# **GUJARAT TECHNOLOGICAL UNIVERSITY BE - SEMESTER-VIII EXAMINATION - SUMMER 2016**

Subject Code:181904

Subject Name: Thermal Engineering

Time:10:30 AM to 01:00 PM

## Instructions:

- 1. Attempt all questions.
- Make suitable assumptions wherever necessary. 2.
- 3. Figures to the right indicate full marks.
- 4. Use of steam table and Mollier diagram is permitted.
- Q.1 Obtain equation of critical pressure ratio of nozzle and explain its 07 (a) significance. Calculate its value for dry and saturated steam.
  - A group of six nozzles receives steam at 30 bar and  $300^{\circ}$ C. The steam 07 **(b)** flow rate is 5 kg/s and it expands up to 3 bar. For metastable expansion, find (i) diameter of nozzle at exit neglecting friction and (ii) degree of subcooling.
- Differentiate clearly between Impulse and Reaction turbine. Q.2 (a) 07 For an Impulse turbine, obtain expression for work done and axial thrust.
  - The steam is supplied to a de- Laval turbine at a velocity of 950 m/s at **(b)** 07 an angle of  $20^{\circ}$ . Mean blade velocity is 350 m/s and the blades are equiangular. The mass flow rate of steam is 0.5 kg/s. If blade velocity coefficient is 0.8, determine blade efficiency, power developed and stage efficiency, if nozzle efficiency is 95%.

### OR

- At a stage of 50% reaction turbine, the pressure is 1.4 bar and steam is 07 **(b)** 0.9 dry. The inlet and outlet angles are  $35^{\circ}$  and  $20^{\circ}$  respectively. The blade velocity is 67 m/s. Determine the blade height, if the ratio of drum diameter to blade height is 8.0 and mass flow rate is 4.8 kg/s. Also find the power developed.
- Q.3 (i) Explain velocity compounding of Impulse turbine with the help of 04 (a) sketch and explain its advantage. 03
  - (ii) Explain working of Pass- out turbine.
  - In a Reheat Rankine cycle, the steam at 150 bar and 500<sup>o</sup>C expands **(b)** 07 through the high pressure turbine. It is then reheated at constant pressure of 40 bar to 500°C and expands through the low pressure turbine to a condenser pressure of 0.1 bar. Find quality of steam at outlet and thermal efficiency. Neglect pump work.

#### OR

- (i) What is function of governing system of steam turbine? Compare Q.3 (a) 04 throttle governing with nozzle governing. (ii) Explain working of Back- pressure turbine. 03
  - Explain Regenerative feed heating with the help of sketch of steam 07 **(b)** power plant. How does the feed water heating increases efficiency of Rankine cycle?

### **Total Marks: 70**

Date:18/05/2016

- Q.4 (a) Derive an expression for optimum pressure ratio for maximum work 07 output in ideal Brayton cycle.
  - (b) Air enters in compressor of gas turbine plant at 1 bar, 300 K with a 07 volumetric flow rate of 5 m<sup>3</sup>/s. The pressure ratio is 10 and turbine inlet temperature is 1400 K. If isentropic efficiency of compressor is 0.8 and that of turbine is 0.85, find thermal efficiency of plant and power developed in kW.

#### OR

- Q.4 (a) Derive an expression for thermal efficiency of gas turbine plant and 07 show that it is independent of mass flow rate of air through the plant.
  - (b) A gas turbine plant draws air at 1 bar and 300K. Air is compressed to 4 07 bar and then heated to temperature of 900 K. The isentropic efficiency of compressor is 81% and that of turbine is 86%. Neglecting mass of fuel, determine overall efficiency of the plant (i) without regenerator and (ii) with regenerator of 75% effectiveness. Take Cp= 1.005 kJ/ kg K and  $\gamma = 1.4$  for air and gases.
- Q.5 (a) Draw schematic diagram of Turboprop engine and explain its working. 07 List its advantages and disadvantages also.
  - (b) Enlist different losses of steam turbine and explain them briefly. 07

#### OR

- Q.5 (a) Explain with neat sketches, different methods used to improve 07 efficiency and specific work output of open cycle gas turbine plant.
  - (b) Explain working of Pulsejet engine with the help of its schematic 07 diagram. State its advantages and disadvantages.

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