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B.TECH
(SEM IV) THEORY EXAMINATION 2017-18
APPLIED THERMODYNAMICS

Time: 3 Hours**Total Marks: 100**

- Note:** 1. Attempt all Sections. If require any missing data; then choose suitably.
 2. Use of steam table and Mollier's chart is allowed.

SECTION A

1. **Attempt all questions in brief.** **2 x 10 = 20**
- a. Discuss the effect of increase in boiler pressure on Rankine cycle.
 - b. Differentiate between accessories and mountings.
 - c. Enlist the advantages of gas turbine over steam turbine.
 - d. Explain the function of fixed blades in reaction turbine.
 - e. What is cogeneration?
 - f. Draw the pressure and velocity changes in a turbojet engine.
 - g. Discuss the significance of equivalent evaporation.
 - h. Write difference between natural and artificial draught.
 - i. What are Gibbs and Helmholtz function? Write their significance.
 - j. Draw p-v and T-s plot of Brayton's cycle.

SECTION B

2. **Attempt any three of the following:** **10 x 3 = 30**
- a. Derive the condition of maximum discharge of flue gases through the chimney of boiler.
 - b. What is degree of reaction of a reaction turbine? Derive the condition for maximum blade efficiency in case of 50% reaction turbine.
 - c. What is a convergent-divergent nozzle? Derive the condition and expression for maximum discharge through a nozzle.
 - d. Derive Maxwell relations and discuss their significance.
 - e. Explain the construction and working of an economizer with a neat well labelled schematic diagram. Also discuss the advantages of using an economizer.

SECTION C

3. **Attempt any one part of the following:** **10 x 1 = 10**
- (a) Air at a temperature of 15 °C enters a gas turbine plant working at pressure ratio of 5. Turbine inlet temperature is 800 °C. Isentropic efficiency of compression and expansion is 0.85 and the calorific value of fuel is 42MJ/kg. Find thermal efficiency. Air-fuel ratio and specific fuel consumption of the gas turbine plant.
 - (b) Derive Clausius Clayperon equation. Using the Clapeyron equation, estimate the enthalpy of vaporization at 110°C and compare it with the tabulated value.
4. **Attempt any one part of the following:** **10 x 1 = 10**
- (a) A sample of fuel has the following percentage composition by weight: C =

84%, $H_2 = 10\%$, $O_2 = 3.5\%$, $N_2 = 1.5\%$ and ash = 1%. Determine the stoichiometric air fuel ratio by mass. If 20% excess air is used, find the percentage composition of dry flue gases by volume.

- (b) Steam at 20 bar and 360°C expands in a steam turbine to 0.08 bar. It is then condensed in a condenser to saturated water. The pump feedback the water to the boiler. Assume ideal Rankine cycle and determine the net work done/kg of steam and Rankine efficiency.

5. Attempt any one part of the following: 10 x 1 = 10

- (a) In a reheat cycle steam leaves the boiler and enters the turbine at 4Mpa, 400°C . After expansion in the turbine to 400kPa, the steam is reheated to 400°C and then expanded in the low pressure turbine to 10kPa. Show the cycle on T-s and p-v Diagram and determine the cycle efficiency.
- (b) Discuss the working of a pulse jet engine in detail. Also enlist the disadvantages of a pulsejet engine.

6. Attempt any one part of the following: 10 x 1 = 10

- (a) A convergent divergent nozzle is required to discharge 2kg/sec of steam. The nozzle is supplied with steam at 7 bar and 200°C and the discharge takes place against a back pressure of 1 bar. The expansion up to the throat is isentropic and the frictional resistance between throat and exit is equivalent to 63kJ/kg of steam. Taking approach velocity of 75m/sec and the throat pressure of 4 bar, estimate the suitable areas at the throat and exit.
- (b) Dry and saturated steam at a pressure of 12 bar is supplied to a double acting steam engine cylinder. The cut-off occurs at 40% of the stroke, the exhaust pressure is 1.2 bar. The clearance is 10% of the stroke. Find the mean effective pressure. If the brake power of the engine is 21kW running at 120rpm, mechanical efficiency is 80%, mean piston speed is 70m/min. Find the cylinder dimensions.

7. Attempt any one part of the following: 10 x 1 = 10

- (a) The following data belong to a single stage of Parson's steam turbine consisting of one ring of fixed blade and one ring of moving blades: Average diameter of blade ring = 70cm, Speed of turbine = 3000rpm, Steam velocity at exit from blades = 160m/sec, Blade outlet angle = 20° , Steam flow rate through blades = 7kg/sec. Draw the velocity diagram and find: (i) blade angle at inlet (ii) tangential force on the moving blades (iii) power developed in a stage.
- (b) Discuss the working of a double acting steam engine with neat sketch. Also explain saturation curve and missing quantity.