Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2014

Subject code: 712103N **Date: 03-12-2014**

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)** From fundamentals derive the one-dimensional momentum equation in differential form. **07**

(b) Derive a relation for speed of sound in a gas in which the pressure is P and density is ρ state the assumption to be made if this relation is to be written in terms of temperature. **07**

Q.2 **(a)** What is meant by steady flow ellipse? Indicate various regions of flow on this ellipse. **07**

(b) From fundamentals derive the differential form of continuity equation applicable for one dimensional compressible flow. How does the equation gets simplified when the flow is steady? **07**

OR

(b) For air at a stagnation temperature of 1000 K find (i) the static temperature and velocity for a Mach number of 0.8 (iii)the Mach number and velocity for a static temperature of 800 K (iv) the Mach number and static temperature for a velocity of 1000 m/s. **07**

Q.3 **(a)** Define: Stream function state properties of a stream function and prove each one of them **07**

(b) Derive expression for stream and velocity potential functions for any two of the following four basic two dimensional potential flows. **07**

(i) Uniform flow
(ii) Source or sink
(iii) Vortex
(iv) Doublet

OR

Q.3 **(a)** How is a Rankine's body produced? Starting from stream function and velocity potential function for the basic flow combination , derive expressions for the size of Rankine's body **07**

(b) Given the stream function $\psi=3(x^2+y^2)$. Prove that the flow is rotational. Determine the magnitude and direction of velocity at (3,-5) **07**

Q.4 **(a)** State Buckingham's π theorem. Using Buckingham's π theorem , show that the velocity through a circular orifice is given by $V=\sqrt{2gH}\ \varphi$ [D/H , μ /ρ V H] Where H is the head causing flow , D is the diameter of the orifice , μ is co-efficient of viscosity ,ρ is the mass density and g is the acceleration due to gravity. **07**

(b) What is meant by geometric, kinematic and dynamic similarities? Are these similarities truly attainable? If not why? **07**

OR

Q.4 **(a)** A fluid flow under steady state through a CD nozzle , prove that $\frac{dA}{A}=\frac{dV}{V}(M^2-1)$ **07**

Q.4 **(b)** At a section in an isentropic flow passage air is having a temperature and pressure of 27^{o} C and one bar respectively and is flowing with a velocity of 300 m/s what will be the pressure and temperature of the fluid in the reservoir from where the flow has started? **07**

Q.5 **(a)** What is Fanno flow? What are the assumptions made in deriving equations for Fanno flow? **07**

(b) Air at Mach number 1.5, pressure 300 KN/m^2 and temperature 288 K is brought to sonic velocity in a frictionless constant are duct through which heat transfer occurs. Determine the final pressure, final temperature and heat added during the process. **07**

OR

Q.5 **(a)** Derive the Prandtl Meyer relationship for a normal shock. **07**

(b) What do you understand by choking in Rayleigh flow? **07**

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