MASTER OF POWER ENGINEERING FIRST YEAR FIRST SEMESTER EXAMINATION, 2018
SUBJECT: POWER PLANT CYCLES AND SYSTEMS

Time: Three Hours   **100 Marks**

Answer Question No. 1

1.

(a) Why are the dual pressure steam cycles used for GTCC power plants? Explain with a neat sketch of the HRSG layout and the *T-L* diagram   **4+4 Marks**

(b) A cogeneration power plant operates with two heat sources at 1200K and 800 K, while it rejects heat to the atmosphere at 300K and to a process plant at 400 K. If the known heat and work transfers are as shown in Fig. 1c, find the values of Q_{H2}, Q_{L2}, and the thermal efficiency of the power plant. Consider the plant to be reversible.   **4 Marks**
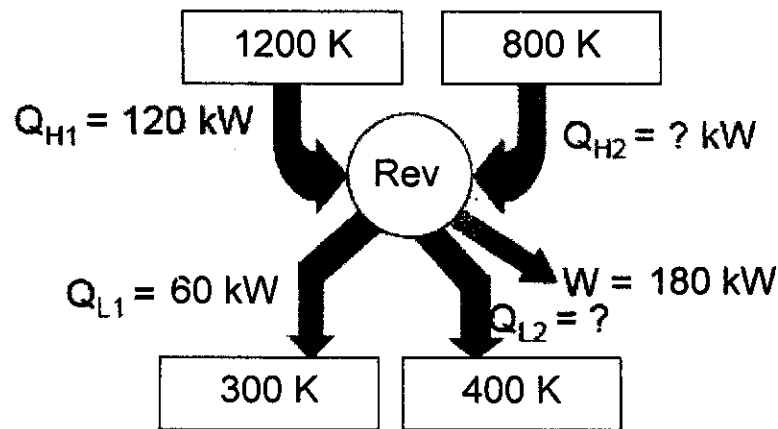

Fig 1c

(c) What are the ideal working fluid properties for a vapor power cycle?   **4 Marks**

(d) What do you mean by PG test? Why are they conducted?   **3 Marks**

(e) What is role of ACW system in a power plant?   **1 Marks**

Answer <u>any two</u> from Q 2, 3 and 4

2.

(a) For a regenerative cycle employing *n* number of direct contact type feedwater heaters, show that the cycle efficiency is maximized when the feedwater enthalpy rise in each heater is the same.

(b) A 100 MW non-reheat regenerative vapor power plant operates between a boiler pressure of 100 bar and a condenser back pressure is 0.1 bar. The cycle employs two direct contact type feedwater heaters that receive bled steam from the turbine. Find out the optimum extraction pressures that will produce maximum cycle efficiency. At what temperature would the feed water enter the economizer section of boiler?

15 + 5 = 20 Marks

Time: Three Hours

100 Marks

3.

The full-load rating of a TG Set with other cycle parameters are given below:

a) TG output = 210.01 MW,

b) Steam/ water parameters:

MS at TSV: 540°C and 130 bar; CRH: 340°C and 30 bar; HRH: 540°C and 27 bar, S/H spray water temperature = 162°C, R/H spray water temperature = 102°C; Final feed water temperature = 245°C.

c) Flow Rates:

MS at TSV: 661.089 t/h; CRH: 572.675 t/h; S/H spray flow rate = 15 t/h; R/H spray flow rate = 10 t/h.

d) Power Consumed by:

BFP motor: 4.4 MW; CEP motor = 1.6 MW, Bus fed excitation system for the generator = 2.0 MW; Turbine auxiliaries = 1.2 MW.

Calculate:

i. GHR of the turbine cycle as per ASME PTC 6
ii. NHR of the same as per ASME PTC 6
iii. Specific steam consumption
iv. Heat rejected to CW at the condenser
v. Work ratio

20 Marks

4.

A supplementary-fired GTCC plant operates with simple GT cycle with a HRSG. The GT, HRSG and ST operating parameters are as follows:

GT Cycle: Temperature ratio = 3.33, Pressure ratio = 6.5, GT output = 100 MW

HRSG: HRSG efficiency 80%. 5% of the total heat is supplied directly at the HRSG as supplementary-firing.

Steam Cycle: Simple Rankine cycle with boiler and condenser back pressures of 30 bar and 0.02 bars, respectively.

Assume steam and gas turbine expansions and the compression in air compressor isentropic, and neglect pump work.

Determine, (i) GT cycle efficiency, (ii) ST cycle output, and (iii) Overall plant efficiency.

20 Marks

Answer <u>any two</u> from Q 5, 6 and 7

5.

(a) What are the roles of 'primary air' and 'secondary air' in a pulverized fuel fired boiler? Why is it necessary to preheat the primary air and secondary air?

(b) Draw a neat sketch of the Flue gas systems in a modern power plant and label its salient components.

(c) What is a deaerator? Why is it provided in a vapor power cycle? State the working principle of deaerator with a neat sketch.

(2+2)+(4+4)+(2+2+4) = **20 Marks**

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6.

(a) Draw a neat sketch of the HP-LP Bypass system of a modern steam power plant. State its functions during (i) plant start-up and (ii) rapid load throw-off.

(b) What are the standard capacities of HP-LP Bypass system in terms of mass flow rate?

(c) What is the function of steam jet air ejector?

(d) Why would a turbine cycle require make-up water? Where from the make up water is fed to the cycle?

(e) What are the functions of Gland Steam Condenser in a power plant?

(6+3)+2+2+3+4= 20 Marks

7.

(a) State how the following factors influence the net plant heat rate of a 500 MW power plant?
  i. Main and reheat steam sprays
  ii. Operating under HP heaters bypassed condition
  iii. Air ingress in the condenser
  iv. Increase in condenser vacuum beyond optimum level
  v. Increase in cycle blow down
  vi. Poor maintenance of cooling tower fill materials

(b) What are the roles of ACF and degasser in a DM plant?

(c) What is the significance of wind rose diagram for a power plant layout

(d) What is STEP factor?

(6×2)+3+2+3= 20 Marks