Ref. No. Ex/PE/PC/H/T/324A/2023

B.E. POWER ENGINEERING THIRD YEAR SECOND SEMESTER EXAM 2023

SUBJECT: ***ADVANCED POWER CYCLES(HONS.)***

Time: Three Hours **100 Marks**

Part I—CO1 (20 marks)

1.

(a) Why is reheating done in a vapor power cycle? (b) Draw a neat sketch of a reheat vapor power cycle and plot the corresponding T-s and h-s diagrams. (c) Compare the efficiency and specific steam consumption of a reheat vapor power cycle with a corresponding simple Rankine cycle operating between the same main steam parameters and condenser back pressure. (d) For which type of cycles double-reheat is required and why? **2+8+ 5+4=20**

OR

Draw a neat sketch of a regenerative gas turbine cycle and deduce its expression of efficiency and work ratio in terms of the pressure ratio and temperature ratio. Also compare the variations of cycle efficiency against pressure ratio for regenerative cycle and a simple Brayton cycle, and comment on the operable range of pressure ratio for regenerative cycles. **10+10**

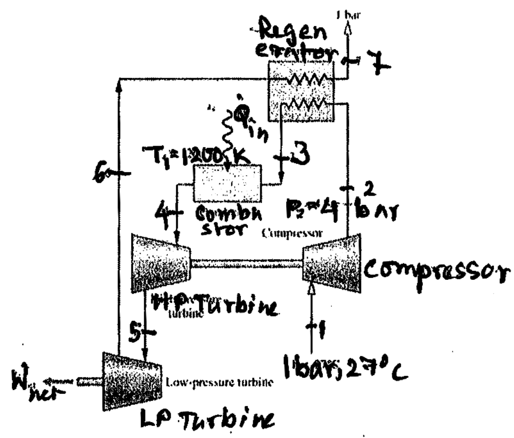
Part II – CO2 20 Marks)

2.

A steam power plant operates on an ideal reheát– regenerative Rankine cycle and has a net power output of 100 MW. Steam enters the high-pressure turbine at 10 MPa and 550°C and leaves at 0.8 MPa. Some steam is extracted at this pressure to heat the feedwater in an open feedwater heater. The rest of the steam is reheated to 500°C and is expanded in the low-pressure turbine to the condenser pressure of 10 kPa. Show the cycle on a T-s diagram with respect to saturation lines, and determine (a) the mass flow rate of steam through the boiler and (b) the extraction flow the feedwater heater. (c) Also calculate the net and gross heat rates of the cycle. **20**

OR

A regenerative gas turbine power plant is shown in the Figure. Air enters the compressor at 1 bar, 27°C with a mass flow rate of 0.562 kg/s and is compressed to 4 bar. All the power developed by the high-pressure turbine is used to run the compressor. The low-pressure turbine provides the net power output. Assume that each turbine has an isentropic efficiency of 100% and the temperature at the inlet to the high pressure turbine is 1200 K. Determine (a) the net power output, (b) thermal efficiency and (c) the temperature of the air at states 2, 3, 5, 6, and 7.



20

Part III: CO 3 – Answer any two (40 Marks)

3.

(a) What do you mean by combined cycle? What is the main advantage of using combined cycle? **5 marks**

(b) Discuss the classification of combined cycles and cite examples of each. **5 marks**

(c) In a supplementary fired GTCC plant, 10% of the total heat is added directly to the HRSG in terms of direct firing of vacuum residue fuels. The open cycle GT operates at an efficiency of 32% while the steam cycle has a net heat rate of 2500 kCal/kWh. The

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efficiency of HRSG is 85%. Draw a neat schematic of the cycle and derive an expression for the overall plant efficiency and calculate its value. **10 marks**

4.

(a) Draw a neat sketch of the combustion chamber of a gas turbine cycle and explain how the combustor liner is safeguarded against thermal failure despite the high temperature in the combustor.
(b) Why are dual-pressure cycles used for the steam cycle of GTCC?
(c) What are the purposes of GT inlet fogging and GT blade-cooling?
(d) With a neat sketch, show the T-s diagram of an externally-fired gas turbine cycle. What are the advantages of using this cycle?

5×4=20 Marks

5.

(a) What do you mean by IGCC plant? What are the salient merits of an IGCC plant?
(b) Draw a neat sketch of an IGCC plant and label it. State the role of each component of the IGCC plant.
(c) What are the principal reactions taking place in the gasifier of an IGCC plant?
(d) With a neat sketch, show the T-s diagram of an externally-fired gas turbine cycle. What are the advantages of using this cycle?

5×4=20 Marks

Part IV: CO4 (20 Marks)

6.

Consider the HBD of a 330 MW steam power plant (see next page) under VWO operating condition. Find (a) Gross Heat Rate as per the ASME PTC 6, (b) net power and net heat rate of the cycle as per the ASME PTC, considering the electromechanical efficiencies of the BFP and CEP drives to be 95%, (c) Exergy destruction inside the Deaerator. (d) CW mass flow rate, (e) Mass flow rate through the drip pump, (f) Dryness fraction of the steam at LPT exhaust, (g) Feed water temperature rise in the heater with pumped ahead configuration, (h) the % pressure drop in the extraction lines to heaters DJ3, (i) Steam pressure at the outermost sealing pocket of the turbine gland, (j) TTD and DCA of the DJ1.

20

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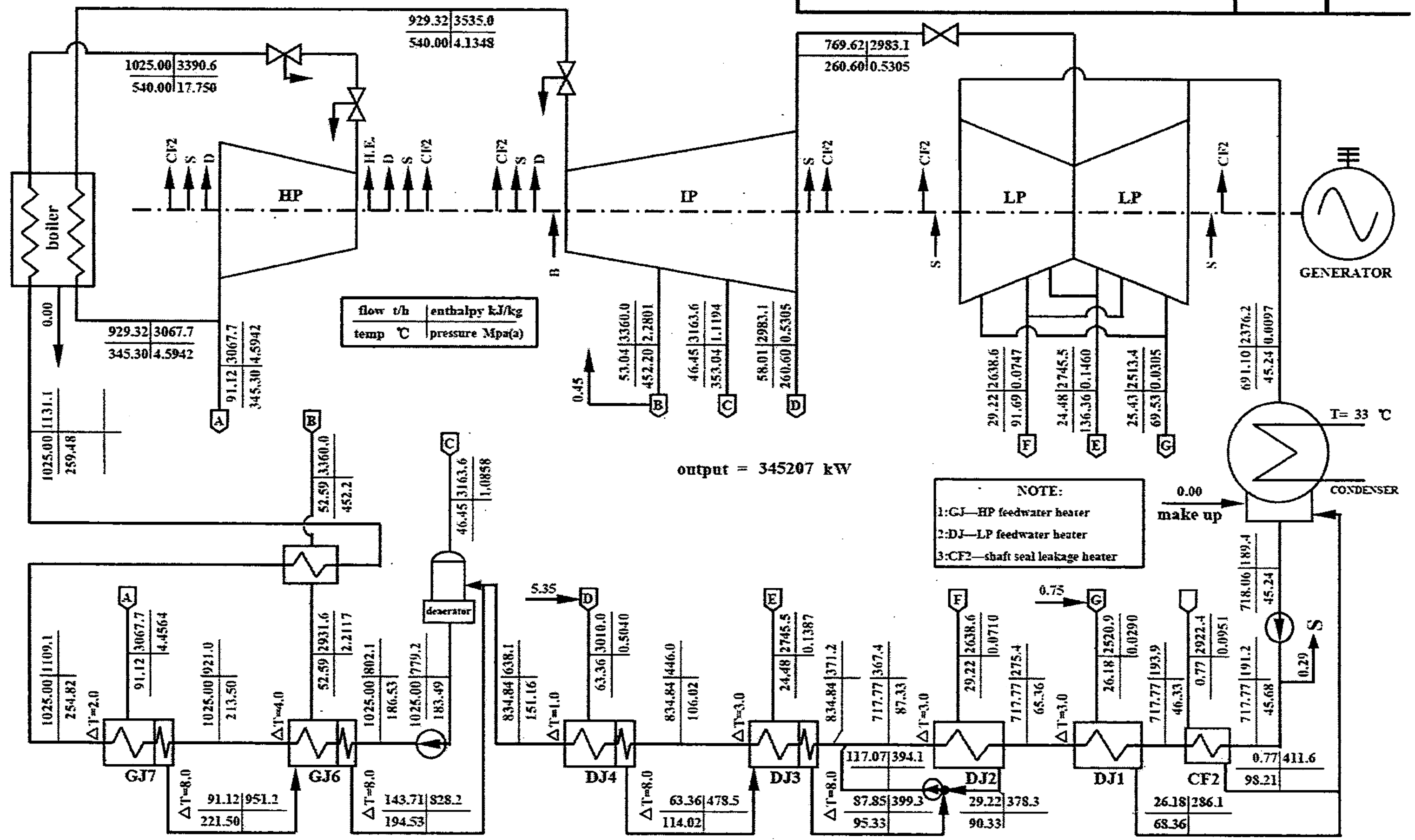
Time: Three Hours **100 Marks**

VWO(CW temp 33℃,Make up 0%)



Date

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