Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_

G:\logo and QP Template\logo 3 Feb 2018 final.tif

**End Semester Examination – Nov/Dec – 2018**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **Code :** | **14AE2021** | **Duration :** | **3hrs** |
| **Sub. Name :** | **GAS DYNAMICS** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Sub Div.** | | **Questions** | | | **Course**  **Outcome** | | **Marks** |
| 1. | a. | | Define Mach Number and Semi-angle of Mach Cone. | | | CO1 | | 2 |
| b. | | Write the expressions for T0/T, P0/P and ρ0/ρ in terms of Mach number and specific heat ratio for an isentropic flow. | | | CO1 | | 2 |
| c. | | State First Law of Thermodynamics and explain the concept of Internal Energy of a system. Obtain a relation between heat received (Q), internal energy (E) and work done (W) by the system. Deduce First Law for a cycle. | | | CO1 | | 10 |
| d. | | Obtain the dimensionless velocity M\* for the supersonic flow with velocity 2400 m/sec and temperature 1400 K. Find the dimensionless velocity M\* when freestream Mach number goes to infinity. | | | CO1 | | 6 |
| (OR) | | | | | | | | |
| 2. |  | | | Derive (i) the governing physical relations of the Normal Shock, (ii) obtain the governing equations of the Normal Shock for perfect gas and (iii) deduce the working formulas of the Normal Shock for the perfect gas. | | CO2 | | 20 |
|  | | | | | | | | |
| 3. | a. | | On both sides of slipline, pressures are \_\_\_\_\_\_\_\_\_\_ and the flow directions are \_\_\_\_\_\_\_\_. | | | CO1 | | 1 |
| b. | | Detached shock occurs when δ is \_\_\_\_\_\_\_\_\_ and δ\* is always less than \_\_\_\_\_\_\_. | | | CO2 | | 1 |
| c. | | Illustrate attached and detached shocks by drawing flow over a sharp wedge. | | | CO2 | | 2 |
| d. | | State the Prandtl Relation and the Rankine-Hugoniot Equations for both oblique and normal shocks. | | | CO2 | | 2 |
| e. | | Derive an expression for mass flow rate in a convergent-divergent nozzle and deduce the equation for maximum mass flow rate. Further obtain the Area Ratio-Mach number relation. | | | CO1 | | 8 |
| f. | | Explain in detail, the effect of back pressure in the formation of weak and strong shock in two-dimensional supersonic flow in a duct having one concave corner and one convex corner and draw both shock polars. | | | CO2 | | 6 |
| (OR) | | | | | | | | |
| 4. | a. | | Derive the equations for Rayleigh flows . | | | CO3 | | 15 |
| b. | | State the frictional effect in subsonic and supersonic flows. | | | CO3 | | 15 |
|  | | | | | | | | |
| 5 | a. | | Prove that after passing through an oblique shock, the streamline turns towards the shock. | | | CO2 | | 5 |
| b. | | Air flow at Mach 4, pressure 1 atmosphere and temperature 270 C, is turned abruptly by a wall into the flow with a turning angle of 200 (Figure 1). If the shock is reflected by another wall, determine the flow properties downstream of reflected shock.    Fig. 1 | | | CO3 | | 15 |
|  |  | |  | | |  | |  |
| (OR) | | | | | | | | |
| 6. |  | Describe the Fanno line and Rayleigh line in detail. Prove that (i) the Mach number at the maximum entropy point on Fanno line is unity and that (ii) the normal discontinuity always involves a change from supersonic to subsonic speed and never the reverse. | | | | CO3 | | 20 |
|  | | | | | | | | |
| 7. | a. | | Explain the regular refection of shock from a solid boundary. Draw the corresponding shock polars. | | | CO3 | | 6 |
| b. | | Draw figures to illustrate (i) the isentropic compression, (ii) the centered expansion and (iii) the simpile expansion. State in which region, the flow is non-isentropic. | | | CO3 | | 6 |
| c. | | Draw the shock cell structure of an over-expanded jet. | | | CO3 | | 8 |
| (OR) | | | | | | | | |
| 8. |  | | a. Describe the high-speed subsonic flow over aerofoil.  b. Using Prandtl-Glauert Theory results, write the expression for pressure coefficient and lift coefficient and deduce the expression for lift-curve slope.  c. Compare lift coefficient vs angle of attack curve of high subsonic speed with that of incompressible flow and  d. Write a note on the design of highspeed subsonic aerofoil sections. | | CO3 | | 20 | | |
|  | | |  | | |  | |  |
|  | | | **Compulsory**: | | |  | |  |
| 9. |  | | A flat plate aerofoil has a chord of 2 m and is flying at M = 2 and at 70 angle of attack. The ambient pressure at that altitude is 0.8 \* 105 Pa and temperature 250 K.  a. Determine the pressure above and below the aerofoil.  b. Calculate the lift and drag force per unit span.  c. Determine the pressure and flow direction as the air leaves the trailing edge. | | CO3 | | 20 | | |