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

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX7301/DMX6535 Thermal Power Generation**
Academic Year	:	2020/2021
Date	:	2nd January 2022
Time	:	1400-1700hrs
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Three (3)** pages.
3. Answer any **Five (5)** questions including **only one (1)** question from **part B.**
4. All questions carry equal marks.
5. Use separate answer books for part **A** and **B.**
6. Answer for each question should commence from a new page.
7. This is an Closed Book Test (**CBT**).
8. Answers should be in clear hand writing.
9. Do not use red colour pen.
10. h-s chart is provided.

PART A

(01) (i) Thermal power plant of rated capacity 100 MW had an "availability" of 92% and a gross plant factor of 0.45 during its operation in a particular year. The plant had scheduled maintenance hours of 12% of the total hours available for power generation in the year. In addition, certain number of down time hours was observed due to breakdowns in the same year.

Calculate,

(a) Total time lost due to breakdowns
(b) Total power generated in the year
(c) Net plant factor of the plant.

(ii) Based on the operating principle, thermal generating plants can be broadly classified into three groups. What are these groups? Describe them briefly.

(02) (i) Why is superheating of steam essential in a steam power plant?

(ii) In a 120 MW steam power plant operating on ideal reheat-regenerative cycle , steam enters the high pressure (HP) turbine at 90 bar and 550°C. The condenser is maintained at a pressure of 0.07 bar. After expansion of steam in HP turbine to 7 bar pressure some of the steam goes to an open heater and the balance is reheated to 400°C. Then steam enters the low pressure ((LP) turbine and expands to the condenser pressure. Neglect total feed pump work. Assume 100% isentropic efficiency for turbines,

Determine the,

(a) steam flow rate to the HP turbine.
(b) thermal efficiency of the cycle.
(c) If there is a 15°C rise in the temperature of the cooling water, what is the rate of flow of the cooling water in the condenser?

(Saturated liquid enthalpy at 7 bar and 0.07 bar are 697 kJ/kgK and 163 kJ/kgK respectively)

(03) In a gas turbine plant, the compressor takes in air at a temperature of 28°C and compresses it to four times the initial pressure with an isentropic efficiency of 82%. The air is then passes through a heat exchanger heated by the turbine exhaust before reaching the combustion chamber. In the heat exchanger 92% of the available heat is given to the air. The maximum temperature after constant pressure combustion is 600°C.

You may take following data,

combustion efficiency - 90%

isentropic efficiency of the turbine - 70%.

Cp = 0.0045 kJ/kgK and $\gamma = 1.4$ for air and constant specific heats throughout.

Determine the,

(a) temperature of compressed air after the heat exchanger.
(b) actual heat supplied by the combustion chamber.
(c) thermal efficiency of the cycle.

(04) (i) What is 'excess air' and why is it required for 'combustion' in a boiler?

(ii) There are different types of valves on boilers. Name five types of such valves and mention where they are fitted on boilers.

(iii) Why boiler blow-down is required?

(iv) What are the advantages of having "bent tubes' in water tube boilers?

(05) (i) Explain the concept of a nuclear power plant on the basis of a pressurised water reactor. In which aspects does a boiling water reactor differ from a pressurised water reactor?

(ii) "The principal risks associated with nuclear power arise from health effects of radiation". Comment on this statement.

(06) (i) Write a note on the nuclear fuel cycle, explaining in detail the different stages of the cycle.

(ii) Give examples for the following types of reactors.

(a) Reactor fueled with natural uranium.
(b) Reactor fueled with enriched uranium.

(iii) What are the main mechanisms of interaction of gamma rays with matter? Explain them briefly.

(iv) Determine the energy released by the fission of 1.5g of U^{235} in kWh, assuming that energy released per fission is 200 MeV.

PART B

(07) (i) A 3 phase Star connected synchronous generator is rated at 15 kVA, 400V, 50Hz. If rated load at 0.8 pf lagging is supplied where resistance is 0.3Ω and synchronous reactance is 10Ω. Find the voltage regulation of an alternator.

(ii) Explain the advantages of having the revolving field of the alternator.

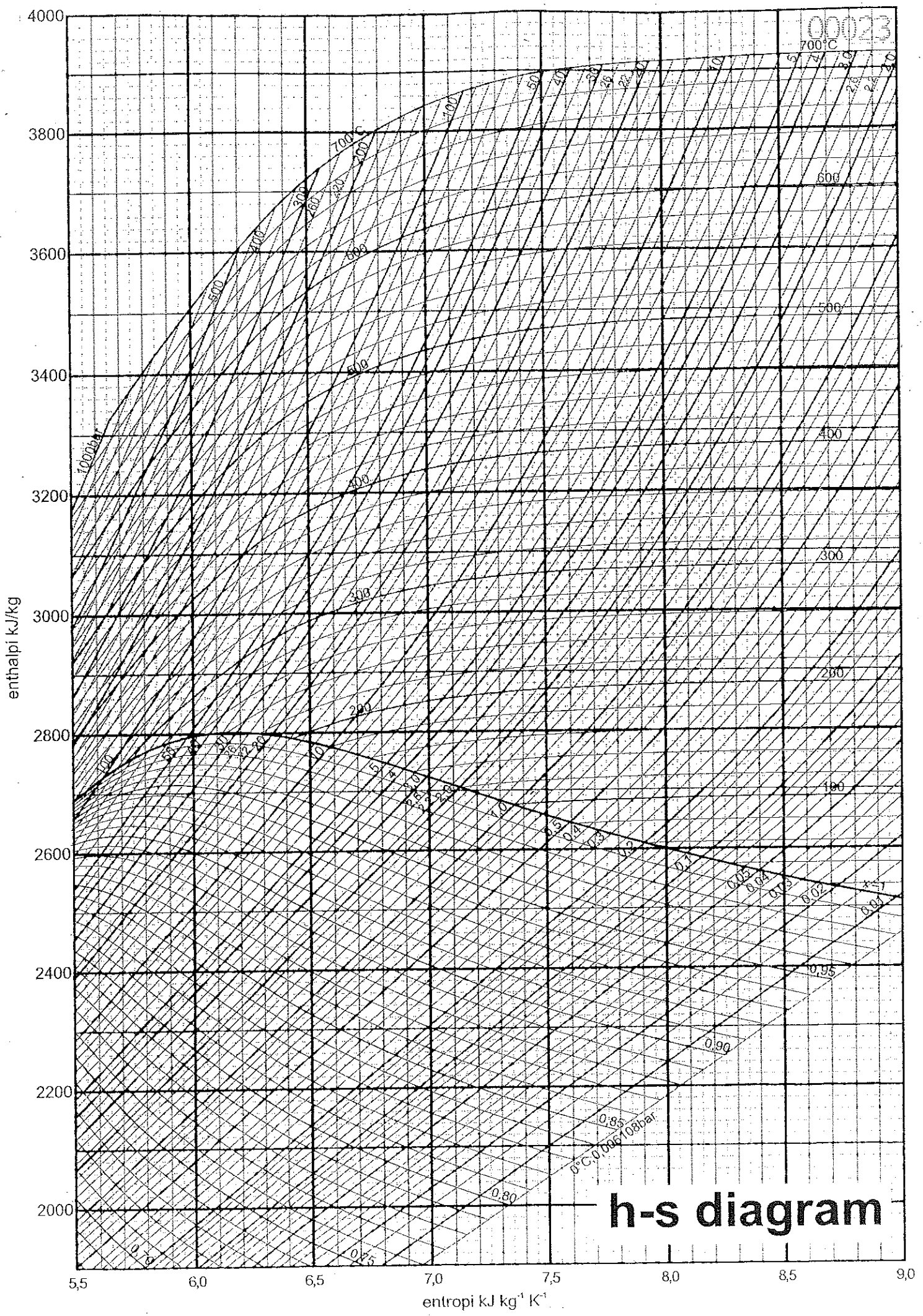
(iii) A 10 pole 25 Hz alternator is directly coupled to and is driven by 60 Hz synchronous motor then calculate the number of poles in a synchronous motor.

(iv) Explain the functions of a Governor.

(08) (i) When the speed of an alternator changed from 3600 rpm to 1800 rpm, calculate the generated emf/phase, if the initial emf/phase is 11kV.

(ii) Explain the function of damper winding in an alternator.

(iii) A 3-phase 11kV star connected alternator has armature resistance of 1ohms/phase and a synchronous reactance of 20 ohms/phase. Calculate the regulation for a load of 1500 kW at P.F of; (i) 0.8 lagging (ii) unity (iii) 0.8 leading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h-s diagram
enthalpi kJ/kg
entropi kJ kg⁻¹ K⁻¹
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
5,5
6,0
6,5
7,0
7,5
8,0
8,5
9,0
700°C
600
500
400
300
200
100
1000bar
0,95
0,90
0,85
0,80
0°C,0,006108bar