

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

PDDC - SEMESTER-VIII • EXAMINATION – SUMMER 2013

Subject Code: X81901

Date: 09-05-2013

Subject Name: Thermal Engineering

Time: 10:30 am – 13:00 pm

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Using the neat sketch, explain construction and working of open gas turbine cycle with reheating. **07**
- (b) Classify the various types of steam turbine. Differentiate impulse and reaction turbine. **07**

- Q.2** (a) Explain the working of back pressure and pass out turbine with neat sketch. **07**
- (b) Explain the term nozzle efficiency with h-s diagram. State the three application of nozzle and three application of diffuser. **07**

OR

- (b) Explain working of the Ram Jet with neat sketch. **07**
- Q.3** (a) Discuss about the open cycle gas turbine. Also derive the equation for thermal efficiency for the same. **07**
- (b) A gas turbine plant consists of one turbine for compressor drive and another for output and both are having their own combustion chambers which are served by air directly from the compressor. Air enters the compressor at 1 bar and 15° C and is compressed with an isentropic efficiency of compressor is 0.76. Gas inlet temperature and pressure in both turbines are 680° C and 5 bar. The isentropic efficiency of turbine is 0.86. The mass flow rate of air at the inlet is 23 kg/s. The calorific value of fuel is 42000 kJ/kg. Calculate the output of the plant and thermal efficiency. Assume $C_p = 1.005$ kJ/kg-K, $\gamma = 1.4$ for air and $C_p = 1.128$ kJ/kg-K $\gamma = 1.34$ for gases. **07**

OR

- Q.3** (a) A steam jet enters the row of blades with a velocity of 375 m/s at an angle of 20° with the direction of motion of the moving blades. If the blade speed is 165 m/s, find the suitable inlet and outlet blade angles assuming that there is no thrust on the blades. The velocity of steam passing over the blades is reduced by 15%. Also determine power developed by the turbine per kg of steam flowing over the blades per seconds. **07**
- (b) Explain the velocity diagram for impulse turbine in detail with sketch. **07**
- Q.4** (a) Why compounding of compounding of Impulse turbine is required? Explain the construction and working of Velocity compounding of **07**

- Impulse steam turbine with neat sketch.
- (b) Write a short note on supersaturated flow in nozzle. **07**

OR

- Q.4 (a)** Explain any one method of steam turbine governing with neat sketch. **07**
- (b)** Derive the equation of maximum discharge from the steam nozzle. **07**

- Q.5 (a)** Classify the gas turbine. Using T-s diagram, explain construction and working of open gas turbine cycle with Intercooling. **07**
- (b)** Steam at 10 bar and 205°C is expanded isentropically in a nozzle to 0.1 bar. Using steam tables only, find the dryness fraction of the steam at exit. Also find the velocity of steam leaving the nozzle when 1. Initial velocity is negligible, and 2. Initial velocity of the steam is 135 m/s. **07**

$$\begin{aligned} \text{At 10 bar : } T_s &= 179.9^{\circ}\text{C} \quad h_f = 762.8 \text{ kJ/kg} \quad h_{fg} = 2015.3 \text{ kJ/kg} \\ s_f &= 2.139 \text{ kJ/kg-K} \quad s_{fg} = 4.448 \text{ kJ/kg-K} \end{aligned}$$

$$\begin{aligned} \text{At 0.1 bar : } T_s &= 45.81^{\circ}\text{C} \quad h_f = 191.83 \text{ kJ/kg} \quad h_{fg} = 2392.8 \text{ kJ/kg} \\ s_f &= 0.6493 \text{ kJ/kg-K} \quad s_{fg} = 7.5009 \text{ kJ/kg-K} \end{aligned}$$

OR

- Q.5 (a)** State the six requirement of combustion chamber of gas turbine. Also state the six factors affecting the performance of combustion chamber. **07**
- (b)** Steam enters a group of nozzles of a steam turbine at 12 bar and leaves at 1 bar. The steam turbine develops 200 kW with a specific steam consumption of 10 kg/kWh. If the diameter of nozzle at throat is 6 mm, calculate the number of nozzles. **07**

$$\begin{aligned} \text{At 12 bar : } T_s &= 188^{\circ}\text{C} \quad h_f = 798.6 \text{ kJ/kg} \quad h_{fg} = 1986.2 \text{ kJ/kg} \\ s_f &= 2.217 \text{ kJ/kg-K} \quad s_{fg} = 4.306 \text{ kJ/kg-K} \end{aligned}$$

$$\begin{aligned} \text{At 1 bar : } T_s &= 99.6^{\circ}\text{C} \quad h_f = 417.5 \text{ kJ/kg} \quad h_{fg} = 2258 \text{ kJ/kg} \\ s_f &= 1.303 \text{ kJ/kg-K} \quad s_{fg} = 6.057 \text{ kJ/kg-K} \end{aligned}$$
