Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2013

Subject code: 712103N Date: 13-06-2013

Subject Name: Fluid Mechanics and 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. **Using of gas tables is permitted**

Q.1 **(a)** Derive the continuity equation in Cartesian co-ordinates for multi dimensional fluid flow with usual notation. **07**

(b) Explain what do you understand by doublet? Derive equation for flow over Rankin oval. **07**

Q.2 **(a)** Derive Eulerôs equation and Bernoulliôs equation for one dimensional incompressible flow. **07**

(b) A uniform flow with a velocity 3 m/s is flowing over a plan source of strength 30 m^2/s. The uniform flow and source flow are in the same plane. A point P is situated in the flow field. The distance of the point P from the source is 0.5 m and it is at an angle of 30^0 to the uniform flow. Determine stream function at point P, resultant velocity of flow at P and location of stagnation point from the source. **07**

OR

(b) What is an aerofoil? Define with a sketch the various terms used in aerofoil geometry. **07**

Q.3 **(a)** Define stagnation temperature and critical temperature of a gas. Also derive the equation. $T/T^*=(2/ɔ+1)$ **07**

(b) The pressure, temperature and mach number at the entry of a flow passage are 2.45 bar, 26.5^0C and 1.4 respectively. If the exit Mach number is 2.5 determine for adiabatic flow of a perfect gas (ɔ = 1.3, R = 0.469 kJ/kg. K): **07**

(i) Stagnation temperature,
(ii) Temperature and velocity of gas at exit, and
(iii) The flow rate per square meter of the inlet cross-section.

OR

Q.3 **(a)** Starting from energy equation for flow through normal shock obtain relations $M^*_x M^*_y = 1$ **07**

(b) Air flowing in a duct has a velocity of 300 m/s, pressure 1.0 bar and temperature 290 K. Taking ɔ = 1.4, 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 **(a)** 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**

(b) Give three example of Fanno flow in thermal system; give reason justifying Fanno flow in each of these cases. **07**

OR

Q.4 **(a)** Derive Rankine-Hugoniot equation for a normal shock wave. **07**

(b) Explain the difference between source flows and sink flow with figure. Derive equation of stream line and potential flow with uniform flow parallel to x-axis. Draw profile also. **07**

Q.5 **(a)** The lift force F_L on an aerofoil depends upon the mass density óρô of the medium, velocity of the flow óVô, a characteristic length ólô, viscosity óμô, and angle of attack óαô. Obtain an expression for the lift force. **07**

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

(i) Reynolds Number
(ii) Froude Number
(iii) Euler Number
(iv) Mach Number
(v) Weber Number

OR

Q.5 **(a)** What is similitude and model testing? Explain geometric, kinematic and dynamic similarity **07**

(b) The force óFô acting on a propeller of an aircraft depends upon the forward speed of the aircraft óUô, the density of air óρô, the viscosity of air óμô, diameter of the propeller ódô and the speed of rotation of the propeller in revolutions per minute óNô. Derive non dimensional functional relationship between variables using Buckingham theorem. **07**

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