

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-VII (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2171910

Date: 11/05/2017

Subject Name: Power Plant Engineering

Time: 02.30 PM to 05.00 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Use of steam tables, Mollier chart and calculator is permissible.

- Q.1** (a) Draw a neat layout of thermal power plant and make a list of site selection criteria for the same. **07**
- (b) Draw a line diagram of a Benson boiler. State the main difficulties experienced in the La Mont boiler and how it is prevented? **07**
- Q.2** (a) Discuss requirements of oil burners. With neat sketch explain long flame, turbulent burners and tangential Burners. **07**
- (b) Enumerate different types of Ash handling system. Explain Pneumatic ash handling system with advantages and disadvantages. **07**
- OR**
- (b) State the classification of Draught. Derive an expression for maximum discharge through a chimney. **07**
- Q.3** (a) State and explain losses in steam turbine. **07**
- (b) The Data pertaining to an impulse turbine is as : Blade speed = 300 m/s, Isenthalpic enthalpy drop in nozzle = 450 kJ/kg, Nozzle efficiency = 90 %, Nozzle angle = 20°, Blade velocity coefficient = 0.85, Blade exit angle = 25°. Calculate for a mass of 1 kg/sec;
- (1) Inlet angle of moving blades (2) The axial thrust
(3) The driving force on the wheel (4) The diagram power
(5) The energy lost in blades due to friction (6) Blade efficiency
- OR**
- Q.3** (a) Define Fill, Drift and cooling efficiency of cooling tower. Explain the methods for obtaining maximum vacuum in condenser. **07**
- (b) A reaction turbine runs at 3000 RPM and steam consumption is 18000 kg/hr. The pressure of Steam at a certain pair is 2 bar, its dryness fraction is 0.94 and the power developed by the pair is 52 kW. The discharge blade angle is 20 ° for both fix and moving blades and the axial flow velocity is 0.72 times the blade velocity. Find out the drum diameter and blade height. Take the tip leakage steam as 8 %. Neglect the Blade thickness. **07**
- Q.4** (a) The air at p_1 and T_1 enters into a gas turbine cycle and compressed to p_2 ($R = p_2/p_1$) and then heated to temperature T_3 . The air is expanded into two stages having same pressure ratio in each turbine. The air after expansion in first stage is reheated to T_3 before passing to second stage of the turbine. Considering all processes ideal and intermediate pressure,  **07**

Prove that,

$$\frac{C_p T_3}{C_p T_1} = \frac{2\gamma}{\gamma+1} \left(1 + \frac{\gamma}{2} \right) \cdot \left(\frac{K}{K+1} \right)$$

Where, $T = T_3 / T_1$, $K = R^m$ and $m = \gamma - 1 / \gamma$

Also derive for the maximum specific work output, $R = \left(\frac{\gamma+1}{\gamma-1} \right)^{\frac{\gamma}{\gamma+1}}$

- (b) A gas turbine plant is operated between 1 bar and 9 bar pressures and minimum and maximum cycle temperatures are 25 °C and 1250 °C. A compression is carried out in two stages with perfect intercooling. The gases coming out from H.P. turbine are heated to 1250 °C before entering into L.P. turbine. The expansions in both turbines are arranged in such a way that each stage develops same power. Assuming compressors and turbines isentropic efficiencies as 83 %. (a) Determine the cycle efficiency assuming ideal regenerator. (b) Find the power developed by the cycle in kW if the air flow through the power plant is 16.5 kg/sec. Neglect the mass of fuel. All the components are mounted on a single shaft. 07
- OR**
- Q.4** (a) Describe working of hot sodium zeolite process with neat sketch and chemical reactions. List advantages and disadvantages over ion exchange system. 07
- (b) In a closed cycle gas turbine the following data apply, 07
Working substance is air, $C_p = 1$ kJ/kg K and $\gamma = 1.4$; Ambient temperature = 27 °C; Top temperature = 823 °C; Pressure at compressor inlet = 1 bar; Pressure ratio = 4; Compressor efficiency = 80 %; Turbine efficiency = 85 %; Heating value of fuel = 41800 kJ/kg; Heater loss = 10 % of heating value; Neglect mass of fuel. Find the following :
(1) Specific Compressor work (2) Heat supplied per kg of air
(3) Specific Turbine work (4) Specific Net work output
(5) Work ratio (6) Thermal efficiency of cycle
- Q.5** (a) Derive the condition and then equation of maximum discharge through the nozzle, also write maximum discharge for different condition of steam. 07
- (b) Steam is expanded in nozzle from 15 bar and 350 °C to 1 bar. Find the throat and exit area if flow rate is 1 kg/sec. What should be coefficient of velocity if exit velocity is 1150 m/sec? 04
- (c) Explain the principle of jet and rocket propulsion with neat sketch. 03
- OR**
- Q.5** (a) Explain with neat sketch construction and working of CANDU type reactor. 07
- (b) The maximum load on thermal power plant of 70 MW capacity is 55 MW at an annual load factor of 60 %. The Coal consumption is 0.96 kg per unit of energy generated and the cost of coal is Rs. 2 per kg. Find the annual revenue earned if the electric energy is sold at Rs. 2.5 per kWh. 04
- (c) Explain Demand Factor, Diversity Factor and Plant Capacity Factor. 03
