Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 712103N **Date: 17/02/2012**
Subject Name: Fluid Mechanics & 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.**
4. **Use of gas table is permitted.**

Q.1 **(a)** Give three examples of Fanno flow in thermal systems; give reason justifying Fanno flow in each of these cases. **07**

(b) Obtain the equation representing the Rayleigh line. Draw Rayleigh lines on h-s and p-v planes for two different values of the mass flux. **07**

Q.2 **(a)** Derive the following relation for flow through a normal shock: **07**

$$M_y^{\ 2} = \frac{[2/(\gamma-1)] + M_x^{\ 2}}{[2\gamma/(\gamma-1)]M_x^{\ 2} - 1}$$

(b) The state of gas (γ=1.3, R=0.469 kJ/kg K) upstream of a normal shock wave is given by the following data: $M_x = 2.5$, $p_x = 2$ bar, $T_x = 275$ K. Calculate the Mach number, pressure, temperature and velocity of the gas downstream of the shock; check the calculated values with those given in the gas table. **07**

OR

(b) A circular duct passes 8.25 kg/s of air at an exit Mach number of 0.5. The entry pressure and temperature are 3.45 bar and 38 ^{0}C respectively and coefficient of friction 0.005. If the Mach number at entry is 0.15, determine: (a) the diameter of the duct (2) length of the duct (c) pressure and temperature at the exit (d) stagnation pressure loss (e) verify the exit mach number through exit velocity and temperature. **07**

Q.3 **(a)** (a)Define circulation and velocity **07**
(b)Show that the line integral between two points in a flow field is independent of the path for irrotational flow.

(b) Derive the momentum equation for compressible fluid flow under steady state conditions. **07**

OR

Q.3 **(a)** Explain the importance of continuity and momentum equations. **07**
Derive continuity equations in Cartesian coordinates system

(b) Write down the Navier-Stocks equations of motion for three-dimensional, unsteady, compressible and viscous flow with body and pressure forces. **07**

Q.4 **(a)** Show that a source-sink pair (source and sink of equal strength) when viewed from infinity looks like a doublet. **07**

(b) Define the following terms for an aerofoil with figure: **07**
(1) Drag force (2) Chord length (3) Angle of attack (4) Span

OR

Q.4 **(a)** (i)Under what conditions a compression wave changes into a shock wave? **04**
(ii) Why are expansion shocks not possible? Justify. **03**

(b) Show that the upper and lower branches of a Fanno curve represent subsonic and supersonic flows respectively. Prove that at the maximum entropy point Mach number is unity and all processes approach this point. **07**

Q.5 **(a)** Using Buckingham's π Theorem show that the thrust F of a propeller having diameter d, moving with a velocity V in a fluid of viscosity μ and density ρ, rotating at a speed of N is expressed as **07**
$F = \rho V^2 d^2 f [N d / V, \rho V d / \mu]$

(b) Derive Kutta-Joukowski equation for lift of a cylinder. **07**

OR

Q.5 **(a)** The conditions of a gas in a combustor at entry are: p_1=0.343 bar, T_1=310 K, C_1=60 m/s; determine the mach number, pressure, temperature and velocity at the exit, if the increase in stagnation enthalpy of the gas between entry and exit is 1172.5 kJ/kg. **07**
Take cp = 1.005 kJ/kg , γ =1.4

(b) Derive the following equation for Rayleigh flow: **07**

$$\frac{T_1}{T_2} = \left(\frac{M_1}{M_2}\right)^2 \left(\frac{1+\gamma M_2^{\,2}}{1+\gamma M_1^{\,2}}\right)^2$$

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