TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS FOR
THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

(Y5 S1)

EMG 2501 POWER PLANTS

SUPPLEMENTARY EXAMINATIONS
SERIES: AUGUST 2017
TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

This paper contains **FIVE** questions. Answer **ANY THREE** questions

Supplied: *Thermophysical and Transport Properties of Fluids (SI Edition),* by Y.R. Mayhew and G.F.C. Rogers

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Question 1

An ideal Rankine cycle with reheat uses water as the working fluid. Steam at 32 MPa, 520^{o}C enters the first stage of supercritical reheat cycle including three turbine stages. Steam exiting the first-stage turbine at pressure p is reheated at constant pressure to 440^{o}C, and steam exiting the second stage-stage turbine at 0.5 MPa is reheated at constant pressure to 360^{o}C. Each turbine stage and the pump has an isentropic efficiency of 85%. The condenser pressure is 8 kPa.

(a) Draw a schematic of the entire process and sketch the process on a T-s diagram.

For p = 4 MPa, calculate;

(b) The net work per unit mass of steam flowing, in kJ/kg and

(c) The thermal efficiency.

(20 marks)

Question 2

A power plant operates on a regenerative vapour power cycle with one closed feedwater heater. Steam enters the first turbine stage at 120 bar, 520^{o}C and expands to 10 bar, where some of the steam is extracted and diverted to a closed feedwater heater. Condensate exiting the feedwater heater as saturated liquid at 10 bar passes through a trap into the condenser. The feedwater exits the heater at 120 bar with temperature of 170^{o}C. The condenser pressure is 0.06 bar.

(a) Draw a schematic diagram for the cycle and sketch the process on a *T-s* diagram.

If each turbine stage and the pump has an isentropic efficiency of 100%, calculate for the cycle;

(b) The thermal efficiency and

(c) The mass flow rate into the first stage turbine, in kg/h, if the net power developed is 320 MW.

(20 marks)

Question 3

A regenerative gas turbine power plant is as shown in Figure Q3. Air enters the compressor at 100 kPa, 300 K. The air is compressed in two stages to 1200 kPa, with intercooling to 300 K between the stages at a pressure of 350 kPa. The turbine inlet temperature is 1400 K and the expansion occurs in two stages, with reheat to 1340 K between the stages at a pressure of 350 kPa. The compressor and turbine efficiencies are 87 and 85%, respectively. The net power developed is 2.5 MW and the regenerator effectiveness is 80%.

(a) Draw a schematic and *T- s* diagram for the process.

Calculate;

(b) The volumetric flow rate, in m^3/s, at the inlet of each compressor stage.

(c) The thermal efficiency of the cycle.

(d) The back work ratio.

(20 marks)

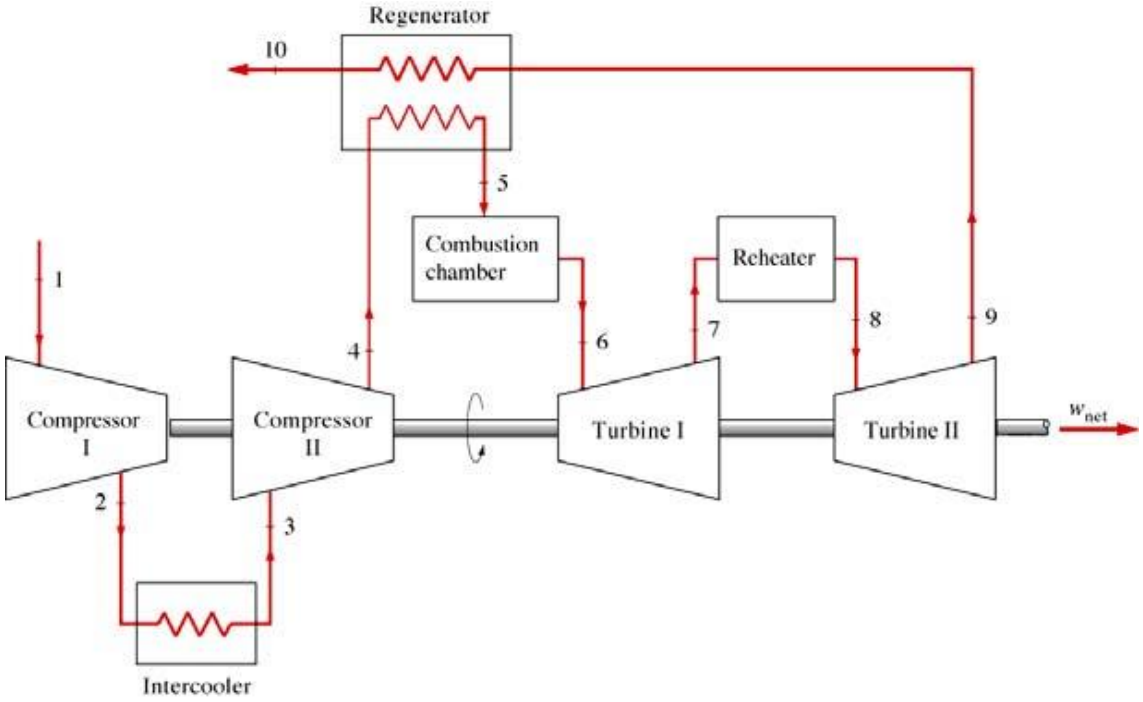

Fig. Q3. Gas turbine power plant

Question 4

The pressure and temperature at the beginning of compression of an air standard Diesel cycle are 95 kPa and 300 K respectively. At the end of the heat addition the pressure is 7.2 MPa and the temperature is 2150 K. Calculate:

(a) The compression ratio.

(b) The cut-off ratio.

(c) The thermal efficiency of the cycle.

(d) The mean effective pressure (MEP). **(20 marks)**

Question 5

The displacement of an internal combustion engine 5.6 liters. The processes within each cylinder of the engine are modeled as an air-standard Diesel cycle with a cut-off ratio of 2.4. The state of the air at the beginning of compression is fixed by p_1 = 95 kPa, T_1 = 27°C and V_1 = 6.0 litres.

(a) Sketch the process on a *T*-*s* diagram.

Calculate:

(b) The network per cycle, in kJ.

(c) The power developed by the engine, in kW.

(d) The thermal efficiency, if the cycle is executed at 1500 times per minute.

(20 marks)