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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – April 2017

Program/course: B.Tech- ADE, Mechatronics | **Semester – : VIII**
Subject: Computational Fluid Dynamics | **Max. Marks : 100**
Code : GNEG403 | **Duration : 3 Hrs**
No. of page/s: 3

Section-A

Answer all the questions. **20M**

1) Derive the finite difference expressions for a first order derivative with forward, backward and central difference approximations. (use Taylor series) [5M]

2) Explain the following [5M]

   a) Truncation error
   b) Round off error
   c) Discretization error

3) Explain the procedure to solve the 1-D steady heat conduction using implicit method. Discuss the accuracy of the scheme. [5M]

4) Distinguish between : [5M]
   a) Steady flow and un-steady flow,
   b) Compressible and incompressible flow,
   c) Rotational and irrotational flow

Section-B

Answer all the questions. **40M**

5) How computational Fluid Dynamics is different from analytical technique? Write its advantages and limitations. [10M]

6) Discuss the difference between Finite difference methods, Finite volume method, Finite Element Method. [10M]

7) Discretize the following equation by using FTCS scheme. Find out the truncation by using Taylor series. [10M]

$$\frac{\partial T}{\partial t} = \alpha \left[\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right]$$

8) Answer any one question out of two [10M]

a) Find out the shape functions for 2D 6 noded element.

(or)

b) A solution of the given equation is desired using the simple explicit scheme. What is the stability requirement for the method? (Hint:$\varepsilon_{i,j}^{n} = e^{at}.e^{K_x x}.e^{K_y y}$)

$$\frac{\partial u}{\partial t} = \alpha \left[\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right]$$

Section-C

Answer all the questions. **40M**

9) Formulate the 2D steady heat conduction in a rectangular geometry shown in the figure by using finite volume method. Boundary condition on surface ab is T=A, on surface bc is q=B, on surface cd is T=C, on surface da is q=D. (A,B,C,D are constants) [20M]

10) Answer any one question out of two [20M]

a) Formulate the 1D steady heat conduction with constant heat generation in finite element method. Find out the shape functions and stiffness matrix. Boundary conditions are constant temperature at both the ends.

(or)

b) Derive the energy equation for 3D unsteady flow in Cartesian coordinates.