



RM-7843

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

May / June - 2010

Elements of Gas Turbines

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

नीचे दशांशवैध निशानीवाणी विगतो उत्तरवही पर अवश्य लपवी.
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 Turbines

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) Draw neat sketches wherever necessary.
- (5) Use of gas table is permitted.
- (6) Assume suitable data if necessary.

1 Attempt the following :

20

- (a) Define following terms : Streamline, compressible flow, steady flow, Mach number, coefficient of skin friction.
- (b) Argon is stored in a reservoir at 300 K, determine stagnation enthalpy, and velocity of sound in it. $r = 1.658$ and molecular weight of argon is 39.94.
- (c) Give three equations of Fanno flow in thermal system give reason justifying Fanno flow in each of these cases.
- (d) Air at 320 KPa, 300 K and $M = 0.6$ flows through a duct. Determine velocity and stagnation temperature, pressure and density of air.

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[Contd...

2 Attempt any **two** :

16

(a) Prove that
$$\frac{P_y}{P_x} = \frac{M_x}{M_y} \left[\frac{1 + \left(\frac{\gamma-1}{2}\right) M_x^2}{1 + \left(\frac{\gamma-1}{2}\right) M_y^2} \right]$$

- (b) Explain why normal shock wave causes supersonic flow to jump to subsonic flow. Substantiate your answer with governing equations relevant reasons and using (T-S) diagram.
- (c) Air in a reservoir is kept at 500 KPa and 308 K it is supplied to a nozzle and normal shock appears at a section where Mach number is 2.5. Find the condition of air just after the shock. In case this air after shock is divergent portion flows in isotropically still it is brought to rest find the condition at exit.

3 Attempt any **two** :

14

- (a) Sketch the Rayleigh line on (T.S) plane and explain the significance of it.
- (b) A pipe of 0.1 m diameter is attached to the exit of a convergent divergent nozzle having the same exit diameter as that of the pipe. Its stagnation conditions at entry to C-O nozzle is 12 bar, 500 K. The mach number at exist of nozle and at the exit of pipe are 2.0 and 1.2 respectively.
- (c) Explain the following terms :
- (i) Fanning's coefficient of friction
 - (ii) Hydraulic diameter
 - (iii) Fanno flow
 - (iv) Isothermal flow

4 Attempt the following :

20

- (a) Compare open cycle and closed cycle gas turbine cycle.
- (b) With line diagram explain working of gas turbine cycle with inter cooling on p-v and T-S diagram.
- (c) Write brief note on gas turbine irreversibilities and losses.

- (d) In an air standard brayton cycle the minimum and maximum temperatures are 300 k and 1200 k respectively. The pressure ratio is that which maximizes the network developed by the cycle per unit mass of air flow. Calculate the network developed by the cycle per unit mass of air flow. Calculate the compressor and turbine work each in kJ/kg air and thermal efficiency of the cycle.

$$r_p = \left(\frac{T_{\max}}{T_{\min}} \right)^{\frac{\gamma}{2(\gamma-1)}}$$

$$r_p = 11.3$$

$$\frac{p_2}{p_1} = r_p = 11.3$$

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1} \right)^{\frac{\gamma-1}{\gamma}}$$

$$T_2 = 600.21 \text{ k}$$

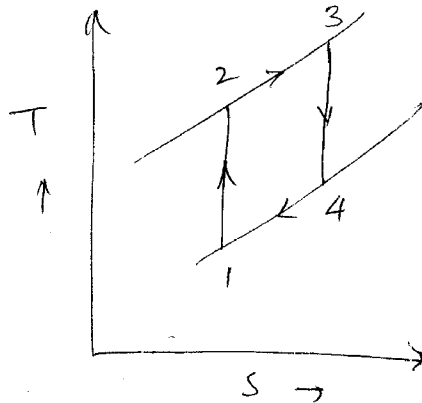
$$\frac{T_3}{T_4} = \left(\frac{p_3}{p_4} \right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{p_2}{p_1} \right)^{\frac{\gamma-1}{\gamma}} = 599. \text{k}$$

$$\text{Heat supplied } Q = c_p (T_3 - T_2) = 602 \frac{\text{kJ}}{\text{kg}}$$

$$\text{Compressor work } W_c = c_p (T_2 - T_1) = 301 \text{ kJ/kg}$$

$$\text{Turbine work } W_T = c_p (T_3 - T_4) = 603 \text{ kJ/kg}$$

$$\text{Thermal efficiency} = \frac{\text{Network}}{\text{Heat supp}} = 0.5002$$



- 5** Attempt any **two** : **16**
- (a) With neat sketch discuss characteristic curves of axial flow compressors.
 - (b) List advantages and disadvantages of centrifugal compressor.
 - (c) Draw neat sketches of following :
 - (i) Velocity diagram for centrifugal compressor
 - (ii) Pressure and velocity variation in compressor
 - (iii) Axial flow compressor
- 6** Attempt any **two** : **14**
- (a) Discuss design requirements of combustion chamber of gas turbine plant
 - (b) State with neat sketch explain arrangements of combustion chamber.
 - (c) Explain following terms :
Surging, choking, prewhirl, stalling, slip factor.
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