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5E3177

Roll No. 030 Total No of Pages: 4

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B. Tech. V Sem. (Main/Back) Exam., Nov.-Dec.-2016

Mechanical Engineering

5ME3 Fundamentals of Aerodynamics

Time: 3 Hours **Maximum Marks: 80**

Min. Passing Marks Main: 26

Min. Passing Marks Back: 24

Instructions to Candidates:

*Attempt any **five questions,** selecting **one question** from **each unit.** All questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.*

Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination.

1. Gas Table 2. NIL

UNIT – I

Q.1 (a) Explain the concept of lift and drag. How the lift and the drag varies with their dependent variables. [4+4=8]

(b) Consider the lifting flow over a circular cylinder with a diameter of 0.5m. The freestream velocity is 25 mk and the maximum velocity on the surface of the cylinder is 75 mk. The freestream conditions are those for a standard altitude of 3km. Calculate the lift per unit span on the cylinder. (ρ at 3 km is 0.90926 kg/m^3). [8]

OR

Q.1 (a) Explain the Kelvin's circulation theorem. Calculate the lift over an airfoil. [4+4=8]

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(b) An airplane is cruising at a velocity of 219.94 m/s at an altitude of 10058.4m, where the ambient air density is 0.4105 kg/m^3. The weight and wing plan form areas of the airplane are 66723.33 N and 31.83m^2, respectively. The drag coefficient at cruise is 0.015. Calculate the lift coefficient and the lift – to – drag at cruise. [8]

UNIT – II

Q.2 (a) Explain the blade theory relative to it's design and applications. What is turbine cascade nomenclature? [4+2=6]

(b) Calculate the energy transfer in terms of lift and drag. [10]

OR

Q.2 (a) Define the cascade lift and drag coefficients. What are the losses in the cascade? [4+2=6]

(b) A compressor cascade is working with air of 1.25 kg/m3 density and100 m/s velocity at the entry. The air is making angles of 50° and 25° at entry and exit, respectively. The pitch to cord ratio of the compressor cascade is 1.5. If the stagnation pressure loss is 15mm, determine the pressure loss coefficient, lift coefficient and drag coefficient. [10]

UNIT – III

Q.3 (a) With the help of the relation for velocity change in terms of area change in a divergent duct, explain how the flow velocity charges in the duct when - [6]

(i) The entry Mach number is subsonic, and

(ii) The entry Mach number is supersonic.

(b) Air enters in a variable area duct at pressure of 350 kN/m2, a temperature of 27°C and a velocity of 150m/s. The area of cross – section at entry is 500 cm^2 and the exit area is 350 cm^2. If the flow is isentropic, determine: [10]

(i) The mass flow rate through the duct.

(ii) The pressure, temperature and velocity at exit from the duct, and

(iii) The change in impales function.

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OR

Q.3 (a) Explain the phenomenon of choking in isentropic flow. [6]

(b) Air is discharged from a reservoir at 1MB and 500k through a nozzle to an exit pressure of 0.09 MPa. If the flow rate through the nozzle is 3600 kg/h, determine following for isentropic flow: [10]

(i) Throat area, pressure and velocity

(ii) Exit area and Mach number.

UNIT – IV

Q.4 (a) What is Fanno flow? What are the assumptions made in deriving equations for Fanno flow? Write the basic equations governing Fanno flow in a constant area duct. [6]

(b) A 3.5m long well – insulated duct of diameter 50mm and average friction coefficient 0.005 is connected to a frictionless bell mouth entrance. Air at 110 kpa and 300 K is drawn through the entrance and flows into the duct. Find the maximum mass flow rate, the flow parameters at exit and the range of back pressures that will produce the flow. [10]

OR

Q.4 (a) Differentiate between Fanno flow and Rayleigh flow. [4]

(b) Drive expressions for: [12]

(i) Pressure Ratio,

(ii) Stagnation Pressure Ratio,

(iii) Temperature Ratio,

(iv) Stagnation Temperature Ratio,

(v) Density Ratio and

(vi) Velocity Ratio

Assume finite control volume in Rayleigh flow.

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UNIT – V

Q.5 (a) Explain the phenomena of normal shock with the help of Fanno line and Rayleigh line on the same h- s plot. [6]

(b) An aircraft engine employs a subsonic inlet diffuser of area ratio 4. Free stream air at a total pressure and temperature of 1×10^5 N/m2 and 570K approaches the diffuser with a Mach number 2.2 A shock wave stands just outside the diffuser inlet. Determine the Mach number, pressure and temperature of the air at the exit of the diffuser. Also, find the loss in stagnation pressure of air. [10]

OR

Q.5 (a) Show that the entropy increase across a normal shock is a function of the ratio of specific heat capacities and the Mach number on the upstream side of the shock. [6]

(b) The exit to entry area of a divergent duct is 14:1. The Mach number at inlet and exit are 1.7 and 0.5 respectively. A normal shock occurs in the duct.

Assuming isentropic flow of air before and after the shock, determine - [10]

(i) Location of the normal shock in the duct.

(ii) Percentage loss in stagnation pressure, and

(iii) Change in entropy.

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