Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Remedial Examination January/ February 2011

Subject code: 712103
Subject Name: Fluid Mechanics and Gas Dynamics

Date: 02 /02 /2011 **Time: 02.30 pm – 05.00 pm**
Total Marks: 60

Instructions:

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

Q.1 **(a)** Explain clearly velocity potential φ and stream function Ψ and hence prove Cauchy - Riemann's equation in Cartesian co-ordinates? **06**

(b) Explain what do you understand by doublets? Show that the combine flow field of a uniform flow & a doublet gives the flow around the cylinder, Hence analyze the flow? **06**

Q.2 **(a)** Derive Euler's momentum equations in Cartesian coordinates system? **06**

(b) What is velocity of sound? From fundamental equation show that velocity of sound is given by $a^2 = (\partial P/\partial \rho)_s$. Hence obtain the expression of the velocity of sound in perfect gas& explain the effect of molecular weight on it? **06**

OR

(b) Derive continuity equation in cylindrical polar co-ordinates for a two dimensional fluid flow with usual notations. **06**

Q.3 **(a)** The power developed by hydraulic machine is found to depend on the head h, flow rate Q, density σ, speed N, runner diameter D, and acceleration due to gravity, g. Obtain suitable dimensionless parameter to correlate experimental results. You can adopt MLT set of dimensions. **06**

(b) Define stagnation temperature and critical temperature of a gas. Also derive the equation $\frac{T^*}{T} = \left(\frac{2}{\gamma+1}\right)$ **06**

OR

Q.3 **(a)** Define Static and Stagnation enthalpies. Also prove that $h_0 = h\left[1+\left(\frac{\gamma-1}{2}\right)M^2\right]$ **06**

(b) discuss the type of nozzles required for subsonic and supersonic flows $\frac{dC}{C} = \left(\frac{1}{M^2-1}\right)\frac{dA}{A}$ **06**

Q.4 **(a)** Explain Stream function for two dimensional fluid flow and give its properties. **06**

(b) Define the following terms for an aerofoil with figure: **06**
(1) Drag force (2) Chord length (3) Angle of attack (4) Span

OR

Q.4 **(a)** What is similitude and model testing? Define conditions for similarity between models and prototype with different similarity? Express types of model studies in brief? **06**

(b) Explain the difference between Source flow and Sink flow with figures. **06**

Q.5 **(a)** Using fundamental equation obtain the Rankine – Hugonout equation for a 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? **06**

(b) For a flow in a constant area duct in which friction is predominant & heat transfer negligible ,discuss **06**

a) Duct length limitation

b) Chocking due to friction, considering initial velocity as subsonic as well as supersonic.

OR

Q.5 **(a)** Derive the following equation for maximum heat transfer (Q_{max}) for Rayleigh flow with usual notations. **06**

$$Q_{\max} = C_p T_1 \cdot \frac{(1-M^2)^2}{2(1+\gamma)M^2}$$

(b) From fundamental equation prove that ,for the flow in constant area duct with heat transfer **06**

a) $T1/T2 = (M1/M2)^2 (1+ \gamma M_2^2 / 1+ \gamma M_1^2)^2$

b) $C1/C2 = \rho2/ \rho1 (M1/M2)^2 1+ \gamma M_2^2 / 1+ \gamma M_1^2$

c) $S2\text{-}S1/ R = Ln\ M2/M1\ (M2/M1\ ) (1+ \gamma M_1^2 / 1+ \gamma M_2^2)^{\gamma+1/(\gamma-1)}$

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