Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**M. E. - SEMESTER – I • EXAMINATION – WINTER 2012**

**Subject code: 712103N Date: 12-01-2013**

**Subject Name: Fluid Mechanics &Gas Dynamics**

**Time: 02.30 pm – 05.00 pm Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of Gas Table is permitted**

**Q.1** **(a)** Define geometric, kinmatic and dynamic similarities. Explain how the condition of dynamic similarity of a hydraulic model are satisfied in actual practice. **07**

**(b)** An agitator of diameter D requires power P to rotate at a constant speed N in a liquid of density ρ and viscosity μ. Show with the help of Pi theorem that **07**

$P = \rho N^3 D^5 F(\rho N D^2 / \mu)$

**Q.2** **(a)** Explain Source flow ,Sink flow and Doublet with figures **07**

**(b)** What is meant by stream function? State the properties of a stream function and prove each one of them. **07**

**OR**

**(b)** What is meant by velocity potential function? State and prove its properties. **07**

**Q.3** **(a)** Derive expressions for stream and velocity potential function for following two dimentional potential flow **07**

(1) Uniform flow

(2) Source or Sink

**(b)** What is lift and drag co-efficient of an aerofoil ? write expressions for lift and drag. Show by graph how lift and drag co-efficient vary with angle of attack. **07**

**OR**

**Q.3** **(a)** Derive the continuity equation in Cartesian co-ordinates for multi-dimensional fluid flow with usual notations. **07**

**(b)** Derive the Prandtl Meyer relationship for a normal shock **07**

**Q.4** **(a)** With the help of (a-C ) diagram show the various region of flow. **07**

**(b)** Derive Euler's Momentum equation in Cartesian coordinate system. **07**

**OR**

**Q.4** **(a)** Air flowing in a duct has a velocity of 300 m/s, pressure 1.0 bar and temperature 290 K.Taking $\gamma$=1.4 and R=287 J/Kg.K determine: **07**

(i) Stagnation pressure and temperature,

(ii) Velocity of sound in the dynamic and stagnation conditions,

(iii) Stagnation pressure assuming constant density.

**Q.4** **(b)** Define static and stagnation enthalpies . Prove that **07**

$h_0 = h [ 1 + ((\gamma-1)/2)M^2 ]$

**Q.5** **(a)** Using fundamental equation obtain the Rankine-Hugonout equation for a **07**

normal shock. Hence show that a normal shock can not compress the gas to a density more than six times the density on upstream side. Also show that product of upstream and downstream velocity is equal to a square of critical velocity of flow.

**(b)** Represent the Rayleigh flow on (h-s) diagram and explain the different mach number regions for heating and cooling of gas flow in duct. **07**

**OR**

**Q.5** **(a)** Explain the variation in flow parameters for the Fanno Flow Process. Also show that the stagnation pressure always decrease in Fanno Flow Proess. Also represent graphically the variation of stagnation pressure on enthalpy-entropy diagram **07**

**(b)** Air enters a pipe of 0.05 m diameter at stagnation conditions of 10 bar and 400 K at Mach number of 2.8 If the Mach number at exit is 1.2 and friction factor is 0.005. Find the mass flow rate and length of pipe required. Assume $C_p$ = 1.005 kj/kg.k **07**

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