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	:	**DMX6535/MEX6235 Thermal Power Generation**
Academic Year	:	2019/2020
Date	:	24th July 2020
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 0.5 during its operation in a particular year. The plant had scheduled maintenance hours of 10% 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) What are the types of thermal power plants suitable for daily peaking duties? Discuss the reasons for certain types of thermal power plants that are incapable of daily peaking operations.

(02) (i) Distinguish open feedwater heaters from closed feedwater heaters?

Steam at 70 bar and 450°C is supplied to a steam turbine. After expanding to 25 bar in high pressure (HP) stage, it is reheated to 420°C at the constant pressure. Then it is expanded up to intermediate pressure of 10bar and the portion of steam is bled at this pressure and sent to the open feed water heater. The

remaining steam expands from this pressure to a condenser pressure of 0.07 bar in the low pressure (LP) stage. Assume 100% isentropic efficiency for all turbine stages.

a) Show the cycle in a T-S diagram.
b) Calculate the total pump work.
c) Calculate the quantity of steam bled per kg of flow.
d) Determine the cycle efficiency.

Saturated liquid enthalpy at 0.07bar and 10bar are 163.4kJ/kg and 762.6kJ/kg respectively.

(03) (i) Discuss the merits and demerits of power generation using gas turbine cycle.

(ii) In an open cycle gas turbine plant air at a temperature 303K and a pressure 1 bar is compressed through a pressure ratio of 9. The compression of air is achieved in two stages with complete intercooling in between at optimum pressure and it is driven by a separate turbine (compressor turbine). The gases coming out from compressor turbine are passed on to the second turbine (power turbine) after reheating to the temperature of 900K. The power turbine generates the electrical energy.

Use the following data;
Maximum cycle temperature – 1000 K
Air mass flow – 15 kg/s
Isentropic efficiency of each compressor – 100%
Isentropic efficiencies of turbines – 100%
Take C_p = 1.0032 kJ/kgK and γ = 1.4 throughout the cycle.

a) Sketch the T-S diagram to show all processes.
b) What is the optimum pressure ratio for each stage of compression?
c) Calculate the power required to run the compressor.
d) Calculate the temperature of gases coming out from the compressor turbine.
e) Determine the reheat pressure.
f) Calculate the net output of the plant and thermal efficiency of the cycle neglecting mass of fuel supplied to the combustion chamber.

(04) (i) What are the classifications of boilers?

(ii) Briefly describe the function/s of the following accessories used in boilers.

a) Safety Valve
b) Blow-off Cock
c) Pressure Gauge
d) Fusible Plug
e) Feed Check Valve

(05) (i) Describe the principle of operation of the steam turbine.

(ii) What are the classifications of steam turbines? Explain their structural and functional differences.

(iii) Define the term, "capability of steam turbine".

(iv) Governing of steam turbine is done by regulating the steam supply, and maintain the speed of rotation according to load conditions and there are three governing methods. What are those three methods?. Briefly explain.

(06) (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) Discuss the factors which go in favour of nuclear power plant as compared to other types of power plants.

(iii) What is meant by fissile fuel and fertile fuel? Explain the reaction involved in the conversion of the fertile isotope Th - 232 and U - 238 to fissile isotopes U - 233 and Pu - 239 respectively.

PART B

(07) (i) A 3-phase 11kV star connected alternator has armature resistance of 1 ohms/phase and a synchronous reactance of 20 ohms/phase. Calculate the regulation for a load of 1500kW at P.F of (i) 0.8 lagging (ii) unity (iii) 0.8 leading.

(ii) Draw a sketch of synchronous generator and name the main parts of it and describe the working principal of synchronous generator.

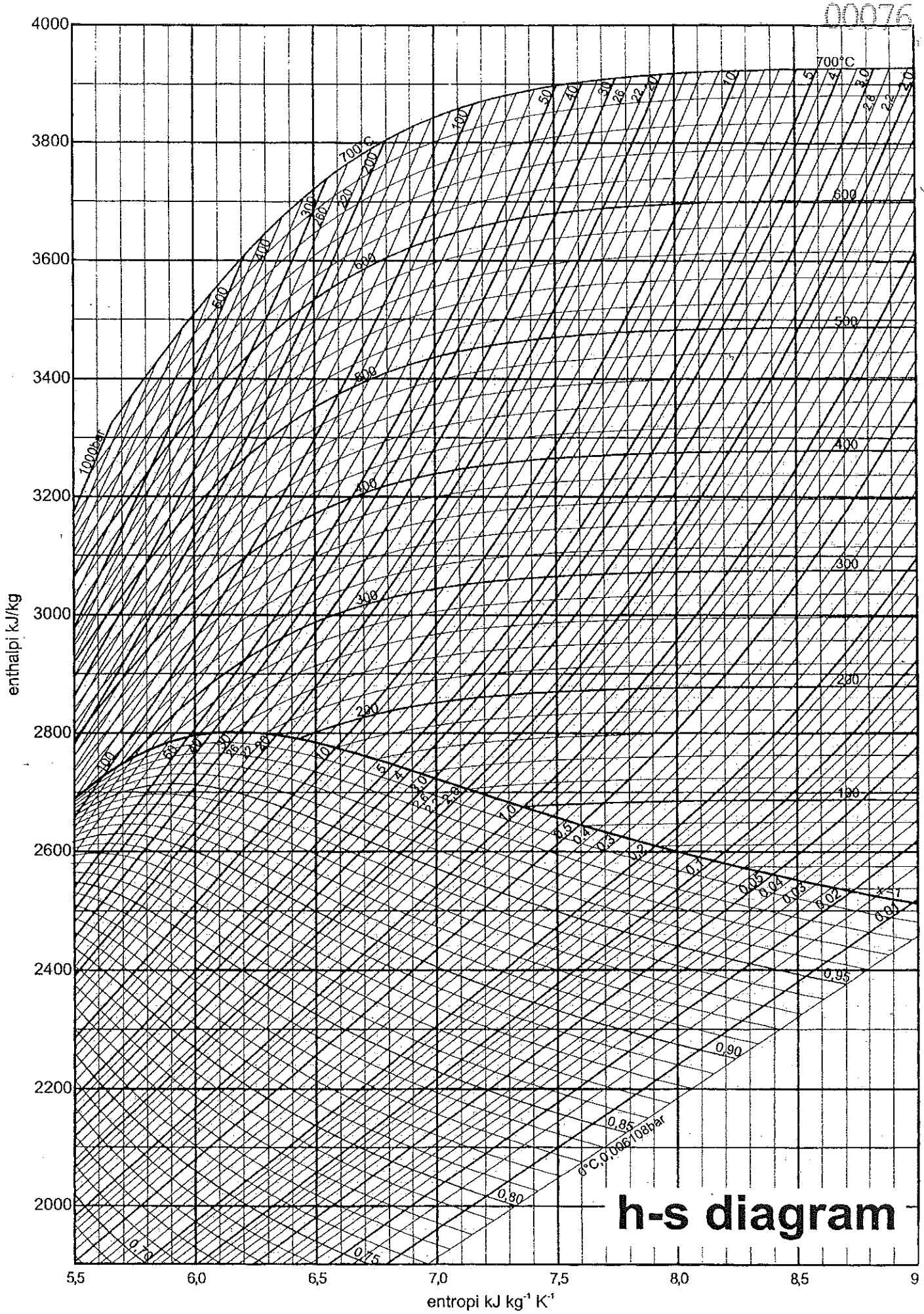
(iii) Explain the function of excitation system of a power plant.

(08) (i) Calculate the speed at which 6-pole alternator should be driven to generate 50 cycles per second.

(ii) A 3-phase 11kV star connected alternator is rated at 1500kVA, 11kV. The resistance and reactance per phase are 1.5 ohms and 30 ohms respectively. To what value will the terminal voltage rise when full-load at P.F. 0.8 lagging is switched off?

(iii) (a) What are the main parameters that should be considered when selecting a generator?

(b) Explain the function of governor of a power plant. Explain the function of excitation system of a power plant.


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
700°C
1000bar
0°C,0,006108bar