[Total No. of Questions - 9] [Total No. of Printed Pages - 3]
(2125)

15121

B. Tech 4th Semester Examination

Heat Power Engineering (OS)

ME-4005

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Candidates are required to attempt five questions in all selecting one question from each of the section A, B, C and D of the question paper and all the subparts of the questions in section E. Use of non-programmable calculator, steam table and Molliers diagram is allowed.

SECTION - A

1. A gas fuel has the following percentage composition by volume: CO-10%; H_2-50%; CH_4-26%; O_2-3%; CO_2-2% and N_2-9%. Estimate the minimum volume of air required for complete combustion of $1m^3$ of the gas. If 50% excess air is supplied, give the volumes of each of the dry constituents of the flue gas. Air contains 21% by volume of oxygen. (15)

2. Draw a neat sketch of Lancashire Boiler and label its parts. Explain its construction and working. (15)

SECTION - B

3. In a reheat cycle, the initial steam pressure and the maximum temperature are 150 bar and 550°C respectively. If the condenser pressure is 0.1 bar and the moisture at condenser inlet is 5%, and assuming ideal processes, determine (a) the reheat pressure, (b) the cycle efficiency, (c) the steam rate. (15)

[P.T.O.]

4. Dry saturated steam at 10 bar is expended isentropically in a nozzle to 0.1 bar. Using steam tables only, find the dryness fraction of the steam at the exit. Also find the velocity of the steam leaving the nozzle when 1. Initial velocity is negligible, and 2. Initial velocity of the steam is 135 m/s. (15)

SECTION - C

5. The following particulars refers to a single raw impulse turbine: Mean diameter of the blade ring = 2.5m; speed 3000 rpm; Nozzle angle= 20°; ratio of blade velocity to steam velocity= 0.4; blade friction factor = 0.8; blade angle at exit=3° less than that at inlet; steam flow= 36000 kg/h. Draw velocity diagram for moving blade and estimate (a) Power developed; (b) Blade efficiency; and (c) Steam consumption in kg/kW h. (15)

6. Derive the condition of maximum efficiency of an impulse turbine and show that the maximum efficiency is $\cos^2\alpha$, where α is the angle at which the steam enters the blade. Define degree of reaction as applied to reaction turbines and show that it is 50% for a simple reaction turbine. (15)

SECTION - D

7. Discuss different methods of governing a steam turbine. Explain compounding of steam turbine and also write the methods of reducing rotor speed. (15)

8. The air entering a steam condenser with steam is estimated at 6 kg per hour. The temperature at inlet to air cooler section is 30°C and at the outlet 26°C. The vacuum in the shell is essentially constant throughout and is 721 mm of Hg, while the barometer reads 758 mm of Hg. Calculate :

   (i) The volume of air entering the cooling section per hour;

   (ii) The mass of moisture contained in the air; and

   (iii) The mass of steam condensed per hour in cooling section. (15)

SECTION - E

9. Attempt all part in this question. All questions carry 5 marks.

(a) Define enthalpy of combustion, enthalpy of formation, adiabatic flame temperature, Gibbs and Helmholtz functions and calorific value of fuel.

(b) What are the differentiating features between a water tube and fire tube boiler?

(c) Draw P-V and T-S diagrams of simple Carnot and Rankine cycle. Write down the limitations of Carnot cycle.

(d) Draw the discharge vs ratio of pressure at outlet to inlet curve for a convergent steam nozzle, write the physical significance of critical pressure ratio.

(e) Differentiate between impulse and reaction turbines with example and enumerate the different losses in steam turbine.

(f) When is reheating of steam recommended in a steam power plant? How does the reheat pressure get optimized?

(g) What role is played by a cooling tower? What are the different types of cooling towers? Mention their advantage and disadvantage.

(h) Draw schematic and T-S diagram of ideal regenerative steam plant. (8×5=40)