

## B.Tech 5th Semester Exam., 2017

## STEAM POWER SYSTEM

Time : 3 hours

Full Marks : 70

## Instructions :

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.
- (v) Use of steam tables and steam charts are allowed.

1. Choose the correct answer of any seven of the following : 2×7=14

(a) Superheating of steam is done at

- (i) constant volume
- (ii) constant temperature
- (iii) constant pressure
- (iv) constant entropy

(b) If partial pressure of air and steam be  $P_a$  and  $P_s$  respectively in a condenser, then according to Dalton's law, the pressure in condenser is equal to

- (i)  $P_s - P_a$
- (ii)  $P_a - P_s$
- (iii)  $P_s + P_a$
- (iv) 0

- (c) If a steam sample is nearly in dry condition, then its dryness fraction can be most accurately determined by
  - (i) throttling calorimeter
  - (ii) separating calorimeter
  - (iii) combined separating and throttling calorimeter
  - (iv) bucket calorimeter
- (d) A wet vapour can be completely specified by
  - (i) pressure only
  - (ii) temperature only
  - (iii) dryness fraction only
  - (iv) pressure and dryness fraction
- (e) Hygrometer deals with the
  - (i) density measurement
  - (ii) water vapour in air
  - (iii) temperature of air
  - (iv) pressure of air
- (f) Orsat meter is used for
  - (i) volumetric analysis of the flue gases akubihar.com
  - (ii) gravimetric analysis of the flue gases
  - (iii) mass flow of the flue gases
  - (iv) measuring smoke density of the flue gases

- (g) The basic purpose of drum in boiler is to
- (i) serve as storage of steam
  - (ii) serve as storage of feed water for water wall
  - (iii) remove salts from water
  - (iv) separate steam from water
- (h) The water tubes in a Babcock and Wilcox boiler are
- (i) horizontal
  - (ii) vertical
  - (iii) inclined
  - (iv) horizontal and inclined
- (i) In Rankine cycle, the work output from the turbine is given by the
- (i) change of internal energy between inlet and outlet
  - (ii) change of enthalpy between inlet and outlet
  - (iii) change of entropy between inlet and outlet
  - (iv) change of temperature between inlet and outlet

- (j) The condenser in which there is direct contact between the steam and cooling fluid is
- (i) jet condenser
  - (ii) surface condenser
  - (iii) evaporative condenser
  - (iv) None of the above

2. (a) Describe superheater, economiser and air preheater. 6

(b) Explain working of Babcock and Wilcox boiler with neat sketch. What are the outstanding features of this boiler? 8

3. (a) State the methods of increasing the thermal efficiency of a Rankine cycle. 5

(b) A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550 °C expands through the high-pressure turbine. It is reheated at a constant pressure of 40 bar to 550 °C and expands through the low-pressure turbine to a condenser at 0.1 bar. Draw T-s and h-s diagrams. Find (i) quality of steam at turbine exhaust, (ii) cycle efficiency, and (iii) steam rate in kg/k-Wh. 9

4. (a) Describe briefly different types of mechanical draught. 6
- (b) A boiler house has natural draught chimney of 17 m height. Flue gases are at temperature of 380 °C and ambient temperature is 27 °C. Determine the draught in mm of water column for maximum discharge through chimney and also the air supplied per kg of fuel. 8
5. (a) Discuss the effects of friction on the performance of nozzles. Also show these effects on  $T$ - $s$  and  $h$ - $s$  diagrams. 6
- (b) An impulse turbine of 1 MW has steam entering at 20 bar and 300 °C and steam consumption of 8 kg per kW-hr. Steam leaves at 0.2 bar and 10% of total heat drop is lost in overcoming friction in diverging portion of nozzle. If throat diameter of each nozzle is 1 cm, then determine (i) the number of nozzles required and (ii) exit diameter of each nozzle. 8
6. (a) How do reaction turbine blades differ from impulse turbine? 5

( Turn Over )

- (b) A De Laval turbine runs with steam supplied at 16 bar, 250 °C. The nozzle efficiency is 90%, blade velocity coefficient is 0.98, mechanical efficiency is 95%, nozzle angle is 15°, symmetrical blades with 30° angle, mean diameter of wheel is 80 cm, back pressure is 0.15 bar. Determine (i) the speed of rotation, (ii) the steam consumption per bhp-hr and (iii) the stage efficiency. 9
7. (a) What is meant by reheat factor? Also discuss its relevance with the help of  $T$ - $s$  and  $h$ - $s$  diagrams. 6
- (b) A Parson's reaction turbine has blade speed of 157.08 m/s, stage efficiency of 80%, blade speed to steam velocity ratio of 0.7 and blade outlet angle of 20°. Estimate the work output per kg of steam and isentropic enthalpy drop in the stage. 8
8. (a) How does condenser improve performance of steam power plant? Define (i) vacuum efficiency and (ii) condenser efficiency. 6

- (b) In a surface condenser operating with steam turbine the vacuum near inlet of air pump is 69 cm of Hg when barometer reading is 76 cm of Hg. Inlet temperature of vacuum pump is 30 °C. Air leakage occurs at the rate of 60 kg/hr. Determine (i) the capacity of air pump in m<sup>3</sup>/hr and mass of vapour extracted with air in kg/hr, and (ii) the dimension of reciprocating air pump cylinder if it runs at 240 r.p.m. and L/D ratio is 1.5. 8
9. (a) State the advantages of using pulverised coal in a boiler. 4
- (b) What are meant by 'over feed' and 'under feed' principles of firing coal? 5
- (c) What do you understand by cooling towers? Explain their utility. 5

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