# COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra.)
SHIVAJI NAGAR, PUNE - 411 005

## END Semester Examination

### (AT-603) Computational Modeling and Simulation

Course: M.Tech (Automotive Technology) Branch: Mechanical Engineering

Semester: Sem III Max.Marks:60

Year: 2014-2015 Date: 30/11/2014

Duration: 3 Hours Time:- 2 to 5 p.m

**Instructions:** MIS No.

1. Figures to the right indicate the full marks.
2. Mobile phones and programmable calculators are strictly prohibited.
3. Writing anything on question paper is not allowed.
4. Exchange/Sharing of anything like stationery, calculator is not allowed.
5. Assume suitable data if necessary.
6. Write your MIS Number on Question Paper.
7. Solve any **six** questions.

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| Q. 1 | A. | Explain for a simple geometry problem on 2-D Navier-Stokes equation, why only explicit method solution is not possible. Explain how the different terms are calculated for X- momentum and Y- momentum equation in a staggered grid system. | [10] |
| Q. 2 | A. | Consider a 2-D CV with cell center P and its east neighbor E in materials with thermal conductivities, $k_1$ and $k_2$ respectively, and volume $\Delta V_E = 2\Delta V_P$. Also its north neighbor N in material with thermal conductivity $k_3$ and volume $\Delta V_N = 2\Delta V_P$. Determine the expression for conductivity at each face center. | [6] |
| | B. | Write down the algebraic equation for unsteady state conduction equation using explicit and implicit methods for simple domain. Also differentiate between explicit and implicit approaches in finite volume method. | [4] |
| Q. 3 | A. | Consider a square plate of side 10 units with circular hole at centre having diameter of 4 units. Draw the grid points in computational domain for C- type and O type physical domain, write down the appropriate x and y coordinates in a matrix form. | [6] |
| | B. | Explain the methods: FEM, FDM and FVM with suitable examples. What is discritization? Why it is necessary? | [4] |
| Q. 4 | A. | Consider 1-D unsteady state advection diffusion in a domain of length L = 1. The fluid has a density $\rho = 1$, diffusion coefficient $\Gamma = 0.1$ and a velocity of $u = 0.2$. The value of advected variable is $\phi$ | [10] |

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| | | = 1 at x= 0 and $\phi$ =0 at x = L. Write down the explicit form of finite volume discretized governing equation and boundary conditions. For 5 equally spaced cells and $\Delta t$ = 0.1, perform three time marching steps for Quadratic Upstream Interpolation for Convective Kinetics (QUICK) advection scheme for an explicit method. Take initial condition: $\phi$ = 0.5. | |
| Q. 5 | A. | What is Navier Stokes equation? Write 3-D Navier Stokes equations and explain the terms used in them. Also write the 3-D Energy equation. | **[6]** |
| | B. | Explain with neat sketch Geometric Parameters for a representative Simple Domain Control Volume. | **[4]** |
| Q. 6 | A. | Explain with neat sketches the different advection schemes for 2-D simple domain control volume for both direction flow of advective variable. | **[8]** |
| | B. | Explain the time step restriction criteria for diffusion and advection in Explicit method of finite volume discretization. | **[2]** |
| Q. 7 | A. | Consider 1-D unsteady State Heat Conduction in a plate with uniform initial temperature is $T_i$ = 200°C, at time t = 0 sec. Suddenly one end temperature, T = 0°C and other end is insulated, using explicit finite volume method formulate the equations and find for 7 cells the temperature distribution. Calculate for the 4 time step with an interval of 20 sec each, thermal conductivity of 10 W/m-K, plate thickness is 2 cm, product of density and specific heat is 10000 kJ/m$^3$/ K | **[10]** |