

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 3989

Roll No.

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**B. Tech.**

(SEM. IV) THEORY EXAMINATION 2010-11

**APPLIED THERMODYNAMICS**

*Time : 3 Hours*

*Total Marks : 100*

**Note :** (i) Attempt **all** questions. All questions carry equal marks.

(ii) Use of steam table and Mollier chart is permitted.

(iii) Assume suitably, any missing data.

1. Attempt any **two** of the following : **(10×2)**
- (a) Define mathematical condition for exact differential and derive Maxwell's equation.
- (b) What do you understand by standard heat of reaction and heat of formation ? Carbon reacts with oxygen to form carbon dioxide in a steady flow chamber. Reactants and products are at 25°C and 1 atm. Find the energy involved and type of reaction. Assume enthalpy of formation of CO<sub>2</sub> gas as (-) 393520 kJ/kmol.
- (c) Answer the following :
- (i) What is Joule-Thompson coefficient ? Why is it zero for an ideal gas ?

- (ii) Methane is burned with dry air. Find the theoretical air fuel ratio for complete combustion and dew point temperature of products of combustion.

2. Attempt any two of the following :

(10×2)

(a) Answer the following :

(i) A boiler generates steam at 10 bar and 200°C from feed water at 37°C. Calorific value of fuel is 8050 kcal/kg. Steam capacity is 10kg/kg of coal. Find equivalent evaporation.

(ii) State the function of economizer and air preheater. Also indicate suitable location of superheater, economizer and air preheater in the path of flue gases in a boiler with line diagram.

(b) What do you understand by boiler draught ? Also name the various systems for producing draught in the boiler. Determine the quantity of air required per kg of coal burnt in a boiler fitted with 30 meters high chimney. Draught produced is 18.5 mm of water column when the temperature of the flue gases in the chimney is 370°C and that of the ambient is 303 K.

(c) Answer the following :

(i) Discuss the effect of air leakage upon the performance of condenser.

(ii) Make comparison between fire tube and water tube boilers.

3. Attempt any two of the following : (10×2)

(a) If 8 kg/sec air at 9 bar & 200 °C expands through the nozzle in a space at 1.1 bar. Find the diameter at the throat and exit of nozzle. Neglect the approach velocity.

(b) Dry and saturated steam at a pressure of 12 bar is supplied to a double acting steam engine cylinder. The cutoff occurs at 40% of stroke and 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 21 kW running at 120 rpm, mechanical efficiency is 80%, mean piston speed is 70 m/min. Find the cylinder dimensions.

(c) Discuss :

(i) Supersaturated flow through nozzle

(ii) Missing quantity of steam in steam engines.

4. Attempt any two of the following : (10×2)

(a) Steam is supplied by steam generator at 90 bar and 500°C. After expansion in turbine to 10 bar a portion of steam is bled for regeneration in open heater and remaining steam is reheated to 500°C. Condensor pressure is 0.07 bar. Draw schematic diagram of the system and show the cycle on T-s chart. Find thermal efficiency and steam rate in kg/kW-hr. Neglect pump work.

(b) Steam flows from the nozzles of a single row impulse turbine with a velocity of 450 m/s at a direction which is inclined at an angle of 16° to the blade velocity. Steam comes out of the moving blades with a velocity of 100 m/s in the direction of 110° with the blade velocity. The blades are equiangular.

Steam flow rate is 6 kg/s. Determine the power developed by the wheel and power loss due to friction.

- (c) Answer the following :
- Discuss, the governing of steam turbine.
  - Show the variation of pressure and velocity along the axial direction through the different stages of reaction turbine.

5. Attempt any two of the following : (10×2)

- (a) Air at 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 calorific value of fuel used is 42 MJ/kg. Find thermal efficiency, Air fuel ratio and specific fuel consumption of the gas turbine plant.
- (b) Answer the following :
- Discuss the effect of intercooling and regeneration on the performance of Brayton Cycle.
  - Discuss combined cycle power plants.
- (c) Write short notes on :
- Propulsive power and propulsive efficiency
  - Turbojet and turboprop engines.