A Reg. No. : | | | | | | | | | | |

Question Paper Code: 99705

B.E./B.Tech. DEGREE EXAMINATION, APRIL 2024

Elective

Mechanical Engineering

19UME905– COMPUTATIONAL FLUID DYNAMICS

(Regulations 2019)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. For partial differential equation, if $b^2 - 4ac = 0$ then equation is called CO1- U

   (a) hyperbolic (b) parabolic

   (c) elliptic (d) None of the above

2. Truncation error becomes zero as mesh spacing tends to CO1- U

   (a) maximum (b) minimum (c) zero (d) equal

3. When a direct computation of dependent variables can be made in terms of known quantities, computation is said to be CO1- U

   (a) implicit (b) explicit (c) unique (d) dependent

4. If flow across boundary is zero, normal velocities are set to be CO1- U

   (a) maximum (b) zero

   (c) minimum (d) values of nearest node

5. Method of approximating differential equations by a system of algebraic equations for variables at some set of discrete locations in space and time is called CO1- U

   (a) Localization (b) Merging (c) Discretization (d) None of these

6. In steady flow of a fluid, acceleration of any fluid particle is CO1- U

   (a) constant (b) zero (c) variable (d) non zero

7. If Pu is upstream pressure and Pd is downstream pressure, Euler CO1- U

number is equal to

(a) Pd - Pu/pV² (b) Pu - Pd/pV² (c) Pu - Pd/pV³ (d) Pu - Pd/pV

8. Method of approximating differential equations by a system of algebraic equations for variables at some set of discrete locations in space and time is called CO1- U

(a) Localization (b) Merging (c) Discretization (d) None of these

9. Euler equation is useful for CO1- U

(a) viscid flow (b) inviscid flow (c) rotational flow (d) None of these

10. Froude number indicates influence of CO1- U

(a) gravity (b) velocity (c) pressure (d) temperature

PART – B (5 x 2= 10Marks)

11. Classify Partial Differential Equation CO1 R
12. Write about Lagrangian approach. CO2 R
13. Explain the methods involved to solve the FVM for one dimensional steady state diffusion. CO3 R
14. Write the QUICK scheme for steady one dimensional convection diffusion. CO4 R
15. Define Staggered Grid. CO5 R

PART – C (5 x 16= 80 Marks)

16. (a) Derive the mass equation for a 3D compressible flow CO3- A (16)

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. For stream velocity of the flow is uniform and parallel to the plate. Write the governing (partial differential equation for flow and heat balance. Give the appropriate boundary conditions. Identify whether the equations is linear, parabolic or elliptic. CO3 - A (16)

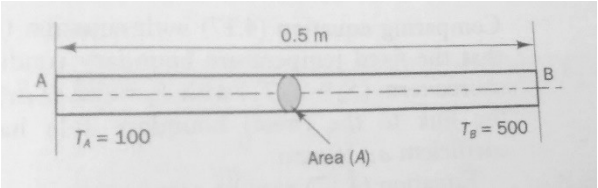
17. (a) Derive the FDM for Simple Methods. CO3 -A (16)

Or

(b) Derive the Iterative Solution Methods. CO3 -A (16)

18. (a) Consider the problem of source-free heat conduction in an CO3- A (16)

insulated rod whose ends are maintained at constant temperatures of 100ºC and 500ºC respectively. The 1D problem sketched in the figure is governed by $\frac{d}{dx}\left(k\frac{dT}{dx}\right)=0$. Calculate the steady state temperature distribution in the rod. Thermal conductivity k equals 1000W/mK, cross-sectional area A is $10x10^{-3}m^2$.



Or

(b) A thin plate is initially at a uniform temperature of 200^0C.At a certain time t=0 the temperature of the east side of the plate is suddenly reduced to 0^0C. The other surface is insulated. Use the Explicit finite volume method in conjunction with a suitable time step size to calculate the transient temperature distribution of the slab and compare it with analytical solution at time i) t = 40s ii) t = 80s iii) t = 120s — CO3 -A — (16)

19. (a) Describe in detail about Transportiveness. — CO4- A — (16)

Or

(b) Discuss in detail about Conservativeness. — CO4- A — (16)

20. (a) Develop mixing length model equation for the turbulence flow. — CO5 -A — (16)

Or

(b) Develop Reynolds Stress Equation Model equation for the turbulence flow. — CO5 -A — (16)