Roll No. | | | | | | | | | | | | **Total No. of Pages : 03**

Total No. of Questions : 09

B.Tech (AE) (Sem.–3rd)

APPLIED THERMODYNAMICS

Subject Code : BTAE-302 (2011 Batch)

Paper ID : [A1115]

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTION TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students has to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students has to attempt any TWO questions.**

SECTION-A

l. Write briefly :

(a) Represent isentropic and isothermal efficiency using T - s diagram and represent in terms of areas.

(b) Explain the term Positive displacement in the context of reciprocating compressors.

(c) Write the names of positive displacement rotary type compressors and discuss its disadvantages with respect to centrifugal compressors.

(d) Under what circumstances multistaging is preferred in reciprocating compressors with the help of a T - s diagram?

(e) Explain flow coefficient and pressure coefficient in the context of centrifugal compressors.

(f) Explain work done factor in the context of an axial flow compressor.

(g) Why is thermal efficiency of the gas turbine less, even though the turbine develops greater power?

(h) Axial compressor is more preferred than centrifugal compressor in aviation. Give reasons.

(i) Compare solid propellent and liquid propellent rocket engines.

(j) Draw a neat diagram of a Turboprop engine and label it.

SECTION-B

2. Draw the performance curves for centrifugal compressor. Explain the phenomenon of surging and chocking in centrifugal compressor.

3. An axial flow air 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 a value of 200 m/s for blade speed, find the number of stages required if the work done factor is

   i) unity

   ii) 0.87 for all angles.

4. Derive an expression for the optimum pressure ratio giving maximum cycle thermal efficiency of gas turbine cycle, if the compressor efficiency is η_c and the turbine efficiency is η_t. The maximum cycle temperature is T_3 and the minimum cycle temperature is T_1

5. A reciprocating air compressor has four stage compression with 2 m^3/min of air being delivered at 150 bar when initial pressure and temperature are 1 bar, 27°C. Compression occur polytropically following polytropic index of 1.25 in four stages with perfect intercooling between stages. For the optimum intercooling conditions determine the intermediate pressures and the work required for driving compressor.

6. Considering a jet propulsion unit to have isentropic compression and expansion and heat supply at constant pressure. Show that thrust developed per kg of air per second for negligible velocity of approach can be given by :

$$\left[2C_p \,.\, T_a \,(t-1)\left(r_p^{\frac{(\gamma-1)}{\gamma}} - 1 \right) \right]$$

   Here t is the ratio of absolute temperature after combustion and before combustion, r_p is compression ratio and T_a is absolute atmospheric temperature.

SECTION-C

7. Determine the impeller diameters and the width at the impeller exit and the power required to drive the compressor, from the following given data :

Speed	12500 rpm
Mass flow rate	15kg/s
Pressure ratio	4:1
Isentropic efficiency	75%
Slip factor	0.9
Flow coefficient impeller exit	0.3
Hub diameter of the eye	15 cm
The velocity of the air at the entry to and the exit from the impeller	150 m/s
Stagnation temperature at inlet	295 K
Stagnation pressure at inlet	1.0 bar

Assume equal pressure ratio in the impeller and diffuser.

8. A closed cycle gas turbine plant comprises an air compressor, a heat exchanger, a heater, a two stage turbine with reheater and a cooler. The maximum and minimum pressures and temperatures in the cycle are 30 bar, 570° C and 7.5 bar, 15° C respectively. The pressure in the reheater is 15 bar.

   Sketch the layout of the plant and indicate pressures and temperatures between the components if :

   i) the heat exchanger is used

   ii) the heat exchanger is bypassed.

   Calculate the ideal cycle efficiencies and work ratios in both the cases. The gas in the circuit is helium, which has a molecular mass of 4 and specific heat C_v = 1.5 R.

9. Write short notes on the following :

   i) Prewhirl

   ii) Losses in axial flow compressors

   iii) Screw compressors

   iv) Propulsive power and propulsive efficiency.