Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E –I[st] SEMESTER–EXAMINATION – JULY- 2012

Subject code: 711103N **Date: 09/07/2012**

Subject Name: Fluid Mechanics & Gas Dynamics

Time: 2:30 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 Non Programmable Calculator & Gas Tables is permitted.**

Q.1 a) Prove that velocity of sound wave in a compressible fluid is given by $C = [k/\rho]^{1/2}$ [07]

b) An aero-plane is flying at 1000 km/h through still air having a pressure of 78.5 kN/m^2 (abs.) and temperature -8° C. Calculate on the stagnation point on the nose of the plane: [07]
   i) Stagnation pressure.
   ii) Stagnation temperature and
   iii) Stagnation density.
   Take for air : R =287 J/kg K and $\gamma = 1.4$.

Q.2 a) What are the applications of model testing? What is meant by geometric, kinematic and dynamic similarities? [07]

b) The resisting force F of a supersonic plane during flight can be considered as dependent upon the length of aircraft **l**, velocity **v** , air viscosity **μ** , air density **ρ** , and bulk modulus of air **K**. Express the functional relationship between these variables and the resisting force using dimensional analysis. [07]

OR

b) Explain i) Reynold model law ii) Froude model law. [07]

Q.3 a) What is an aerofoil? Define Drag and Lift co-efficient in reference of aerofoil. Also explain the variation in the value of the coefficient of lift and the coefficient of drag of an aerofoil with angle of incidence. [07]

b) A jet plane weighing 24.5 kN and having a wing area of 16.7 m^2 flies at a velocity of 950 km/h. When the engine delivers 6125 kW, 65% of the power is used to overcome the drag resistance of the wing. Calculate the co-efficients of lift and drag for the wing. Take density of the atmospheric air= 1.208 kg/m^3 . [07]

OR

Q.3 a) Explain flow past an incline Joukowski aerofoil. [07]

b) A truck having area of 6.5 m^2 travelling at 70 km/h has a total resistance of 2000 N. Of this 20% is due to rolling friction and 10% due to surface friction. The rest is due to form drag. Make calculations for the co-efficients of form drag. Take ρ = 1.22 kg/m^3 for air. [07]

Q.4 a) Discuss the effect of friction on fluid properties in adiabatic flow. [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 Cp = 1.005 kJ/kg K. [07]

OR

Q.4 a) Define Fannow flow. Show that the upper and lower branches of a Fanno curve represent subsonic and supersonic flows. [07]

b) Gas enters a combustion chamber at 400 kPa, 300 K and at a velocity of 69.5 m/s. Heat added in the combustion chamber is 218 kJ/kg. Find :
i) Exit Mach number and exit stagnation temperature.
ii) Exit pressure, temperature and velocity of gas Cp= 1005 J/kg K.

Q.5 a) Starting from the energy Equation for flow through a normal shock obtain the following relation : Mx* My*=1 [07]

b) The state of a gas (γ= 1.3, R= 469 J/ kg K) upstream of a normal shock wave is given by the following data : Mx = 2.5, px= 2 bar, Tx =275 K. Calculate the Mach number , pressure and temperature of the gas downstream of the shock. [07]

OR

Q.5 a) Describe the behaviour of flow in convergent-divergent nozzle when it is operated at (i) the design pressure ratio (ii) Pressure ratio higher than the design value. (iii) Pressure ratio lower then design value. [07]

b) Air at 15 bar and 1000 K enters a convergent-divergent nozzle with negligible velocity under steady state conditions. For a throat area of 30 cm^2 find : [07]
i) The mass flow rate and the throat conditions.
ii) Also, find the pressure and temperature in the divergent portion where Mach number is 2 and the required exit area.

****