Code: 9A21503

R09

B.Tech III Year I Semester (R09) Supplementary Examinations June 2017

AERODYNAMICS - II

(Aeronautical Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

*****

1 (a) Derive x-component momentum equation for steady, inviscid, compressible flow without body forces in differential form stating assumptions involved.

(b) Calculate the mass of gas contained in a room of 6 m x 9 m x 4 m. The pressure is 70 cm of Hg, temperature 25^{o}C, and molecular weight of gas is 30 Kg/kmol. Assuming the gas to be diatomic, calculate time taken for a sound disturbance to travel longest distance inside the room. (Show all unit conversions in detail; Mention assumptions wherever considered)

(c) Define following terms:
(i) Mach number. (ii) Characteristic mach number. Derive suitable expression for characteristic mach number from energy equation (stating all assumptions).

(d) Define mathematically, compressible flow concept. Exemplify your understanding about ideal gas concepts: (i) Isothermal compressibility. (ii) Adiabatic compressibility. (iii) Isentropic compressibility.

2 (a) Explain functional working of De-Laval nozzle. Using mathematical correlations, explain supersonic flow attained in a divergent duct.

(b) Derive relationships between mach number, pressure, temperature and density across a normal shock wave.

(c) In a reservoir, air is stored at a pressure of 10 bar. If the gas has to be expanded in a nozzle such that the exits pressure is 1 atm calculate, ratio of exit area to throat area, if throat is choked (sonic condition).

(d) Deduce mathematical relation between stagnation pressure and static pressure for incompressible and compressible flows. Mention all the assumptions in deriving such relations.

3 (a) Derive Pandit-Meyer function in supersonic expansion flow across a corner.

(b) Air flows at free-steam conditions of M_1 = 3.0 and p_1 = 200 kPa. Represent with sketches and compute: (i) Final downstream mach number. (ii) Pressure for gradual expansion turn of 20^{o} and gradual compression turn of 20^{o}.

4 (a) Derive suitable expression for pressure coefficient in subsonic flow for deflection angle θ from linearized perturbation velocity potential equation.

(b) Explain the physical significance of drag divergence mach number.

(c) Derive the area-mach number relation viz., (A/A*) as a function of mach number. (stating all assumptions)

Contd. in page 2

Code: 9A21503

R09

5 (a) A diamond airfoil of semi-wedge angle of 5^o and chord (c) is at a 3^o angle of attack in supersonic flow of mach number 4.0. Calculate: (i) Sectional lift coefficient. (ii) Drag coefficient. (iii) Moment coefficient about diamond center.
(b) Describe characteristic behavior of a swept wing placed in supersonic flow.
(c) Describe the singularity distribution method to predict flow over three-dimensional body in a supersonic flow.

6 (a) Using the mathematical foundation of hypersonic mach number independence principle, derive hypersonic shock wave relations for: (i) Pressure ratio. (ii) Density ratio. (iii) Velocity component ratio's (for u, v).
(b) Explain design of high lift-to-drag hypersonic configurations (wave riders).
(c) List various hypersonic testing facilities available today and explain any one of the procedure.

7 (a) Sketch a typical shock tunnel and explain its principle of operation. What are the advantages and limitations of shock tunnel?
(b) Explain how measurements of pressure, velocity and mach number can be done in a supersonic wind tunnel.
(c) Briefly explain about the following with layouts and design features:
(i) Blow down. (ii) Indraft. (iii) Induction tunnel.

8 (a) Sketch a typical wind tunnel balance and explain its principle of operation. Exemplify the sensitivity issues associated with model balancing.
(b) Explain the role played by following in wind tunnel balance with schematics: (i) Brake and lower pivot socket. (ii) Pitching moment device. (iii) Microscope. (iv) Vertical force arm.

*****