BASE-005

# B.Tech. AEROSPACE ENGINEERING (BTAE)

## Term-End Examination

## June, 2019

00641

## BASE-005 : INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS

Time : 3 hours                          Maximum Marks : 70

Note : (i) Attempt any seven questions.

(ii) All questions carry equal marks.

(iii) Use of scientific calculator is permitted.

1. (a) List out advantages and limitations of panel method.                    2x5=10

   (b) Explain the difficulties of evaluating the influence of a panel at its own control point.

2. Write down the elliptical, parabolic, and hyperbolic partial differential equations as applicable to CFD.                    10

3. (a) Derive the equation of a streamline    2x5=10

   $$u\,dy - v\,dx = 0$$

   for plane flow in the x-y plane.

   (b) Show that following stream function

   $$\psi = 6x - 4y + 7xy + 9$$

   represent an irrotational flow. Find its velocity potential.

4. (a) Consider the following steady, incompressible, two-dimensional velocity field : **2x5=10**

$$V = x^2\hat{i} + (-2xy - 1)\hat{j}\ ;$$

Is this flow rotational or irrotational ? Justify your answer.

(b) A steady two-dimensional, incompressible flow field in the $x$-$y$ plane has a stream function given by

$$\psi = ax^2 - by^2 + cx + dxy$$

where a, b, c are constants.

(i) Obtain expressions for velocity components $u$, $v$.

(ii) Verify that the flow field satisfies the incompressible continuity equation.

5. (a) Write down the second order central mixed finite difference expression for $\dfrac{\partial^2 u}{\partial x\, \partial y}$. **2x5=10**

(b) Discuss the important errors that commonly occur in numerical solutions.

6. (a) What are the different categories of boundary conditions ? Give example of each category. **2x5=10**

(b) Differentiate between Structured and Unstructured grids.

7. What is the Finite Element Method (FEM) ? Explain, why should one use FEM. **10**

8. Derive the first order accurate forward difference and backward finite difference approximation for the second derivative of '$f$' with respect to '$x$' using Taylor series expansion. **10**

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