

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering



057

Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : ~~DM7301~~ Thermal Power Generation (DMX 7301)
Academic Year : 2022/2023
Date : 13th February 2024
Time : 0930-1230hrs
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of of Five (5) questions.
3. Answer all Five (5) questions.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear handwriting.
7. Do not use red colour pen.
8. h-s chart is provided.

Question 1 – 26 marks

- (i) What is the difference between gross plant factor and net plant factor? 03 marks
- (ii) A 25 MW power plant generated 80 GWh during a particular year. Time lost due to planned maintenance and breakdown maintenance during that year were 20 days and 200 hrs respectively. Calculate the gross and the net plant factors. 10 marks
- (iii) How is the efficiency of a steam plant improved through regenerative cycle? 03 marks
- (iv) In a single heater regenerative cycle, the steam enters the turbine at 30 bar, 400 °C and the exhaust pressure is 0.1 bar. The feed water heater is an open type which operates at 5 bar. Saturated liquid enthalpy at 5bar and 0.1 bar are 640 kJ/kg and 192 kJ/kg respectively. Pump work may be neglected. 10 marks
- (a) What is the steam rate of cycle in kg/kwh?
- (b) What is the increase in steam rate as compared to the Rankine cycle (without regeneration)?
- (c) Why is steam rate of regenerative steam cycle higher than the simple cycle.?

Question 2 - 20 marks

- (i) List five operating variables that strongly affect the thermal efficiency of an open cycle gas turbine. 05 marks
- (ii) List five advantages of closed cycle gas turbine plant. 05 marks
- (iii) In a constant pressure open cycle gas turbine air enters at 1 bar and 20° C and leaves the compressor at 5 bar. You are given the following data.
- Temperature of gases entering the turbine: 680 °C
- Pressure loss in the combustion chamber: 0.1 bar
- Isentropic efficiency of the compressor: 100%
- Isentropic efficiency of the turbine: 100%
- Combustion Efficiency: 85%
- $\gamma = 1.4$
- $C_p = 1.024 \text{ kJ/kgK}$ for air and gas,
- Determine the following.
- (a) The quantity of air circulation if the plant develops 1 MW.
- (b) Heat supplied per kg of air circulation.
- (Mass of the fuel may be neglected)
- 10 marks

Question 3 - 18 marks

- (i) What is the function of 'draft' in a boiler? 03 marks
- (ii) What are the advantages of having "bent tubes" in water tube boilers? 05 marks
- (iii) Briefly describe the differences between operating principles of impulse turbine and reaction steam turbines. 10 marks

Question 4 – 14 marks

- (i) Describe the functions of following giving examples of materials used in each nuclear power plants.
- (a) Control rods
 - (b) Moderators
 - (c) Biological shield

06 marks

- (ii) Briefly explain features of Pressurized Water Reactor (PWR) power plant and state support systems employed in a PWR power plant for its safe and reliable operation.

08 marks

Question 5 – 22 marks

- (i) Power generation can be divided as base load generation, middle load generation and peak load generation. Briefly describe them with examples.

06 marks

- (ii) A 480 V, 50 Hz, Y connected, six-pole synchronous generator is rated at 50 kVA at 0.8 PF lagging. It has a synchronous reactance of 1.0 Ohm per phase. Assume that this generator is connected to a steam turbine capable of supplying up to 45 kW. The friction and winding losses are 1.5 kW, and the core losses are 1.0 kW.

- a) Sketch the capability curve for this generator, including the prime-mover power limit.
- (b) Can this generator supply a line current of 56 A at 0.7 PF lagging? Why or why not?
- (c) What is the maximum amount of reactive power that this generator can produce?

08 marks

- (iii) The thermal power plant complex (TPPC) in Sapugaskanda has a total auxiliary power supply load of 100 kW. It is powered by a 415V, three phase, 4 wire power supply. The power factor is 0.85 lagging. The TPPC desires to avoid the payment of penalties for this poor power factor. What should the facility manager advise TPPC management to do? If an improved pf of 0.95 lagging is desired, determine the magnitude of the required reactive power and required capacitor.

08 marks

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