Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME - SEMESTER– I (OLD course)• EXAMINATION – SUMMER 2015**

**Subject Code: 712103** **Date: 13/05/2015**

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

**Time: 10:30 am to 1:00 pm** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

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|---|---|---|---|
| **Q.1** | **(a)** | What is an aerofoil? Define with a neat sketch the various terms used in aerofoil geometry. | **07** |
| | **(b)** | Explain stream function for two dimensional fluid flows and give its properties. | **07** |
| **Q.2** | **(a)** | Derive Eulerôs Momentum equations in Cartesian co-ordinates system. | **07** |
| | **(b)** | Write down the Navier-stocks equations of motion with necessary assumptions, also explain the body and pressure forces. | **07** |
| | | **OR** | |
| | **(b)** | Derive the continuity equation in Cartesian co-ordinates for multidimensional fluid flow with usual notations. | **07** |
| **Q.3** | **(a)** | Derive Rankine-Hugoniot equation for a normal shock wave. | **07** |
| | **(b)** | Air flows through a convergent divergent nozzle. At some section in the nozzle, pressure = 2 bar, velocity = 170 m/s, temperature = 200 °C and cross sectional area = 1000 $mm^2$ assuming isentropic flow conditions determine: (a) stagnation temperature and stagnation pressure, (b) sonic velocity and Mach number at this section and (c) Velocity and Mach number at outlet section where pressure is 1.1 bar. Take, R = 287 J/kg K, $C_p$ = 1000 J/kg K and ɔ = 1.4. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Draw Fanno line on h-s diagram and discuss the effect of friction in subsonic and supersonic flows. | **07** |
| | **(b)** | A normal shock wave occurs in air flowing at a Mach number of 1.5. The static pressure and temperature of the air upstream of a shock wave are 1 bar and 300K. Determine the Mach number, pressure and temperature downstream of the shock wave. Also estimate the shock strength. | **07** |
| **Q.4** | **(a)** | 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 ɟ, and bulk modulus of air K. Express the functional relationship between these variables and the resisting force using Buckinghamôs ´-theorem. | **07** |
| | **(b)** | Explain the objective, importance and applications of prototype model studies. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | The pressure drop æP in a pipe of diameter D and length *l*, depends on the density ɟ, and viscosity µ of the fluid flowing, mean velocity V of flow and the average height of protuberance t. Show that the pressure drop can be expressed in the form: $$\Delta P = \rho V^2 f\left(\frac{l}{D}, \frac{\mu}{VD\rho}, \frac{t}{D}\right)$$ | **07** |
| | **(b)** | What is similitude and model testing? Explain geometric, kinematic and dynamic similarity. | **07** |
| **Q.5** | **(a)** | What is lift and Drag coefficient of an aerofoil? Write expression for lift and drag. Show by graph how lifts and drag coefficient vary with angle of attack. | **07** |

**(b)** Derive the downstream Mach number relation for flow through a normal shock: **07**

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

**OR**

**Q.5** **(a)** Explain clearly velocity potential ű and stream function ɣ and hence prove Cauchy-Riemannôs equation in Cartesian coordinates system. **07**

**(b)** Define following model laws and give their fields of applications. **07**

1. Mach Number
2. Weber Number
3. Reynolds Number
4. Euler Number

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