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Roll No. : .....

**337844(37)**

APR-MAY 2022

**B. E. (Eighth Semester) Examination, 2020**

**(New Scheme)**

**(Mech., Mechatronics Engg. Branch)**

**COMPUTATIONAL FLUID DYNAMICS**

*Time Allowed : Three hours*

*Maximum Marks : 80*

*Minimum Pass Marks : 28*

*Note : Attempt all questions. Part (a) of each question is compulsory. Attempt any two parts from (b), (c) and (d). Assume suitable data, if missing. Be brief and precise in your answers. Marks will be deducted for unnecessary lengthy answers. Draw neat sketches whenever required.*

where ever

**Unit-I**

1. (a) What are the fundamental physical principles on which fluid flow governing equations are derived? 2

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- (b) Derive the continuity, Navier-stokes and energy equations in cartesian co-ordinates from their respective co-ordinate free forms. 7
- (c) Explain classification of physical behaviour of partial differential equations. 7
- (d) Explain the well-posed problems in brief. Solve the Laplace-equation using well-posed problems. 7

### Unit-II

2. (a) Classify boundary value problems. 2
- (b) Write short notes on finit element and finite difference technique in CFD. 7
- (c) Discuss the advantages and disadvantages in using explicit and implicit approach. 7
- (d) Find a forward difference approximation of

$$O(\Delta x) \text{ for } \frac{\partial^4 f}{\partial x^4} \quad 7$$

### Unit-III

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3. (a) Write the governing equation for one dimensional steady state diffusion finite volume method. 2
- (b) Derive the finite volume discretisation using the heat conduction equation

$$\frac{d}{dx} \left[ K \frac{dT}{dx} \right] + S = 0$$

Where  $K$  = Thermal conductivity

$S$  = Source (Internal heat generation per unit volume)

$T$  = Temperature 7

- (c) Explain briefly about the principle of cell vertex formulation-multistage time stepping. 7
- (d) What is up-wind scheme? How is it applicable for solving the convective term? 7

### Unit-IV

4. (a) What is meant by Boundary-Layer? 2
- (b) Write the continuity and momentum equations for Laminar boundary layer, with the applicable boundary

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- conditions for the flow over a flat plate, with assumptions. 7
- (c) Explain the derive implicit first upwind differencing method. 7
- (d) Explain different viscous compressible flows with suitable example. 7

#### Unit-V

5. (a) Write the principle of Grid-Generation. 2
- (b) Explain following topology with neat sketch : 7
- (i) C-Grid topology
  - (ii) O-Grid topology
- (c) Discuss various aspects for assessment and improvement of grid quality. 7
- (d) Write a brief note on "Advancing Front Method". 7