* S F - 7 8 4 3 / 9 0 0 *

SF-7843

B. E. IV (Sem. VIII) (Mech.) Examination

May / June – 2011

Elements of Gas Turbine

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. 4 (Sem. 8) (Mech.)**

Name of the Subject :

☛ **Elements of Gas Turbine**

☛Subject Code No. : **7 8 4 3** ☛Section No. (1, 2,.....) : **Nil**

Seat No. :

Student's Signature

(2) Attempt all questions.
(3) Figures to the right indicate full marks.
(4) Assume suitable data if necessary.
(5) Use of Gas Table and calculator is permitted.

1 (a) Answer the following : **10**
(i) Define : Mach cone
(ii) Define : Stagnation pressure
(iii) What are the assumptions are use for deriving governing equations of Normal shock flow.
(iv) What do you mean by compressible flow ?
(v) What are the areas of application of hypersonic flow ?

(b) Explain fanno flow with h-s diagram. Also discuss limiting condition and chocking due to friction. **10**

2 (a) Use fanno flow concept in a 30 mm diameter pipe 13 meter long with frictional factor is 0.0042. The conditions of air at entry are 2 bar and 300 k. Determine : (i) the mass flow rate, (ii) pressure, (iii) Temperature and (iv) the mach number at exit, if the mach number at inlet is 0.25. **7**

(b) Explain development of normal shock wave theory and expansion wave along the duct. **8**

OR

2 (a) Explain Rayleigh flow theory and state basic governing equations. 7

(b) A supersonic aircraft is flying horizontally at an altitude at 3000 m with a constant flight speed of 2000 km/hr. The aircraft is passes direct over a ground observer post. Find time taken to hear the sound wave from the aircraft at the observation post after its has passed directly over it. Assume average temperature of atmosphere air below 3000 m altitude is 27°C. 8

3 Answer the following questions : (any **two**) 15

(i) An aircraft is flying at an altitude of 12500 m with a mach number of 0.82. The cross-sectional area of the inlet diffuser is 0.51 m^2. Determine (i) the mass of air entering the diffuser per second (ii) the speed of aircraft (iii) The stagnation pressure and temperature of air craft at the diffuser entry. From the table of standard atmosphere, at an altitude of 12500 m, T=216 K,P = 0.193 bar, p = 0.311 and a = 295 m/s.

(ii) The pressure temperature and mach number at the entry of a flow passage are 2.51 bar, 26.4°C and 1.4 respectively. If the exit mach number is 2.6 determine for adiabatic flow of a perfect gas (V=1.3, R=0.469 kj/kg-K) (i) stagnation temperature, (ii) temperature and velocity of gas at exit and (iii) The flow rate per square meter of the inlet cross-section.

(iii) The mach number at the exit of a combustion chamber is 0.9. The ratio of stagnation temperatures at exit 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.

(iv) Explain isentropic flow with variable area of convergent divergent nozzle.

4 (a) With line diagram, explain the working of gas turbine cycle with intercooling and reheating on P-V and T-S diagram. 4

(b) Discuss the advantages of Gas Turbine over Reciprocating engine and vice versa. 4

(c) A gas turbine operates on a pressure ratio 6. The inlet air temperature to the compressor is 300 K and the air entering the turbine is at a temperature of 577 °C. If the volume flow rate of air entering the compressor is 240 m^3. Calculate the net power output of the cycle in MW. Also compute its efficiency. Assume that the cycle operates in ideal condition. 8

5 (a) Briefly explain the phenomena of surge and chocking in centrifugal compressor. 8

(b) A centrifugal compressor compresses 30 kg of air per second at the rotational speed of 15000 rpm. The air enters the compressor axially. At the exit section, the radius is 0.3 m and the relative velocity of air at the tip is 100 m/s at an angle of 80°. Find the torque and power required to drive the compressor and also the ideal head developed. 8

OR

(b) With the help of velocity diagram at inlet and outlet of the rotating mechanism, show that the equation of energy transfer is given by 8

$$E = \frac{1}{2}\left[\left(c_1^2 - c_2^2\right) + \left(u_1^2 - u_2^2\right) + \left(w_2^2 - w_1^2\right)\right]$$

The notations are as usual. Explain the meaning of each term.

6 (a) Axial flow compressor of 50% reaction design has blades with inlet and outlet angles of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.85 when inlet static temperature is 37°C. The blade speed and axial velocity are constant throughout the compressor. Assuming the value of 200 m/s for blade speed, find the number of stages required if the work done factor is 0.87. 8

(b) Attempt any **two** : **10**

(i) Explain the process of combustion in a gas turbine combustion chamber.

(ii) What are the various forms of combustion chamber ?

(iii) Explain the losses in combustion chamber.

(iv) Show that when the degree of reaction is 50%, the blades are symmetrical.
