BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR, HOW-3
B.E. (ME) Part-III 6th Semester Examinations, 2013

Boiler and Steam Turbine

Branch: Mech. Engg.
Time: 3 hrs.

Paper Code: ME-602
Full Marks: 70

SECOND HALF

Attempt ANY THREE questions from this half. Use of steam tables allowed.

1. (a) What is meant by 'compounding' of steam turbine? Explain, with suitable indicative plots, the operating principles of Curtis and Rateau stages in multi-stage impulse turbines.

(b) Following parameters apply to the two-row Curtis stages of an impulse turbine:
Mean blade speed: 125 m/s, Nozzle angle: 17°, Blade friction factor: 0.9
Exit angles of 1st and 2nd rows of moving blades: 22° and 30° respectively
Exit angle of fixed blades: 26°
Assume that final steam exit velocity (absolute) is in axial direction.
Estimate the total diagram work (specific) and diagram efficiency.

[5 + 6]

2. (a) Define 'Degree of Reaction' for an impulse reaction turbine and comment on the velocity diagram of a 50% reaction turbine with identically-shaped fixed and moving blades. Compare the maximum diagram efficiencies of simple impulse, two-row Curtis and 50% reaction stages.

(b) For a Parson's turbine, the mean blade speed is 100 m/s and the blade speed ratio is 0.56. The nozzle angle is 20°. Find the enthalpy drop in the moving blades and the stage specific work. Assume that the moving and fixed blades have same shape and size.

[6 + 5]

3. (a) Define 'Reheat Factor' for a multistage steam turbine and explain the same using condition line on a T-s or a h-s plot.
Show that: Turbine isentropic efficiency = RF x Stage efficiency

(b) Explain, with suitable diagrams, throttle governing and nozzle governing for steam turbines.

[6 + 5]

4. (a) Discuss different types of surface condensers which are used in steam plants.

(b) Draw the temperature profiles for condensing steam and cooling water in a surface condenser and define TTD and LMTD for the same.
Steam is condensed at 40°C in a surface condenser, exchanging heat with cooling water which enters at 32°C. The steam flow rate is 250 t/hr and the TTD is 2°C. Assuming that the initial steam condition is 90% dry and that the overall heat transfer coefficient is 2.6 kW/m^{2}K, estimate the cooling water flow rate. C_p of water is 4.187 kJ/kg-K.

[5 + 6]

5. (a) How does air leakage into the condenser affect its thermal performance? How is the vacuum efficiency defined for a surface condenser?
(b) The vacumm efficiency of a condenser was found to be 96%. The average condenser temperature was 40°C. If the barometer reading wass 758 mm Hg, what was the vacumm gauge reading of the condenser?

[5 + 6]

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B.E. (ME) Part-III 6th Semester Final Examination, 2013.

Subject : Boiler and Steam Turbine — Paper Code : ME-602

Branch : Mech. Engg.

Time : 3 hrs. — Full Marks : 70

FIRST HALF

(Attempt any three questions from this half)

1 (a) Draw the flow and T-s diagrams of an ideal reheat cycle. Discuss each process in brief. Mention the advantages of the cycle in terms of its performance.

(b) In an ideal reheat cycle, the steam expands in the high pressure turbine isentropically from 100 bar, 520^0c to dry saturated condition. It is then reheated to 520^0c at constant pressure. After reheating it expands again isentropically in low pressure turbine to 0.045 bar. Calculate The specific heat addition, heat rejection, work ratio, the cycle efficiency, SSC, and HR. Use Molier chart and steam table.

2 (a) What do you mean by circulation ratio, top dryness fraction, void fraction and slip ratio of a natural circulation boiler? Deduce the expression of slip ratio in terms of top dryness fraction, void fraction, and specific volume of saturated liquid and saturated vapor.

(b) A natural circulation boiler produces steam at 95 kg/s. If the circulation ratio and slip ratio are 8.5 and 1.1, calculate (i) the pressure head developed, (ii) void fraction, (iii) heat absorption rate and (iv) number of risers. The height of the furnace is 16 m. The riser receives saturated water at 120 bar and velocity of 1.5 m/s. Assume that inner diameter of the riser tube is 55 mm.

3 (a) With the help of a neat labeled diagram, explain in brief the working of a cross flow induced draft cooling tower.

(b) In an ideal regenerative cycle, the steam enters the turbine at 90 bar, 480^0c. After isentropic expansion in the turbine, steam leaves at 0.02 bar. An open type heater at 6.5 bar and a closed type heater with dripping arrangement at 1.2 bar are used in the cycle. Calculate the specific work done by the turbine, specific work needed by the pumps, thermal efficiency and SSC of the cycle. Use Molier chart and steam table.

4. Write short notes on <u>any three</u> of the following:-

(a) Location of heating elements in a natural circulation boiler

(b) Various relevant efficiencies of a steam power plant

(c) Pass-out turbine system of a cogeneration unit

(d) Closed type feed water heater with cascading arrangement