The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX6235 Thermal Power Generation**
Academic Year	:	2016/17
Date	:	15th November 2017
Time	:	1330-1630h
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. Answer any **5 questions** including **only one question from part A.**
4. Use **separate answer books** for part A and B.

PART A

(01) Explain the following terms.

a. Continuous Duty Generator

b. Armature Reaction (04 marks)

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

(04 marks)

(iii) Discuss the impact of emissions from thermal power plants to the environment.

(04 marks)

(iv) A 120kVA, 1kV, Δ-connected, three-phase, synchronous generator has a winding resistance of 1.5 Ω/phase and a synchronous reactance of 15 Ω/phase. If the fixed loss is 1500W, determine,

a. the voltage regulation.

b. the efficiency when the generator delivers the rated load at 0.707 P.F lagging. (08 marks)

(02) (i) Explain the difference between Salient and Non-Salient Pole Rotors (Round rotors) used in Synchronous Generators. (04 marks)

(ii) Explain the functions of exciter as generator auxiliary system. (04 marks)

(iii) Draw typical generator capability curve and name its limits. (04 marks)

(iv) A 13.8kV, 10MVA, 0.8 P.F lagging, 60Hz, two pole, Y-connected steam turbine generator has a synchronous reactance of 12 Ω/phase and an armature resistance of 1.5 Ω/phase. This generator is operating in parallel with a large power system (infinite bus).

a. What is the magnitude of EA (internal generated voltage) at rated condition?
b. What is the torque angle of the generator at rated conditions?
c. If the field current is constant, what is the maximum power given out of this generator?

(08 marks)

PART B

(03) Helium is used as the working fluid in modified Brayton cycle. Gas enters the compressor at 27°C and 20 bar and is discharged at 60 bars. The gas is heated to 1000°C as it passes through High Temperature Gas cooled Reactor (HTGR) before expanding through the turbine. After expansion in the turbine, the hot turbine exhaust is sent through the pre-cooler and cooled down to the temperature of 27°C.

Assume

- 2% pressure loss through both the HTGR and the pre-cooler.
- turbine and the compressor are to be 100%efficient.
- C_p for helium as 5.1926 kJ/kgK and ratio of specific heats = 1.667.

Determine the

i. temperature at the end of compression and expansion.
ii. heat supplied, the heat rejected and the network per kg helium.
iii. thermal efficiency.
iv. flow rate if the plant is to have a net output of 1000MW.

(20 marks)

(04) A design for a steam power plant includes:

- A boiler delivering saturated steam at 55 bar.
- A superheater, bringing steam temperature up to 500°C.
- A high pressure (HP) turbine with isentropic efficiency 80% and exhausting at 12 bar.
- A reheater, bringing steam temperature up to 500°C.
- A low pressure (LP) turbine with isentropic efficiency 85% and exhausting at 0.06 bar.
- A condenser, bringing steam to saturated liquid state at the LP turbine outlet pressure.
- A feed pump, with isentropic efficiency 90% bringing the pressure of the feed water up to 55 bar before entry to the boiler.

(i) Sketch the T-S diagram for the cycle.
(ii) Calculate the net work output, the external heat supplied and hence the thermal efficiency of the cycle.
(iii) Calculate the work ratio. Take saturated liquid enthalpy(h_f) at 0.06 bar as 152 kJ/kg

(20 marks)

(05) (i) What are the types of thermal power plants suitable for daily peaking duties?. Discuss why certain types of thermal plants are not capable of daily peaking operations.

(ii) What are the advantages of having bent tubes in water tube boiler? Explain.

(iii) What is the purpose of performing Non Destructive Testing for a boiler? Explain the main operating principles of ultrasonic and eddy current technologies of Non Destructive Testing methods.

(iv) Explain with examples how materials are selected for different components of a boiler.

(05x 4 marks)

(06) (i) "Gas turbines are generally divided into two basic types from the point of view of application". What are these types and their main differences?
(10 marks)

(ii) Explain with relevant illustrations, the effect of pressure ratio and maximum cycle temperature on,

(a) Brayton cycle efficiency.
(b) specific power output of the gas turbine plant. (10 marks)

(07) (i) Explain why the use of a natural Uranium blanket is an important feature of a breeder reactor

(ii) "A person can receive radiation from external and internal sources". What are these sources?. Explain. What are the preventive measures to reduce exposure of such sources?

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

(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.

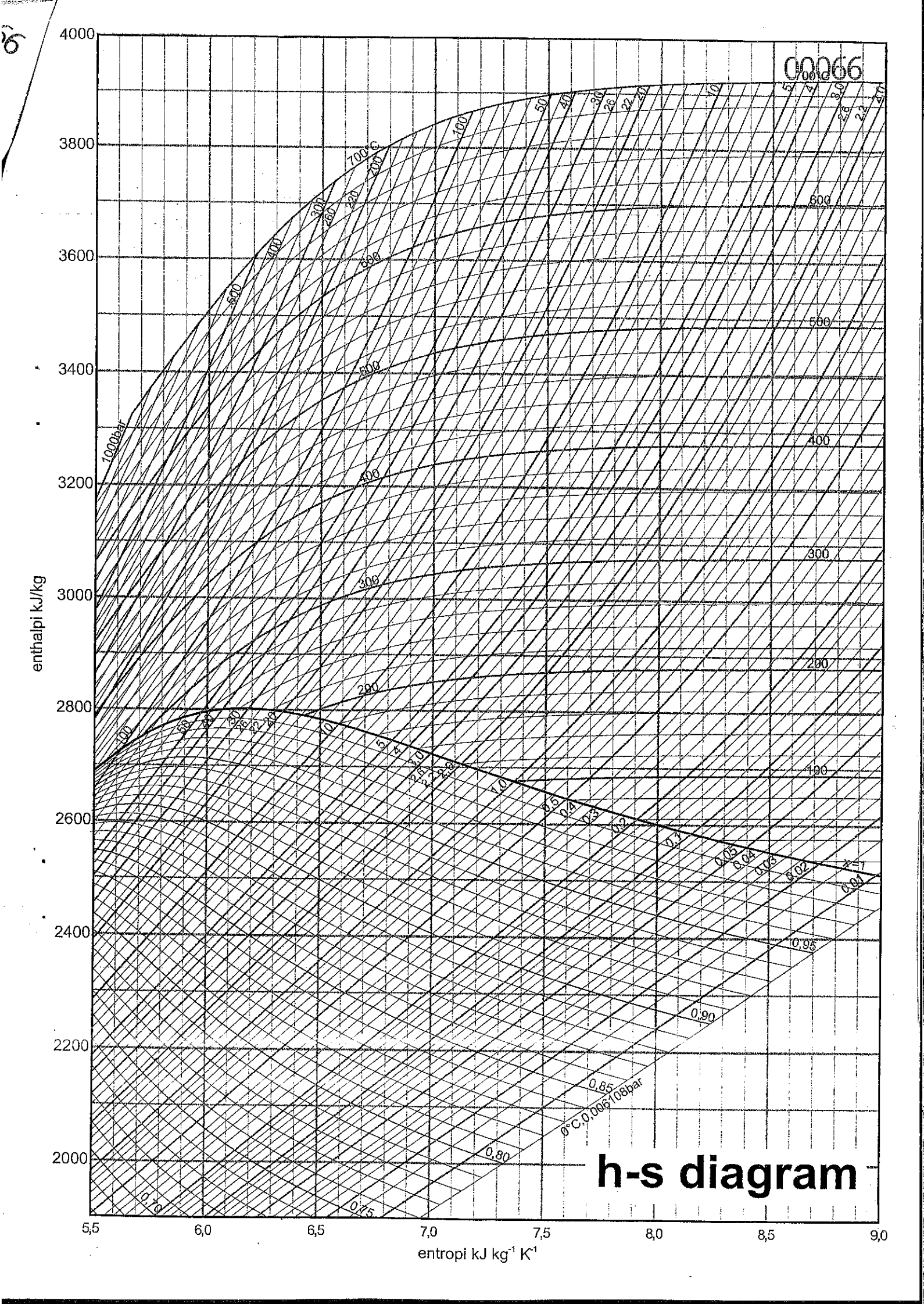
(05 x 4 marks)

(08) (i) Illustrate a Pressurized Water Reactor (PWR) power plant and state support systems employed in a PWR power plant for its safe and reliable operation.

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

(10 x 2 marks)

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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
1000bar
700°C
600
500
400
300
200
100
0,95
0,90
0,85
0,80
0,75
0°C,0,006108bar