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BANGALORE

CBCS SCHEME

USN | | | | | | | | | | 15AE552

Fifth Semester B.E. Degree Examination, Jan./Feb.2021
Gas Dynamics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Derive momentum equation in differential form by control volume approach. **(10 Marks)**
b. Write down steady flow energy equation and explain all the terms involved. **(06 Marks)**

OR

2 a. Derive Bernoulli's equation from Eulers equation. Also write Bernoulli's equation for compressible flow. **(08 Marks)**
b. Derive thrust equation for uninstalled jet engine with sketch. **(08 Marks)**

Module-2

3 a. Derive an expression for variation of Mach number with duct length for a flow in constant area duct with friction. **(08 Marks)**
b. A circular duct passes 8.25 kg/s of air at an exit mach number of 0.5. The entry pressure and temperature are 3.45 bar and 38°C respectively and the co-efficient of friction is 0.15, determine
(i) Diameter of the duct (ii) Length of the duct
(iii) Pressure and temperature at exit (iv) Stagnation pressure loss. **(08 Marks)**

OR

4 a. Explain the following with respect to Rayleigh flow:
(i) Constant entropy lines.
(ii) Constant enthalpy lines. **(06 Marks)**
b. The mach number at the exit of a combustion chamber is 0.9. The ratio of stagnation temperatures at exit and entry is 3.74. If the pressure and temperature of the gas at exit are 2.5 bar and 1000°C respectively. Determine (i) Mach number, pressure and temperature of the gas at entry (ii) The heat supplied per kg of the gas and (iii) The maximum heat that can be supplied. Take $\gamma = 1.3$ and $C_P = 1.218$ KJ/kgK. **(10 Marks)**

Module-3

5 a. Show that the gas velocities before and after the normal shock by using Prandtl-meyer relationship is expressed by $C_x.C_y = a^{*2}$ or $M_x^*.M_y^* = 1$. **(08 Marks)**
b. The state of a gas ($\gamma = 1.3$, R = 0.469 KJ/kgK) upstream of a normal shock wave is given by the following data $M_x = 2.5$, $P_X = 2$ bar, $T_x = 275$ K. Calculate the mach number, pressure, temperature and velocity of the gas down stream of the shock, check the calculated values with those given in the gas tables. **(08 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

6 a. Derive the Rankine-Hugoniot relation for a normal shock wave is,

$$\frac{\rho_Y}{\rho_X} = \frac{1+\frac{\gamma+1}{\gamma-1}\frac{P_Y}{P_X}}{\frac{\gamma+1}{\gamma-1}+\frac{P_Y}{P_X}}.$$ **(08 Marks)**

b. Starting from the general energy equation for flow through an oblique shock obtain the Prandtl's equation $a^{*2} - \frac{\gamma-1}{\gamma+1}C_t^2 = C_{n_1}C_{n_2}$. **(08 Marks)**

Module-4

7 a. Explain the performance of De-Laval nozzle under various back pressures. **(08 Marks)**

b. Air ($\gamma = 1.4$, R = 287.43 J/kg.K) enters a straight axis symmetric duct at 300 K, 3.45 bar and 150 M/s and leaves it at 277 K, 2.058 bar and 260 m/s. The area of cross section at entry is 500 cm^2. Assuming adiabatic flow, determine

(i) Stagnation temperature
(ii) Maximum velocity
(iii) Mass flow rate
(iv) Area of cross section at exit. **(08 Marks)**

OR

8 a. Explain choked flow in a nozzle. With sketch explain over expanded and under expanded nozzle conditions. **(08 Marks)**

b. A nozzle in a wind tunnel gives a test section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310 K. The cross sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow.

(i) Pressure, temperature and velocities at the throat and test section.
(ii) Area of cross section of the test section.
(iii) Mass flow rate.
(iv) Power required to drive the compressor. **(08 Marks)**

Module-5

9 a. The pressure drop in an aeroplane model of size 0.1 of its prototype is 80 N/cm^2. The model is tested in water. Find the corresponding pressure drop in prototype. Take $\rho_{air} = 1.24\,kg/m^3$. Viscosity of water is 0.001 poise and viscosity of air is 0.00018 poise. **(06 Marks)**

b. Solve by Buckingham's π-theorem and give the importance of non dimensional numbers Thrust of a propeller 'P' depends on the angular velocity w, Speed V, diameter of blade D, dynamic viscosity H, density ρ and velocity of sound 'a'. Find the solution and conclude what are the non dimensional number required for design purpose. **(10 Marks)**

OR

10 a. Explain about flame stabilization technique used in combustors and types of flame stabilization methods. **(10 Marks)**

b. Define flame propagation and theories for flame propagation. **(06 Marks)**

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