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The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX6335 Thermal Power Generation**
Academic Year	:	2012/13
Date	:	29th July 2013
Time	:	1330-1630hrs
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 **one question from part A.**

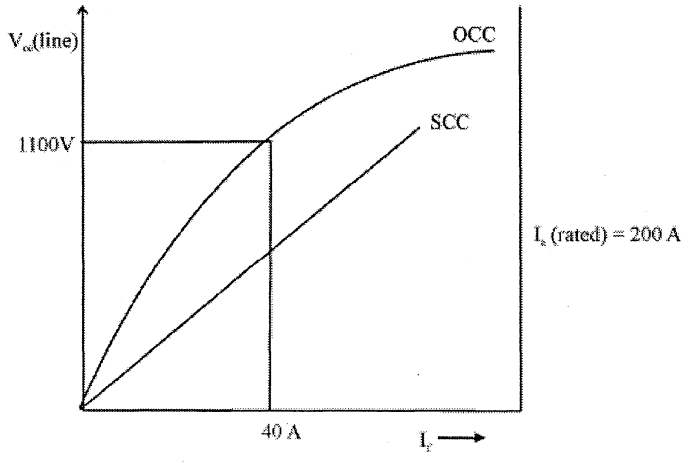
PART A

(1) (i) Draw a sketch of a synchronous generator and name the main parts, and describe the working principle.

(10 marks)

(ii) The effective resistance of a 3 – phase, Y – connected 50 Hz, 2200 V synchronous generator is 0.5 per phase. On short circuit a field current of 40 A gives the full load current of 200 A. An emf (line to line) of 1100 V is produced on open circuit with the same field current. Determine the synchronous impedance. Also compute the power angle and voltage regulation at full – load 0.8 lagging power factor.

The Open Circuit Current (OCC) and Short Circuit Current (SCC) characteristics of the synchronous generator are given in figure below.



(10 marks)

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

(10 marks)

(ii) What is the power angle when the maximum power is generated by a synchronous generator?. (2 marks)

(iii) A 3Ø, 5 kVA, star-connected alternator is rated at 1600kVA, 13500V. The armature effective resistance and synchronous reactance are 1.5 Ω and 30 Ω respectively per phase. Calculate the percentage regulation for a load of 1280 kW at power factors of;

a) 0.8 leading
b) Unity
c) 0.8 lagging (8 marks)

PART B

(3) A gas turbine power plant consists of a two stage compressor with intercooling and a single stage turbine with a regenerator. Air enters the compressor at 1 bar, 300K. The maximum temperature of the cycle is limited to 1090K and the maximum pressure ratio is 6. The effectiveness of the regenerator is 0.7. The rate of air flow through the plant is 210kg/s and the calorific value of fuel used is 40.8MJ/kg.

You are given the following data

- Isentropic efficiency of both the compressors - 80%
- Isentropic efficiency of turbine stage - 90%.
- Combustion efficiency - 0.95
- Generator efficiency - 0.96
- Cp for air - 1.005kJ/kgK, Cp for gas - 1.08 kJ/kgK
- γ for air - 1.4, γ for gas - 1.33

Assuming perfect intercooling and neglecting pressure losses estimate,

(i) temperature of compressed air after the regenerator.
(ii) fuel consumption per kg of air.
(iii) specific fuel consumption in kg/kWh. (20 marks)

(4) The net power output of the turbine in an ideal reheat-regenerative 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 total feed pump work. Assume 100% isentropic efficiency for turbines. (saturated liquid enthalpy at 7 bar and 0.07 bar are 697 kJ/kgK and 163 kJ/kgK respectively)

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?.

(20 marks)

(5) (i) Give examples for the following types of reactors.

(a) Reactor fuelled with natural uranium.
(b) Reactor fuelled with enriched uranium. (04 marks)

(ii) Explain the characteristic features of BWR. What do you mean by external and internal circulation?. (12 marks)

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

(04 marks)

(6) (i) What is the basic difference between the steam turbine and the reciprocating steam engine?.

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

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

(iv) Compare and contrast the fire tube and water tube boilers.

(05 x 4 marks)

(7) (i) 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)

(iii) Explain with a neat sketch the function of different zones of a combustion chamber of a gas turbine plant.

(10 marks)

(8) (i) Define neutron multiplication factor. How does it vary with the reactor condition. Explain how power level is controlled to achieve desired reactor condition.

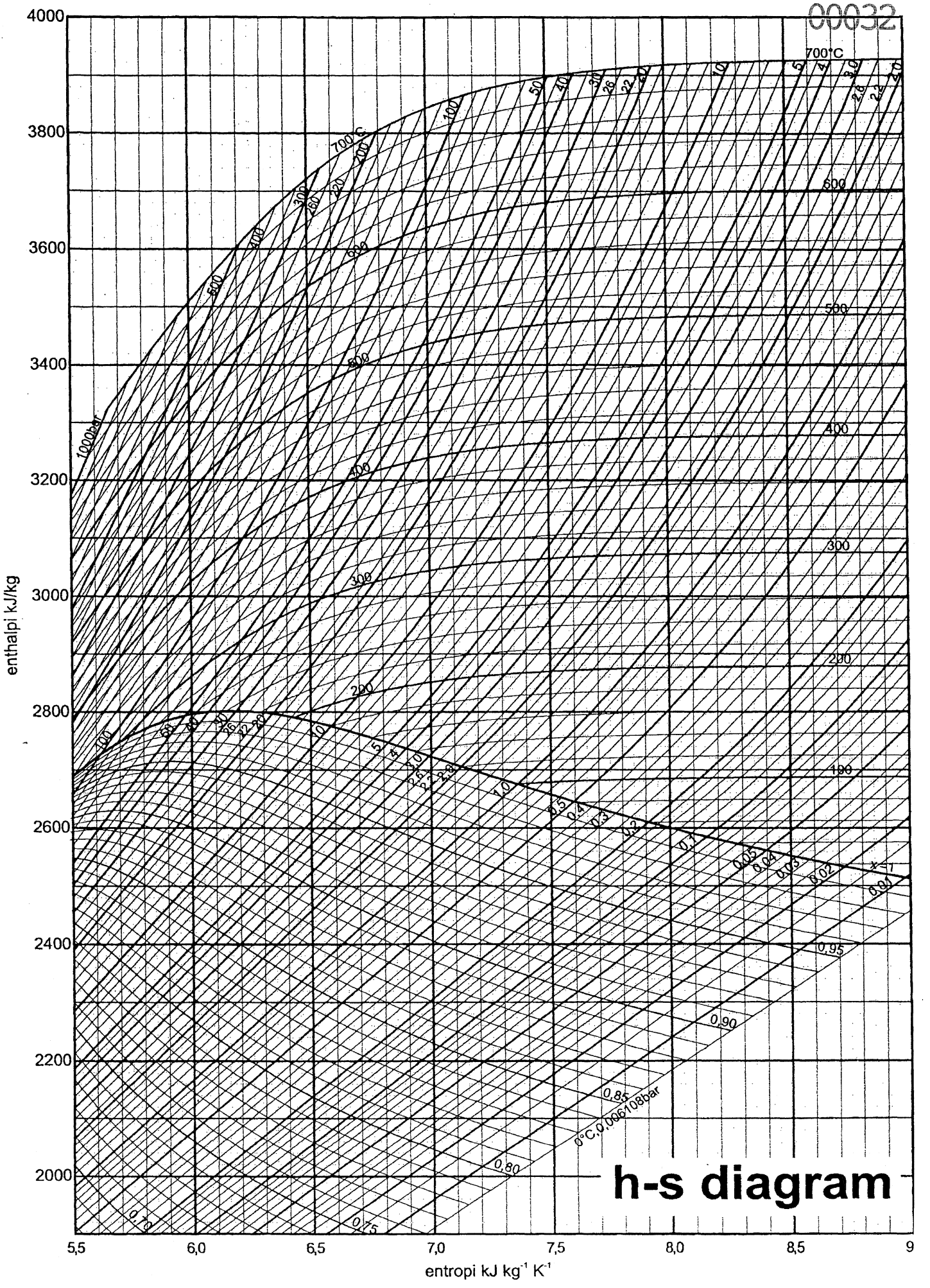
(04 marks)

(ii) A city requires 1800 MWh of electrical energy per day. It is to be supplied by a reactor which converts nuclear energy into electrical energy with an efficiency of 22 percent. If the reactor uses nuclear fuel of U^{235}, calculate the mass of U^{235} needed for one days operation. (08 marks)

(ii) "The principal risks associated with nuclear power arise from health effects of radiation". Comment on this statement. (08 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
700°C
1000bar
0°C,0,006108bar
x=1