Menoufiya University
Faculty of Engineering
Shebin El-Kom
First Semester (Final exam)
Academic Year: 2013-2014

Year: *Third Year*
Department: *Mechanical Power*
Subject: *Gas Dynamics (MPE311)*
Time Allowed: *3 Hours*
Date: *15.01.2014*

Allowed Tables and Charts: (*Gas Dynamics Tables and Charts*)

-Please do not use a pencil to write.
-Assume any missing data from your point of view in the limits of what you studied.

Answer all the following Questions (100 *Marks*)

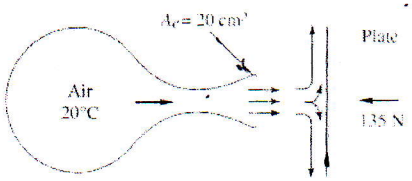
Question (1) *(20 Marks)*

(a) For isentropic flow, start from the first principles to prove that the mass flux ($m^{\bullet}/A$) is given by the following expression:

$$m^{\bullet}/A = \frac{P_o}{\sqrt{T_o}}\left(\frac{\gamma}{R}\right)^{0.5} M\left(1+\frac{\gamma-1}{2}M^2\right)^{\frac{(\gamma+1)}{2(1-\gamma)}}$$ *(8 Marks)*

Prove also that the value of Mach number at which chocking condition occurs is M=1.0. *(2 Marks)*

(b) Air flows steadily from a reservoir at 20°C through a nozzle of exit area 20 cm² and strikes a vertical plate as in the Figure. The flow is subsonic throughout. A force of 135 N is required to hold the plate stationary. *(10 Marks)*



Compute (a) V_e, (b) M_e and (c) The reservoir pressure (P_o) if P_{atm}=101 kPa.

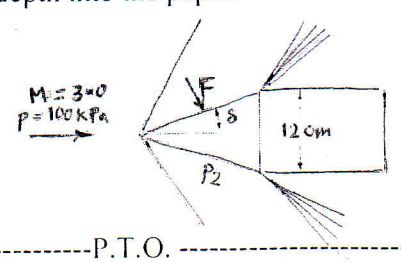
Question (2) *(20 Marks)*

(a) Derive the shock-strength relation as given below:

$$\frac{P_2}{P_1} = \frac{2\gamma M_1^2-(\gamma-1)}{(1+\gamma)}$$ *(10 Marks)*

(b) Air, supplied by a reservoir at 450 kPa, flows through a converging-diverging nozzle whose throat area is 12 cm². A normal shock stands where A_1 = 20 cm². (a) Compute the pressure just downstream of this shock. Still farther downstream, where A_3 = 30 cm², estimate (b) P_3; (c) A_3^* and (d) M_3. *(6 Marks)*

(c) Air flows past a two-dimensional wedge-nosed body as in the Figure. Determine the wedge half-angle δ for which the horizontal component of the total pressure force on the nose is 35 kN/m of depth into the paper. *(4 Marks)*



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Question (3) ***(20 Marks)***

(a) Draw (clearly) h-s diagrams for Fanno-flow and Rayleigh-flow ducts indicating the variation curves of all variables ***(10 Marks)***

(b) Air enters a 3-cm-diameter duct at P_o =200 kPa, T_o = 500 K, and V_1=100 m/s. The average friction factor is 0.02. Compute (*a*) the maximum duct length for these conditions and (*b*) the mass flow if the duct length is 15 m. ***(10 Marks)***

Question (4) ***(20 Marks)***

(a) A supersonic nozzle is fed by a large chamber and produces Mach 3.0 at the exit Sketch curves (to no particular scale) that show how properties (Pressure, Area. And velocity) vary through the nozzle as the Mach number increases from zero to 3.0. ***(8 Marks)***

(b) A supersonic aircraft is flying at an altitude of 3000m. An observer on the ground hears the noise generated by aircraft, which was at a distance of 3000 m away horizontally, after 13 Sec. Determine the Mach number, Velocity of aircraft, and air temperature at that altitude. ***(12 Marks)***

Question (5) ***(20 Marks)***

(a) Sketch the schematic of continuous flow supersonic wind tunnel and explain its loop. ***(6 Marks)***

(b) Comment on the following statement "Stagnation temperature is constant across a stationary normal shock wave but is not constant across a moving normal shock wave". ***(7 Marks)***

(c) Explain sonic boom phenomena. ***(7 Marks)***

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Best Wishes

Assoc. Professor Wageeh El-Askary & *Professor Mostafa Nasr*

Question	1	2	3	4	5	Work &oral exam. through a semester
ILOs	A13, A14,	B3, B5, B13	B3, B13	B3, B5	A13, A14, B3, B5, B13	C12, C13, C15, C16 D4, and D7