(17) 00065

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	:	2017/18
Date	:	23rd January 2019
Time	:	1330-1630h
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Four(4)** 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) State how the boilers are classified?

(ii) Discuss the functions of Safety valve, Blow down valve and Stream trap used in boilers.

(iii) Define safety factor for boilers. "In boiler design and operation, it is essential that working stresses, are maintained considerably below the ultimate stress". Why?

(iv) Distinguish between water-tube and fire-tube boilers and state under what circumstances each type would be desirable.

(v) Explain the advantages and disadvantages of vertical fire tube boiler.

(02) (i) The following data relates to a steam power plant.

Capacity of the plant - 200 MW

Capital cost - Rs 400 $x10^8$

Maximum demand – 150 MW

Rate of Interest and depreciation - 18% on capital

Annual cost of the fuel oil, salaries and maintenance - Rs 550 x 10^7per year

Load factor - 50%

Determine the cost of generation per unit of kWh.

(ii) In power plant terminology, what is understood by combined cycle operation?. Does Cogeneration make sense?. If yes, explain briefly.

(02) The net power output of the turbine in an ideal reheat-regenerative steam cycle is 100MW. Steam enters the high pressure (HP) turbine at 90 bar, 550°C and expands to 7 bar. After expansion in HP turbine 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 0.07 bar. Neglect feed pump work. Assume 100% isentropic efficiency for turbines.
Take saturated liquid enthalpy (h_f)at 7 bar as 697 kJ/kgK and at 0.07 bar as 163 kJ/kgK

Determine,

(i) steam flow rate to the HP turbine.
(ii) thermal efficiency of the cycle.
(iii) If there is a 10°C rise in the temperature of the cooling water, what is the rate of flow of the cooling water in the condenser?

(04) At the design speed the following data apply to use gas turbine set employing the heat exchanger.

Pressure ratio - 5 : 1
Combustion efficiency – 95%
Mechanical transmission efficiency – 95%
Mass flowrate – 30kg/s
Heat exchanger effectiveness – 80%
Maximum cycle temperature – 725°C
The ambient temperature and pressure of air are 27°C and 1.01325 bar respectively.

Determine,

(i) Actual power required to drive the compressor
(ii) the power output of the gas turbine set

(iii) thermal efficiency of the cycle
(iv) specific fuel consumption in kg/kWh

- Assume no pressure loss in heat exchanger and combustion chamber.
- Assume isentropic efficiencies of compressor and turbine are 100%.

Take following data

Cv of fuel as 43500 kJ/kg
Cp as 1.15 kJ/kgK throughout the cycle
γ - 1.4 for both compression and expansion

(05) (i) Discuss the factors to be kept in mind in selecting a site for a nuclear power plant.

(ii) What is the reason for using moderators in nuclear reactors?. Why isn't it possible to use natural Uranium as a fuel in reactors moderated by light water?.

(iii) Four manufacturing factories in an Industrial zone require 1500 MWh of electric energy per day. It is to be supplied by a reactor which converts nuclear energy into electric energy with an efficiency of 30 percent. If a reactor used nuclear fuel of U-235, calculate the mass of U-235 needed for one day's operation of these factories..

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

(ii) What is the reason for using hydraulic power and not electricity for operation of control rods in boiling water reactors?.

PART B

(07) (i) Draw a sketch of synchronous generator and name the main parts. Describe the working principle of synchronous generator.

(ii) Explain the functions of Governor as generator auxiliary system.

(iii) Draw the per phase equivalent circuit of synchronous generator.

(iv) A 22 KV, 3 phase star-connected turbo- alternator with a synchronous impedance of 1.4 ohm/phase is delivering 240 MW at unity p.f. to a 22 KV grid. If the excitation is increased by 25%, then the turbine power is increased till the machine delivers 280 MW. Calculate the new current and power factor.

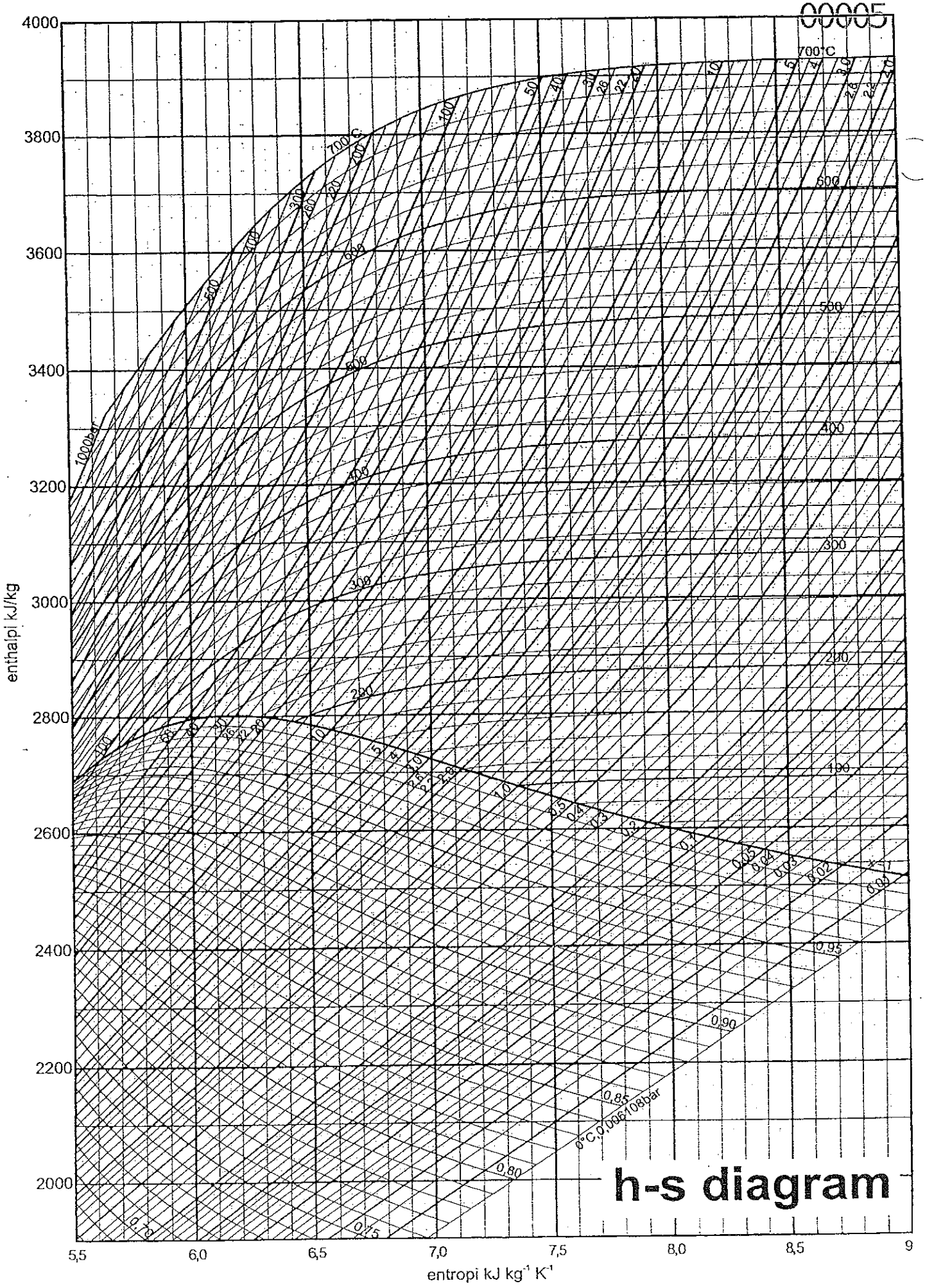
(08) (i) What are the main parameters should be considered when selecting a generator?

(ii) List the advantages of nuclear power plants over conventional thermal power plants.

(iii) Which type of synchronous generators are used in hydro-electric plants and why?

(iv) A 9-kVA, 208 V, 3-phase, Y-connected, synchronous generator has a winding resistance of 0.1 ohm per phase and a synchronous reactance of 5.6 ohms per phase. Determine the voltage generated (exciting emf) by the machine when it is delivering full-load at 0.8 power-factor lagging at rated voltage. Calculate the voltage regulation for rated load at 0.8 power-factor (leading).

00065


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
0,95
0,90
0,85
0,80
0,75
0°C,0,006108bar