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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** (CMEX 6235/MEX 6335)
Academic Year	:	2014/15
Date	:	24th August 2015
Time	:	0930-1230h
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) Name five "Name Plate Indicators" that should be considered when selecting a synchronous generator.

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

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

(iv) A 3-phase, 1500 kVA, star-connected, 50 Hz, 2300 V alternator has a resistance between each pair of terminals as measured by direct current is 0.16 ohms. Assume that the effective resistance is 1.5 times the ohmic resistance. A field current of 70 A produces a short-circuit current equal to full-load current of 376 A in each line. The same field current produces an e.m.f. of 700 V on open circuit. Determine the synchronous reactance of the machine and its full load regulation at 0.8 Power Factor (P.F.) lagging.

(2) (i) List 5 advantages and 5 disadvantages of Hydropower Plants.

(ii) $P = 3\ V_p\ I_p \cos\phi$; where P is the power output, V_p is the phase voltage and I_p is the phase current. Using the phasor diagram, explain what will happen to source voltage (e.m.f.) power factor angle and power angle, when the field current keep on reducing.

(iii) Why is the stator core of an Alternator laminated?

(iv) A 3-phase, star connected alternator is rated at 1500 kVA, 6.6 kV. The armature effective resistance and synchronous reactance are 0.5 ohms and 5 ohms respectively per phase. Find its voltage regulation for (i) unity P.F. (ii) 0.8 lagging P.F. and (iii) 0.8 leading P.F.

PART B

(3) In an open cycle gas turbine plant air at a temperature 30°C 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. The gases coming out from first turbine (compressor turbine) are passed on to the second turbine (power turbine) after reheating to the temperature of 900°C. 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 – 80%
Isentropic efficiencies of turbines – 100%
Combustion efficiency – 93%
Calorific value of fuel used – 43599 kJ/kg
Take C_p = 1.0032 kJ/kgK and γ = 1.4 throughout the cycle .

(i) Sketch the T-S diagram to show all processes.
(ii) What is the optimum pressure ratio for each stage of compression?
(iii) Calculate the temperature of gases coming out from the compressor turbine.
(iv) Determine the reheat pressure.
(v) Calculate the net output of the plant and thermal efficiency of the cycle neglecting mass of fuel supplied to the combustion chamber.
(vi) Estimate the specific fuel consumption of the plant in kg/kWh.

(4) A steam power plant developing 120 MW of electrical output is equipped with regenerative feed heating arrangement consisting of one direct contact type feed water heater. Steam enters the turbine at 8.0 MPa, 600°C and expands to 0.5 MPa, where some of the steam is extracted and diverted to the feed water heater operating at 0.5 MPa. The remaining steam expands through the second-stage turbine to the condenser pressure of 0.02 MPa. Saturated liquid exits the feed water heater at 0.5 MPa. The isentropic efficiency of each turbine stage is 85% and each pump operates isentropically. Assume boiler efficiency and generator efficiency as 90% and 96% respectively.

Neglecting the feed pump work determine the

(a) amount of steam bled off.
(b) thermal efficiency of the plant.
(c) mass flow rate of steam supplied by the boiler.
(d) specific steam consumption.

(Saturated liquid enthalpy of water at 0.5 MPa and 0.02 MPa are 640 kJ/kg and 251 kJ/kg respectively)

(5) (i) Unlike the acute effects, the delayed effects are not observed in all those who are exposed to radiation but will appear years after the exposure. What are the necessary information in order to quantify the delayed effects of radiation?

(ii) Explain genetic effects of radiation and its categories.

(iii) Name the components of a nuclear reactor and briefly describe the functions of the "Reflectors" .

(6) (i) Compare and contrast the fire tube and water tube boilers.

(ii) Explain the function of the following with clear illustrations.

(a) Safety valves and Blow down valves.
(b) Feed water heaters.
(c) Desuperheaters.

(iii) State two advantages of using superheated steam in industrial applications.

(7) (i) The records maintained at a 100 MW diesel power plant indicate the following in respect of the four quarters of the year 2010.

Quarter of the year	Power generated (GWh)	Lost time due to planned/breakdown maintenance	
		Breakdown maintenance (Hours)	Planned maintenance (days)
First	1.05 a	175	
Second	0.95 a	150	
Third	1.24 a	185	
Fourth	1.10 a	190	25

where a – unknown factor
If the effective plant factor of this plant is 0.56, determine:

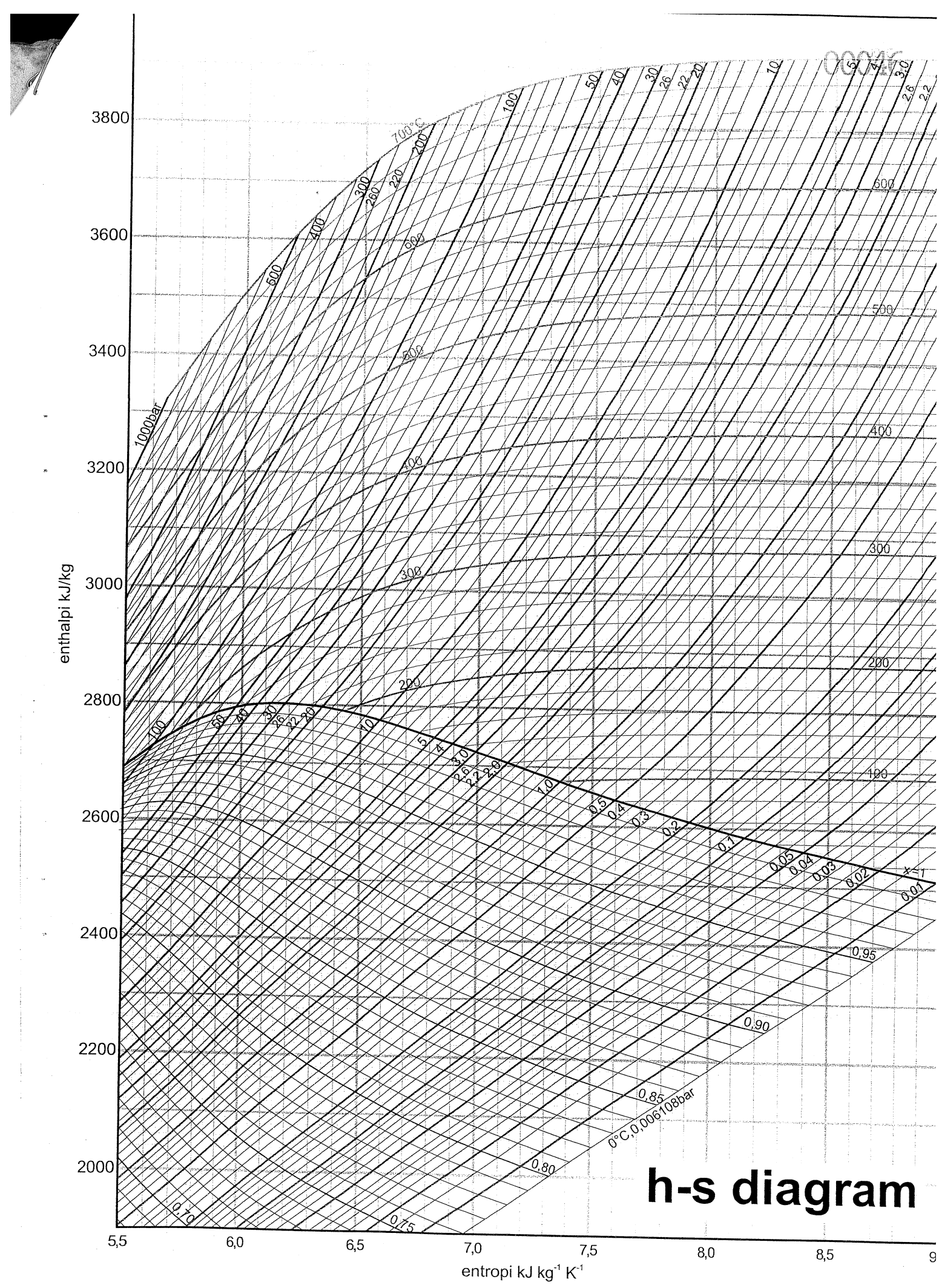
(a) Power generated in each quarter of the year
(b) Gross plant factor
(c) Forced outage rate and
(d) Plant availability

(ii) What are the methods of expressing the "Factor of safety" in boiler usage?. In boiler design and operation it is essential to maintain the working stresses considerably below the ultimate stress. Why?

(8) (i) Name the three main mechanisms of interaction of gamma rays with matter and explain them briefly?

(ii) Some countries in the world reprocessing of nuclear fuel is carried out and one critical issue of this task is to disposing of nuclear waste. Briefly explain the strategies they adopted to prevent these high level nuclear waste from entering the environment.

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h-s diagram
enthalpi kJ/kg
entropi kJ kg⁻¹ K⁻¹
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
5,5
6,0
6,5
7,0
7,5
8,0
8,5
1000bar
700°C
0°C,0,006108bar
x=1
0 x 0