CBCS SCHEME

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15AE552

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
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 is permitted.

Module-1

1 a. Derive one-dimensional continuity equation in the differential form. **(02 Marks)**

b. Derive Euler's equation using fundamental principles. Also obtain Bernoulli's equation from there. **(07 Marks)**

c. Derive steady flow energy equation in the differential form. **(07 Marks)**

OR

2 a. Is Bernoulli's equation applicable for compressible flow? Substantiate the answer. **(02 Marks)**

b. Derive an expression for the thrust function for a one-dimensional steady flow. **(06 Marks)**

c. The exit section of an enclosed aircraft propeller has an area of 9 m^2. The velocity of air at the entry and exit are 133 m/s and 170 m/s, respectively. Determine the thrust developed at STP. **(08 Marks)**

Module-2

3 a. Derive an expression for the acoustic velocity in terms of temperature of air. **(08 Marks)**

b. Air, with $C_p = 1.05$ kJ/kgK, $\gamma = 1.38$ at $\phi_1 = 3$ bar and $T_1 = 500$ K flows with a velocity of 200 m/s in a 30 cm diameter duct. Calculate mass flow rate, Mach number, stagnation temperature and stagnation pressure. **(08 Marks)**

OR

4 a. Air enters a constant area duct at $M_1 = 0.2$, $P_1 = 1$ atm and $T_1 = 273$ K. Inside the duct, 1 MJ/kg heat is added to the air. Calculate the flow properties M_2, P_2, T_2, T_{02} and P_{02} at the exit of the duct. **(08 Marks)**

b. Air at $P_0 = 10$ bar, $T_0 = 400$ K is supplied to a 50 mm diameter pipe. The mean friction factor for the pipe surface is 0.002. If the Mach number changes from 3 at the entry to 1 at the exit, determine the length of pipe and the mass flow rate. **(08 Marks)**

Module-3

5 a. Using fundamental concepts, derive the Hugoniot equation for normal shock. **(08 Marks)**

b. The Mach number, pressure and temperature ahead of a normal shock are 2, 0.5 atm and 300 K respectively. Determine Mach number, pressure, temperature and density behind the wave. Also calculate velocity. **(08 Marks)**

OR

6 a. A uniform supersonic stream with $M_1 = 3$, $P_1 = 1$ atm and $T_1 = 288$ K encounters a compression corner which deflects the stream by an angle of 20°. Calculate the oblique shock angle, P_2, T_2, M_2, P_{02} and T_{02} behind the oblique shock. **(10 Marks)**

b. Derive Rayliegh-Pitot equation applicable for measurement of Mach number for supersonic flow. **(06 Marks)**

Module-4

7 a. Derive an expression for the area-pressure velocity relation for quasi one-dimensional isentropic flow. Discuss the criteria for acceleration and deceleration for subsonic as well as supersonic entry. **(08 Marks)**

b. Air is discharged from a reservoir at $P_0 = 6.91$ bar and $T_0 = 325°C$ through a nozzle to an exit pressure of 0.98 bar. If the mass flow rate is 3600 kg/h, determine for isentropic flow:
i) Throat area, pressure and velocity
ii) Exit area and Mach number **(08 Marks)**

OR

8 a. For isentropic flow through a converging-diverging nozzle, derive the Area-Mach number relation. Also derive an expression for the maximum mass flow rate for choking the flow. **(08 Marks)**

b. A nozzle in a wind tunnel gives a test section Mach number of 2. 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:
i) Pressures, temperatures and velocities at throat and test sections.
ii) Area of cross section of the test section
iii) Mass flow rate. **(08 Marks)**

Module-5

9 a. With the help of necessary equations, explain in details:
i) Dimensional analysis
ii) Similitude and similarities **(08 Marks)**

b. Through a derivation, prove that the Mach number must be the same for the model and prototype if the flows are to be similar. **(08 Marks)**

OR

10 Write short notes on:
a. Flame propagation
b. Premixed flame
c. Diffusion flame
d. Flame velocity
e. Theories of flame propagation **(16 Marks)**

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