Code : 021512

B.Tech. 5th Semester Exam., 2013

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 any **FIVE** questions.*

*(iv) Question No. **1** is compulsory.*

(v) Use of steam table allowed.

1. Answer any *seven* questions by writing True or False :   2×7=14

   (a) Once through boilers operate at supercritical pressure.

   (b) Steam trap drains off water collected by partial condensation of steam in pipes.

   (c) Supersonic nozzle is a converging passage.

   (d) The compounding of steam turbines is done to increase blade speed ratio.

   (e) Curtis turbine is a two-stage velocity compounded turbine.

14AK—1000/200   (Turn Over)

(**2**)

   (f) La Mont boiler is a high pressure water-tube boiler.

   (g) The effect of friction in a steam nozzle is to decrease the velocity.

   (h) Reheat factor is zero if efficiency of the turbine is close to unity.

   (i) The sequence superheater, economizer, air preheater is the correct order for flue gas flow in the steam power plant layout.

   (j) In a shell and tube surface condenser for a power plant, cooling water passes through the tubes and steam surrounds them.

2. (a) What is the mean temperature of heat addition? What is its effect on cycle efficiency?   5

   (b) How is the maximum pressure of a steam cycle fixed up?   4

   (c) Explain the function of the deaerator. Why is it installed at a large height from the basement?   5

3. (a) Differentiate between fire-tube and water-tube boilers.   6

14AK—1000/200   (Continued)

(3)

(b) From the data given below, estimate the power of a motor required to drive an induced draft (ID) fan :

Draft to be maintained—50 mm of water

Temperature of boiler house— 310 K

Temperature of flue gases—475 K

Coal consumption—1600 kg/hr

A/F—15

Efficiency of fan—75%

If the ID fan is replaced by an FD fan of the same efficiency, what would be the power consumption in this case? Comment on your result. 8

4. (a) Derive the condition for maximum discharge through the chimney. 5

(b) Explain the functions of economizer, superheater and air preheater. 9

5. (a) Explain the effect of supersaturation phenomenon in the steam nozzle with the help of T-S and H-S diagrams. 7

(b) Steam initially at 12·5 bar and 250 °C is expanded in a nozzle to 2 bar. The condensation does not take place while the steam is in the nozzle due to super-saturation phenomenon. Determine for the mass flow rate of 2 kg/s degree of under cooling, degree of supersatura-tion and throat area. 7

(4)

6. (a) Differentiate between surface condenser and jet condenser. 5

(b) A surface condenser deals with 5000 kg of steam per hour. The air leakage into the condenser is 0·5 kg per 1000 kg of steam. The vacuum in the air pump suction is 670 mm of mercury and temperature 34 °C. Barometer reading is 755 mm of mercury. Find the volumetric efficiency of a single-acting air pump required to remove the condensate and air having a cylinder diameter of 24 cm and a stroke of 40 cm. The speed of the pump is 60 r.p.m. 9

7. (a) Find the condition for maximum diagram efficiency of a simple impulse turbine. 7

(b) Differentiate between the impulse turbine and reaction turbine with the help of diagrams. 7

8. Steam at a pressure of 11 bar and 260 °C expands in a five-stage turbine to a pressure of 0·07 bar. The steam pressure in five stages are 5, 2, 0·8, 0·2 and 0·07 bar. Tabulate the entropy and total heat data, and also find the reheat factor. The stage efficiency is 60%. 14

(5)

9. Write short notes on any *two* of the following : $7 \times 2 = 14$

 (a) Coal furnace

 (b) Governing of steam turbine

 (c) Spray pond

 (d) Instrumentation in steam turbine plant

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B.Tech 5th Semester Examination, 2016

Steam Power System

Time : 3 hours   Full Marks : 70

Instructions :

(i)   There are Nine Questions in this paper.

(ii) Attempt Five questions in all.

(iii) Question No. 1 is compulsory.

(iv) The marks are indicated in the right-hand margin.

Note : Use of steam table and Mollier chart is permissible in examination.

1. Choose the correct answer (any seven).   2×7=14

(a) Which of the following parameter decreases as the pressure of steam is raised :

   (i)   saturation temperature

   (ii) specific volume

   (iii) sensible heat

   (iv) latent heat of vaporization

(b) In a separation and throttling calorimeter, the steam will be at minimum pressure:

   (i) after separating unit

   (ii) before throttling unit

P.T.O.

(iii) after throttle valve

(iv) pressure remains constant throughout

(c) Benson boiler is one of the high pressure boiler having:

   (i)   one drum

   (ii) one water drum and one steam drum

   (iii) three drums

   (iv) no drum

(d) Which of the following fitting is a boiler mounting?

   (i)   superheater

   (ii) economiser

   (iii) feed check valve

   (iv) air preheater

(e) The Rateau turbine belongs to the category of:

   (i)   pressure compounded turbine

   (ii) reaction turbine

   (iii) velocity compounded turbine

   (iv) radial flow turbine

(f) The isentropic enthalpy drop in moving blade is two-thirds of the isentropic enthalpy drop in fixed blades of a turbine. The degree of reaction will be:

   (i)   0.4

   (ii) 0.6

   (iii) 0.66

   (iv) 1.66

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(g) A correctly designed convergent-divergent nozzle working at designed load is :

   (i) always adiabatic

   (ii) always chocked

   (iii) never chocked

   (iv) never isentropic

(h) In a back pressure turbine, the steam exhaust is:

   (i) below atmospheric pressure

   (ii) at atmospheric pressure

   (iii) above atmospheric pressure

   (iv) discharge of steam can be at any pressure

(i) In a single stage impulse turbine, the maximum blading efficiency is obtained when :

   (i) $\rho = \cos \alpha$

   (ii) $\rho = \cos^2 \alpha$

   (iii) $\rho = \dfrac{\cos \alpha}{2}$

   (iv) $\rho = \dfrac{1 + \cos \alpha}{2}$

where α is the nozzle angle and ρ is the blade speed ratio

(j) In a surface condenser used in steam power station, under cooling of condensate is undesirable as this would:

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   (i) not absorb the gases in steam

   (ii) reduce efficiency of the plant

   (iii) increase the cooling water requirements

   (iv) increase the thermal stresses in the condenser

2. (a) What are the different processes of a Vapour power cycle ? Draw the T-s and h-s diagram of vapour power cycle.

  (b) A steam turbine receives steam at pressure 20 bar and superheated by 88.6°C (degree of superheat). The exhaust pressure is 0.07 bar and the expansion of steam takes place isentropically. Calculate the following, (i) Heat supplied, assuming that the feed pump supplies water to the boiler at 20 bar. (ii) Heat rejected. (iii) Work done by the turbine (iv) Net work done (v) Thermal efficiency (vi) Theoretical stem consumption in kg/k Wh.

                              6+8

3. (a) What are the different types of nozzles ? Why is convergent-divergent nozzle generally used in steam turbine?

  (b) What do you mean by critical pressure ratio? Show that the mass flow rate per unit area in a nozzle flow can be represented as.

$$\frac{m}{A_2} = \sqrt{\left(2\frac{n}{n-1}\frac{p_1}{v_1}\left[\left(p_2/p_1\right)^{(n+1)/n}\right]\right)}$$

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Where , p and v denotes the pressure and sp. volume and n denotes polytropic index.

4+10

4. (a) Explain the state point locus of an impulse turbine with the help of a h-s diagram.

(b) Steam issues from the nozzles of a de Laval turbine with a velocity of 1200 m/s. The nozzle angle is 20°, the mean blade velocity is 400 m/s, and the inlet and outlet angle of blade are equal. The mass of steam flowing through turbine per hour is 900 kg. Calculate: (i) The blade angles, (ii) The relative velocity of steam entering the blades, (iii) The tangential force on the blades, (iv) The power developed, (v) The blade efficiency. Assume that K=0.8.

4+10

5. (a) What is a pendant superheater ? Why does the exit steam temperature increase with the increase in load in a convective superheater?

(b) A steam generator evaporates 18000 kg/h of steam at 12.5 bar and a quality of 0.97 from feed water at 105°C, when coal is fired at the rate of 2040 kg/h. If the higher calorific value of the coal is 27400 kJ/kg, find (i) the heat rate (heat supplied per hour) of boiler in kJ/h, (ii) the equivalent evaporation and the thermal efficiency of the boiler.

6+8

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5

P.T.O.

6. (a) Show that the diagram work per unit mass of steam for maximum blading efficiency of a 50% reaction stage is u^2, where u is the mean blade velocity.

14

7. (a) What is reheat factor? Develop the relation between stage efficiency, internal efficiency and reheat factor for a multistage turbine.

(b) A Parsons reaction (50%) turbine running at 400 rpm develops 5 MW using 6 kg/kWh of steam flow. The exit angle of the blades is 20° and the velocity of steam relative to the blades at exit is 1.35 times the mean blade speed. At a particular stage in the expansion the pressure is 1.2 bar and the steam quality is 0.95. Calculate for this stage (i) a suitable blade height, assuming the ratio of D_m/h_b as 12, and (ii) the diagram power.

7+7

8. (a) What are the chief methods of steam turbine governing ? Why is nozzle control governing not employed in reaction turbine?

(b) Write short notes on any two of the following:
(i) Pulverized coal firing system.
(ii) Draught or Draft system.
(iii) Compounding of steam turbines. 4+10

9. (a) What is a surface condenser? Why does cooling water flow inside the tubes and steam condense outside the tubes?

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6

(b) Water at 30°C flows into a cooling tower at the rate of 1.15 kg per kg of air. Air enters the tower at the *dbt* of 20°C and a relative humidity of 60% (*wbt* 15.2°C, h=43 kJ/kg dry air, W=0.0088 kg/kg dry air) and leaves at a *dbt* of 28°C and 90% RH (*wbt* 26.7°C, h=83.5 kJ/kg dry air, W=0.0213 kg/kg dry air). Makeup water is supplied at 20°C. Determine (i) the temperature of water leaving the tower, (ii) the approach and range of the cooling tower, and (iii) the fraction of water evaporated.

4+10

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B.Tech 5th Semester Exam., 2017

STEAM POWER SYSTEM

Time : 3 hours   Full Marks : 70

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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 :   akubihar.com   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) $P_s - P_a$

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   (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   akubihar.com

   (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

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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

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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

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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.   akubihar.com   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^3/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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