Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 711103N **Date: 03-01-2014**

Subject Name: Fluid Mechanics and Gas Dynamics

Time: 10.30 am – 01.00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Differentiate between **07**

(i) Langrangian and Eulerian methods of representing fluid flow.

(ii) The rotational and irrotational flows

(b) For an incompressible fluid the velocity components are: **07**

$u = x^3 - y^3 - z^2x$, $v = y^3 - z^3$, $w = -3x^2z - 3y^2z + \frac{z^3}{3}$

Determine whether the continuity equation is satisfied.

Q.2 **(a)** Derive the Euler's equation of motion. **07**

(b) A discharge through a 240 mm diameter horizontal pipe increases linearly from 30 to 120 litres/sec of water in 4 seconds. **07**

(i) What pressure gradient must exist to produce this acceleration?

(ii) What is the difference in pressure intensity that exists between two sections that lie 9 m apart?

OR

(b) Determine the components of rotation for the following velocity field pertaining to the flow of an incompressible fluid $u = Cyz$; $v = Czx$; $w = Cxy$ where $C =$ constant . **07**

State whether the flow is rotational or irrotational?

Q.3 **(a)** The velocity components in a fluid are given by $u = 2xy$; $v = a^2 + x^2 - y^2$ **07**

(i) Show that the flow is possible. (ii) Derive the relative stream function.

(b) For the following stream functions calculate velocity at a point (1,2) **07**

$(i)\ \psi = 3xy$ $(ii)\ y = 3x^2y - y^3$

OR

Q.3 **(a)** Show that a circle in ξ – plane displaced from the origin is mapped to an aerofoil in the physical z-plane via the Joukowski transformation. **07**

(b) A source of strength 10 m^2/s at (1, 0) and a sink of the same strength at (-1, 0) are combined with a uniform flow of 25 m/s in the negative x-direction. Determine the size of Rankine body formed by the flow and the difference in pressure between a point far upstream in the uniform flow and the point (1, 1). **07**

Q.4 **(a)** Obtain an expression in differential form for continuity equation for one-dimensional compressible flow. **07**

(b) Describe compressible flow through a convergent-divergent nozzle. How and where does the shock wave occur in the nozzle? **07**

OR

Q.4 **(a)** Define the following terms: **07**

(i) Subsonic flow (ii) Sonic flow (iii) Supersonic flow (iv) Mach cone

Q.4 **(b)** What is the critical pressure ratio for a compressible flow through a nozzle? On what factors does it depend? **07**

Q.5 **(a)** Enumerate different laws on which models are designed for dynamic similarities? Where are they used? **07**

(b) Describe Buckingham's method to formulate a dimensionally homogeneous equation between the various physical quantities affecting a certain phenomenon. **07**

OR

Q.5 **(a)** What is Mach number? Why is this parameter so important for the study of flow of compressible fluids? **07**

(b) For a normal shock wave in air Mach number is 3. If the atmospheric pressure and air density are 27 kN/m^2 and 0.456 kg/m^3 respectively, determine the flow conditions before and after the shock wave. Take $\gamma = 1.4$ **07**

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