLE pressure-correction m coupled mass and momentum equations.

   b) Explain why, in practice, it is necessary t correction and not just the velocity correc mass conservation.

8. a) Show that the QUICK advection scheme is uniform mesh).

   b) Discuss the various relaxation techniques use

   c) Describe the Tri-Diagonal Matrix Algorith linear algebraic equations.