



Kafr elsheikh University
Faculty of Engineering
Mechanical Power Eng. Department
3rd Year Power Mechanics
Subject: Gas Dynamics
Examiner: Dr. M.I. Amro and commit

Date: 23 / 5 / 2018
Time Allowed: 3 Hours
Full Marks: 75
Final Exam
No. of Pages: 2 page
Academic Code: MEP

Answer the following questions and assume any missing data, use schematic diagrams in your answer

يسمح باستخدام جداول الديناميكا الغازية

Question (1) (15 marks)

1-a) At a certain point in an air flow passage, the air velocity and temperature are 450 m/s and 248 K respectively. Calculate Mach number, stagnation sonic speed, critical sonic speed, and maximum velocity of the flow. (5 marks)

1-b) An airplane is flying horizontally at an altitude of 7.6 km and at a cruising speed of 2340 km/h, find the distance that the plane has traveled from the head position of an observer at the ground when he hear the sound of the plane. Calculate also the time elapsed since the plane pass over the observer to the instant of hearing the plane sound. Give a suitable comment. (10 marks)

Question (2) (20 marks)

2-a) Prove that, for isentropic flow of a perfect gas, the temperature ratio is given by:

$$\frac{T_2}{T_1} = \frac{C_2^2}{C_1^2} = \frac{1 + \frac{\gamma - 1}{2} M_1^2}{1 + \frac{\gamma - 1}{2} M_2^2} \quad (5 \text{ marks})$$

2-b) Define the impulse function and calculate the net thrust force as a function of Mach number. (5 marks)

2-c) Air flows from large reservoir where, the pressure and temperature are 300 kPa and 37C respectively, through a nozzle. At some section in the nozzle the pressure is 200 kPa. Find the temperature, velocity and Mach number at this section. If Mach number at other section is 1.65 find the pressure, temperature and air velocity at this section assuming the flow is isentropic. (10 marks)

Question (3) (15 marks)

3-a) Classify and explain with drawing the different types of shock waves (5 marks)

3-b) An air stream with Mach number 2., pressure and temperature are 250 kPa, 320 K respectively enters a divergent channel. If the exit to inlet area ratio of the channel is 3.0, determine the back pressure which causes a normal shock at a section whose area is double the inlet area. Assume the flow is isentropic except across the shock waves. (10 marks)

Question (4) (10 marks)

4-a) Define and draw the Fanno line and the Rayleigh line? (5 marks)

4-b) A certain Pitot tube is used for the measurements of the Mach number of a supersonic air stream. The Pitot and static gauge pressure are 190 and 10 kPa respectively. Find the flow Mach number and velocity, if the flow temperature is 275K. (5 marks)

Question (5) (15 marks)

5-a) Draw and explain the operation characteristics of convergent-divergent nozzle in different flow regimes. (5 marks)

5-b) A convergent-divergent nozzle is designed to expand air from a chamber in which the pressure and temperature are 12 atm and 37C respectively, to give a Mach number of 2.16. The mass flow rate through the nozzle under design conditions is 0.015 kg/s. Find:

1- The throat and exit areas of the nozzle

2- The design back pressure, exit velocity and temperature of the air leaving the nozzle at design conditions.

3- The lowest back pressure for which there will be no supersonic flow on the nozzle, and exit flow velocity, Mach number and temperature at this pressure.

4- The back pressure below which there are no shock wave in the nozzle, and exit flow velocity, Mach number and temperature at this pressure. Define nozzle operation ranges.

(10 marks)

Best wishes