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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION – 2010/2011
THERMAL POWER GENERATION – MEX6335

DATE : 07th MARCH 2011
TIME : 1330 HRS – 1630 HRS
DURATION : THREE HOURS

ANSWER FIVE QUESTIONS ONLY. ALL QUESTIONS CARRY EQUAL MARKS.

(1) A gas turbine power plant of 12 MW capacity working on closed cycle using air as working medium is to be designed for maximum specific work output . Find the cost of energy generated if the plant is running at designed capacity. Use the following data

The temperature of air at inlet	- 30 °C
The maximum temperature in the cycle	- 700°C
Isentropic efficiency of compressor	- 82%
Isentropic efficiency of turbine	- 88%
Mechanical efficiency	- 94%
Generation efficiency	- 94%
Combustion efficiency	- 95%
Effectiveness of regenerator	- 0.7
Cost of fuel	- Rs 16000 per tonne.
Calorific value of fuel used	- 41000 kJ/kg
All other charges including profit per hour	- Rs 12500 per hour

Neglect heat and pressure losses in the system. Take $\gamma = 1.4$ and $C_p = 1.005$ kJ/kgK for air.
For Maximum specific output of the plant, the optimum pressure ratio is given by

$$r_p = \frac{p_2}{p_1} = \left[\eta_c \, \eta_T \, \frac{T_{max}}{T_{min}}\right]^{\frac{\gamma}{2(\gamma-1)}}$$

(20 Marks)

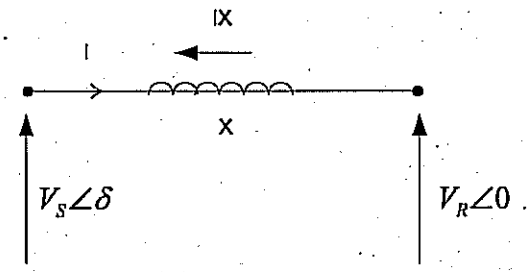
(2) In a cogeneration plant, steam enters the high pressure stage of a two stage turbine at 1 MPa, 200° C and leaves it at 0.3 MPa. At this point some of the steam is bled off and passed through a heat exchanger which it leaves as saturated liquid at 0.3 MPa. The remaining steam expands in the intermediate pressure stage of the turbine to 40 KPa. The turbine is required to produce a total power of 1MW and the heat exchanger to provide a heating rate of 500 kW. Calculate the required mass flow rate of steam into the high pressure stage of the turbine. Take saturated liquid enthalpy at 40kPa and 0.3MPa as 317 and 561 kJ/kg respectively.
Assume

(a) Steady condition throughout the plant
(b) The velocity and gravity terms to be negligible
(c) Both turbine stages are adiabatic with isentropic efficiencies of 0.8
(d) Feed pump work is negligible

(4x5 Marks)

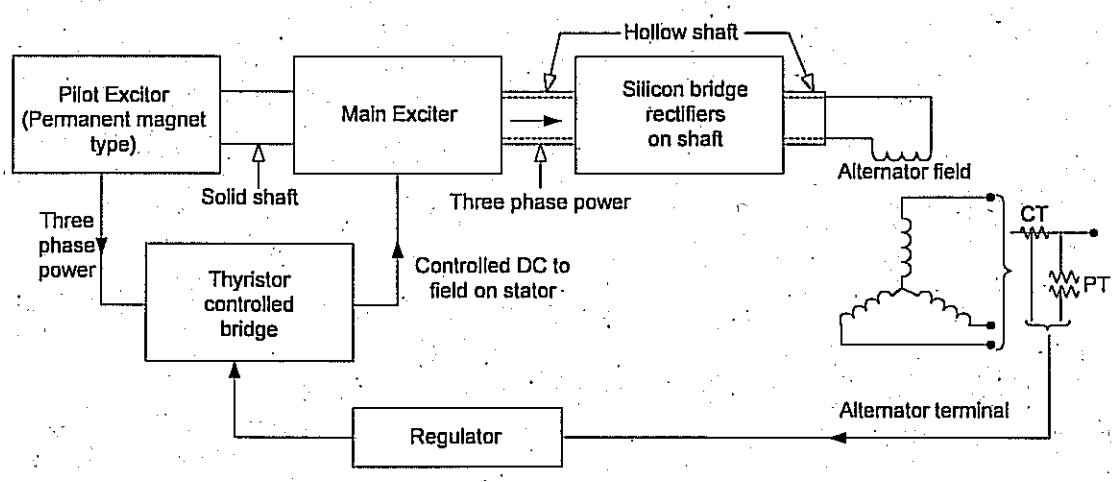
(3) (i) Briefly explain active and reactive power with relation to power factor? (hint: Use power triangle for your explanation)

(ii) Derive the maximum power transfer equation of a transmission line for the system given below. Use phasor diagram and explain each vector.



(iii) What refers to as "Hunting" of an alternating current synchronous generator? Briefly explain how the "Damper" winding can be used to overcome this problem.

(iv) A block diagram of a typical excitation system is given below. Identify the technique and briefly explain the operation.



(4x5 Marks)

(4) i. Describe the functions of safety valves and steam traps used in boilers.
(06 marks)

ii. Where do you usually use vertical tubular boilers? Explain.
(04 marks)

iii. Explain the reasons for fitting blow down valves at the lowest water level.
(05 marks)

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

(5) (i) Discuss the problem of health hazards from nuclear radiation. Briefly enumerate different units of measurement of radiation.

(16 marks)

(ii) What is understood by the "redundancy" in a safe reactor design?

(04 marks)

(6) (i) Describe a nuclear power plant which employs a pressurised water reactor. In which aspects does a boiling water reactor differ from a pressurised water reactor?

(10 marks)

(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?.

(10 marks)

(7) (i) "Steam turbines are sometimes required to operate at reduced power or at power greater than the normal service power rating"
What are the mechanisms that can be adopted to operate steam turbines at these levels?.

(10 marks)

(ii) Explain the difference between the design safety factor and the operating safety factor in a boiler using a numerical example.

(10 marks)

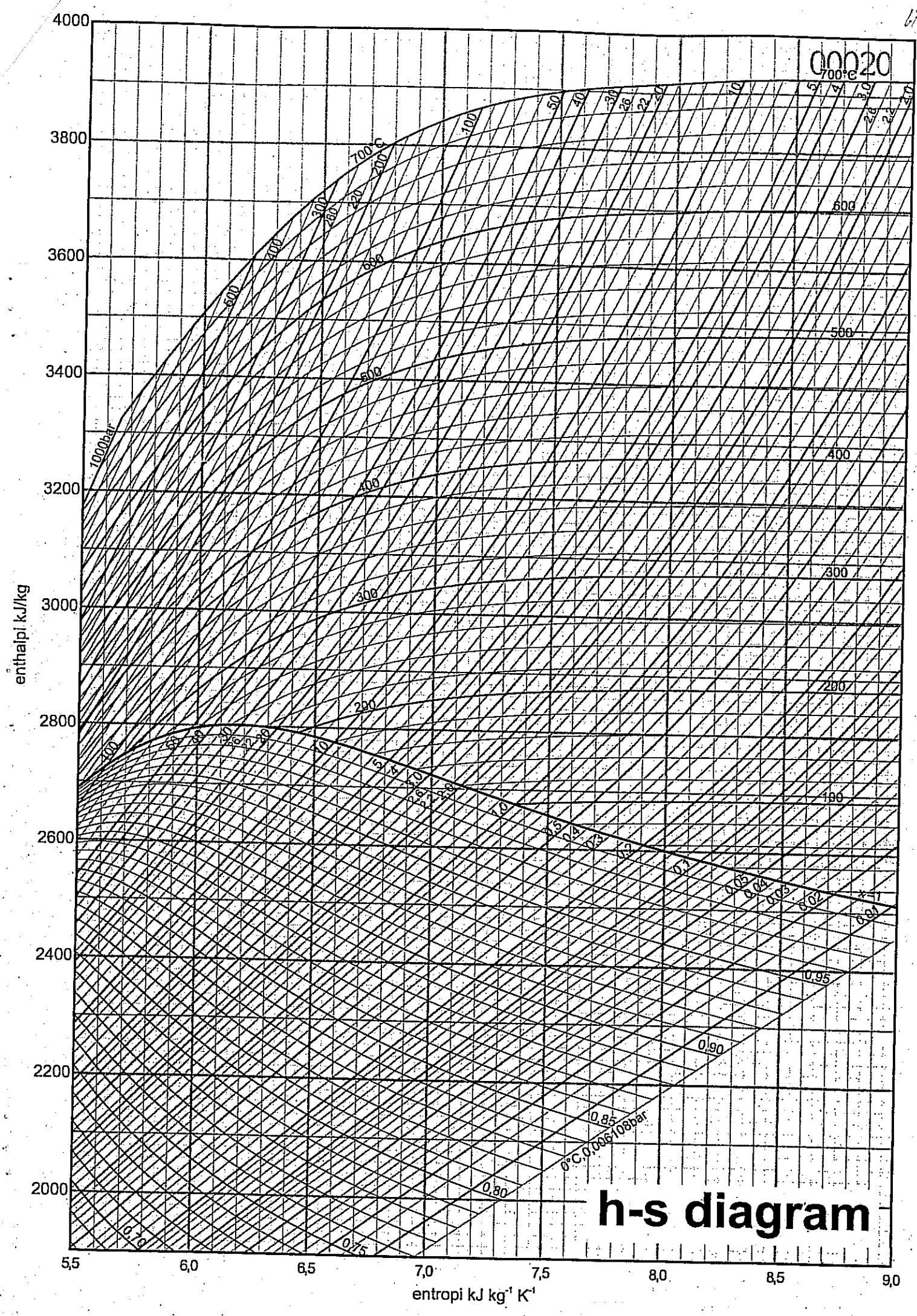
(8) (i) Discuss the various factors to be considered while selecting a site for nuclear power station.

(10 marks)

(ii) List four major pollutants due to thermal power plant operation. What are the negative impacts of each of them to the ecosystem? List at least one remedial measure to overcome the severity of each pollutant you mentioned above?

(10 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
700°C
1000bar
0°C,0,006108bar
0,80
0,85
0,90
0,95
x=1