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CBCS SCHEME

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18AE/AS52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Aerodynamics – II

Time: 3 hrs. Max. Marks: 100

Note: ***1. Answer any FIVE full questions, choosing ONE full question from each module.***
2. Use of Gas tables is permitted.

Module-1

1 a. Derive an expression for area ratio as a function of Mach number with usual notation. **(10 Marks)**

b. Derive the following relation for a Quasi – 1D isentropic flow through variable area duct.

i) $\frac{dA}{A} = -\frac{dv}{v}(1-M^2)$

ii) A/A^*

iii) $\frac{m\sqrt{T_0}}{AP_0}$

in terms of Mach number. **(10 Marks)**

OR

2 a. Air [$C_P = 1.05$ kJ/kg-k, C = 1.38] at $P_1 = 3 \times 10^5 N/m^2$ and $T_1 = 500k$ flows with a velocity of 200m/s in a 30cm diameter duct. Calculate :

i) Mass flow rate
ii) Stagnation temperature
iii) Mach number
iv) Stagnation pressure values

Assuming the flow as compressible and incompressible. **(10 Marks)**

b. Calculate the dynamic pressure of the flow if V_∞ = 175m/s, P_∞ = 1 atm and T_∞ = 298 k. What will be the percentage error? If the flow is treated as incompressible. **(10 Marks)**

Module-2

3 Derive the following relations for flow through a normal shock wave

a. $M_y^2 = \frac{\frac{2}{y-1} + M_x^2}{\frac{2y}{y-1} M_x^2 - 1}$

b. $\frac{P_y}{P_x} = \frac{2y}{y+1} M_x^2 - \frac{y-1}{y+1}$ **(20 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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OR

4 a. A normal shock wave with pressure ratio of 4.5 impinges as a plane wall. Determine the static pressure ratio for the reflected normal shock wave. The air temperature in front of the incident wave is 280K. **(10 Marks)**

b. A gas ($\gamma = 1.4$, R = 0.287 kJ/kg-k) at a mach number of 1.8, P = 0.8 bar and T = 373k passes through a normal shock. Determine its density after the shock, compare this value in an isentropic compression through the same pressure ratio. **(10 Marks)**

Module-3

5 Derive the following using oblique shock waves,

a. Rankine – Hugnoit equation

b. Prandtl – Meyer expansion waves. **(20 Marks)**

OR

6 a. A uniform flow at $M_1 = 2.0$ passes over an expansion corner with wall inclination of 10°. Find the Mach number of the flow downstream of the expansion far. **(10 Marks)**

b. Air flow at Mach 4.0 and pressure 10^5 N/m^2 is turned abruptly by a wall into the flow with a turning angle of 20° as shown in the Fig.Q6(b). If the shock is reflected by another wall, determine the flow properties 'M' and 'P' downstream of the reflected shock.

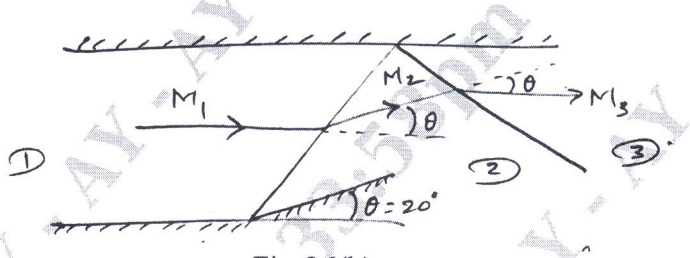

Fig.Q6(b) **(10 Marks)**

Module-4

7 a. Obtain the basic differential equations of motion for steady compressible flows. **(10 Marks)**

b. Describe the various methods of solution of nonlinear potential equation. **(10 Marks)**

OR

8 a. Derive the Linearized pressure coefficient for small perturbations. **(10 Marks)**

b. Deduce $\tan(\theta_0 \pm \alpha) = \tan\left(\frac{1}{2}\frac{t}{C}\left(1 \pm \frac{2\alpha}{t/C}\right)\right)$ using Geothert's rule. **(10 Marks)**

Module-5

9 Discuss the power losses in terms of percentage energy loss in the various parts of the wind tunnel. **(20 Marks)**

OR

10 With neat sketch explain the following with advantages and disadvantages :

a. Blow down – type wind tunnels

b. Continuous supersonic wind tunnels. **(20 Marks)**

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