CS/B.TECH(EE-New)/SEM-4/ME(EE)-411/2012

2012

THERMAL POWER ENGINEERING

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Question)

1. Choose the correct alternatives for the following: 10 x 1 = 10

   i) A cycle consisting of two constant volume and two isothermal processes is known as

      a) Carnot cycle b) Joule cycle

      c) Otto cycle d) Stirling cycle.

   ii) In SI engine, high voltage for spark plug is developed using

      a) battery b) distributer

      c) ignition coil d) carburetor

   iii) Cetane number of the fuel commercially for diesel engines in India is in the range

      a) 40 to 45 b) 60 to 70

      c) 60 to 80 d) 80 to 90

   iv) The pressure at the upstream side of a stage of moving blades in a reaction turbine is

      a) higher than that at the downstream

      b) lower than that at the downstream

      c) equal to that at the downstream

      d) higher or lower, depending upon the turbine load

v) Regenerator in a gas turbine plant is used for

a) improving specific work output

b) improving thermal efficiency

c) improving work ratio

d) none of these.

vi) The main function of drum in steam generator with single drum is to

a) store water in the drum

b) remove salts from the water in the drum

c) separate steam from water in the drum

d) store steam in the drum.

vii) The commonly used method of governing in steam turbines is by

a) throttle governing

b) nozzle control governing

c) bypass governing

d) hydraulic governing

viii) When M=1 occurs at throat, the flow is called

a) choked flow b) steady flow

c) stagnation flow d) none of these.

ix) The ratio of work done per cycle to the swept volume in case of IC engine is called

a) compression index

b) compression ratio

c) mean effective pressure

d) volumetric efficiency

x) The relation between stage efficiency (η_s), blade efficiency (η_b) and nozzle efficiency (η_n) of a impulse turbine is

a) $\eta_s = \frac{\eta_b}{\eta_n}$ b) $\eta_s = \eta_b \times \eta_n$

c) $\eta_n = \eta_s \times \eta_b$ d) $\eta_b = \frac{\eta_s}{\eta_n}$

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 x 5 = 15

2. Prove that for a given temperature limit (Max. temperature T_3 and Min. temperature T_1), the expression of maximum net work output $(W_{net})_{max}$ for a closed gas turbine plant is

$(W_{net})_{max} = C_P(\sqrt{T_3} - \sqrt{T_1})^2$.

3. What are the differences between a closed cycle and an open cycle gas turbine plants?

4. What is DNB? Why and how is it avoided in a water tube boiler?

5. Steam is supplied to 10 MW turbo-alternator 40 bar and 400℃. Auxiliaries consumes 7% of the output. The condense pressure is 0.05 bar and condensate is sub cooled to 30℃. Assuming that the boiler efficiency is 85% and relative efficiency of turbine as 80% and the mechanical efficiency of the alternator 95%, determine

a) the steam consumption per hour

b) the overall efficiency of the plant

c) the quality of the steam at the exit from the turbine.

6. Define the efficiency of a steam generator. What are the major losses in a bipolar? 2+3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 x 15 = 45

7. A gas turbine power plant consists at a two stage compressor with intercooling and a single stage turbine with a regenerator. Air enters the compressor at 1 bar, 20℃. The maximum

temperature of the cycle is limited to 900℃ and the maximum pr. Ratio is 6. The effectiveness of the regenerator is 0.7. The rate of air flow through the plant is 210 kg/s and the calorific value of fuel used is 40.8 MJ/kg. The isentropic efficiency of both the compressors is 0.82, the isentropic efficiency of the turbine is 0.92, the combustion efficiency is 0.85. Take for air C_P=1.005kJ/kg-K and γ=1.33. Assuming perfect intercooling and neglecting pressure and heat losses, estimate

i) the air-fuel ratio

ii) the cycle efficiency

iii) the power supplied by the plant

iv) the sp. fuel consumption at the plant and the fuel consumption per hour.

8. a) With a separating and throttling calorimeter, the following observations were made:

Amount of water separates in the separating calorimeter = 2 kg.

Condensate collected from throttling calorimeter = 20.5 kg

Temperature of steam after throttling = 110℃

Initial pressure of steam after throttling = 11 bar (gauge)

Final pressure of steam after throttling = 28 mm Hg.

Barometer reading of the locality = 760 mm Hg.

Estimate the dryness of steam sampled. 5

b) A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410℃. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. Neglect pump work and any pressure drop and heat loss. 5

c) If the steam is reheated at 5.5 bar to a temperature of 400℃ and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle? 5

9. A furnace wall riser, 18 m long, 76.2 mm outer diameter having 6.1 mm thick wall receives saturated water at 80 bar and 1.5 m/s velocity. Assuming a circulation ratio of 12.5 and a slip of 1.2, determine

   a) the pressure head developed in the riser

   b) the void fraction at the riser exit

   c) the heat transfer rate per unit projected area of the riser tube.

10. a) What is super-charging? What are the effects of super charging in IC engine? 5

   b) An air standard dual cycle has a compression ratio of 16 and the compression begins at 1 bar, 50°C. The max pressure is 70 bar. The heat transferred to air at constant pressure is equal to heat supplied at constant volume. Estimate

      i) the pressure and temperature at the cardinal points of the cycle

      ii) the cycle efficiency

      iii) the m.e.p. of the cycle.

      Given $C_v = 0.718$ kJ/kg-K, $C_v = 0.718$ kJ/kg-K. 10

11. a) Derive the expression of efficiency of an Otto cycle along with the $p - v$ and $T - s$ diagram. 5

   b) Sketch and describe the working principle of a carburetor. 5

   c) Draw the valve timing diagram of a 4-stroke petrol engine and describe the major events. 5

   d) What are the common combustion-generated pollutants from a diesel engine? 2

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