THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION – 2009/2010
THERMAL POWER GENERATION – MEX6335

DATE : 08th MARCH 2010
TIME : 1330 HRS – 1630 HRS
DURATION : THREE HOURS

ANSWER FIVE QUESTIONS ONLY. ALL QUESTIONS CARRY EQUAL MARKS.

(1) (i) A thermal power plant of rated capacity 100 MW had a effective plant factor of 0.640 during its operation in a particular year. The plant had a scheduled maintenance period of 30 days in addition to 740 hrs of down time due to breakdown in the same year. The plant use coal as the fuel and the coal consumption is 1 kg per kWh energy generated and the cost of coal is Rs 9000 per tonne.

Calculate ,

(a) average sent out capacity of the plant.
(b) total power generated
(c) the annual revenue earned if energy is sold at Rs 15 per kWh

(15 marks)

(ii) What are the considerations to be made while selecting a suitable site for a thermal and a nuclear power plant?.

(05 marks)

(2) A gas turbine set having a heat exchanger gave the following data at the design speed.

Isentropic efficiency of the compressor – 80%
Isentropic efficiency of the turbine – 85%
Combustion efficiency – 95%
Mechanical transmission efficiency – 98%
Pressure ratio - 5 : 1
Mass flowrate – 20kg/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) the power output
(ii) specific fuel consumption
(iii) thermal efficiency of the cycle

Assume no pressure loss in heat exchanger and combustion chamber. Take
Cv of fuel - 43500 kJ/kg
Cp – 1.15
γ - 1.4 during compression
γ - 1.35 during heating and expansion

(20 marks)

(3) (i) Explain the characteristic features of a fire tube boiler. How does it differ from a water tube boiler?.

(10 marks)

(ii) What is blow down?. Why is it needed?.

(05 marks)

(iii) What is the function of air preheater?. How does air preheating save fuel?.

(05 marks)

(4) (i) What are the differences between a feed water heater and an economiser?.

(05 marks)

(ii) Steam at 70 bar and 450°C is supplied to a steam turbine. After expanding to 25 bar in high pressure (HP) stage, it is reheated to 420°C at the constant pressure. Next it is expanded in intermediate pressure stage to an appropriate minimum pressure such that part of the steam bled at this pressure heats the feed water to a temperature of 180°C in an open feed water heater. The remaining steam expands from this pressure to a condenser pressure of 0.07 bar in the low pressure (LP) stage. Assume that HP, intermediate and LP turbine stages are having 100% isentropic efficiency.

Determine,
(i) the minimum pressure at which bleeding is necessary
(ii) the quantity of steam bled per kg of flow
(iii) the cycle efficiency

Neglect the feed pump work. h-s chart is provided.

(15 marks)

(5) (i) How does a steam turbine convert energy in steam to shaft work?.

(10 marks)

(ii) What is the important characteristic that distinctly highlights a good burner design?.

(03 marks)

(iii) Explain 'fluidised bed combustion as applied to burning of coal.

What are the advantages of this method of combustion over the others?.

(07 marks)

(6) (i) What is a CANDU reactor? Explain its main features using a sketch. What is a calandria?.

(10 marks)

(ii) Give a brief comparison between a nuclear and conventional thermal power station, in respect of

(a) Capital cost
(b) Fuel cost
(c) Operating and overhead cost

(10marks)

(7) (i) A city requires 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 20 percent. If the reactor uses nuclear fuel of U^{235}, calculate the mass of U^{235} needed for one days operation.

(10 marks)

(ii) Discuss the problem of health hazards from nuclear radiation. Briefly enumerate different instruments used in nuclear power plant to measure radioactive dose.

(10 marks)

(8) (i) Write a note on the nuclear fuel cycle, explaining in detail the different stages of the cycle.

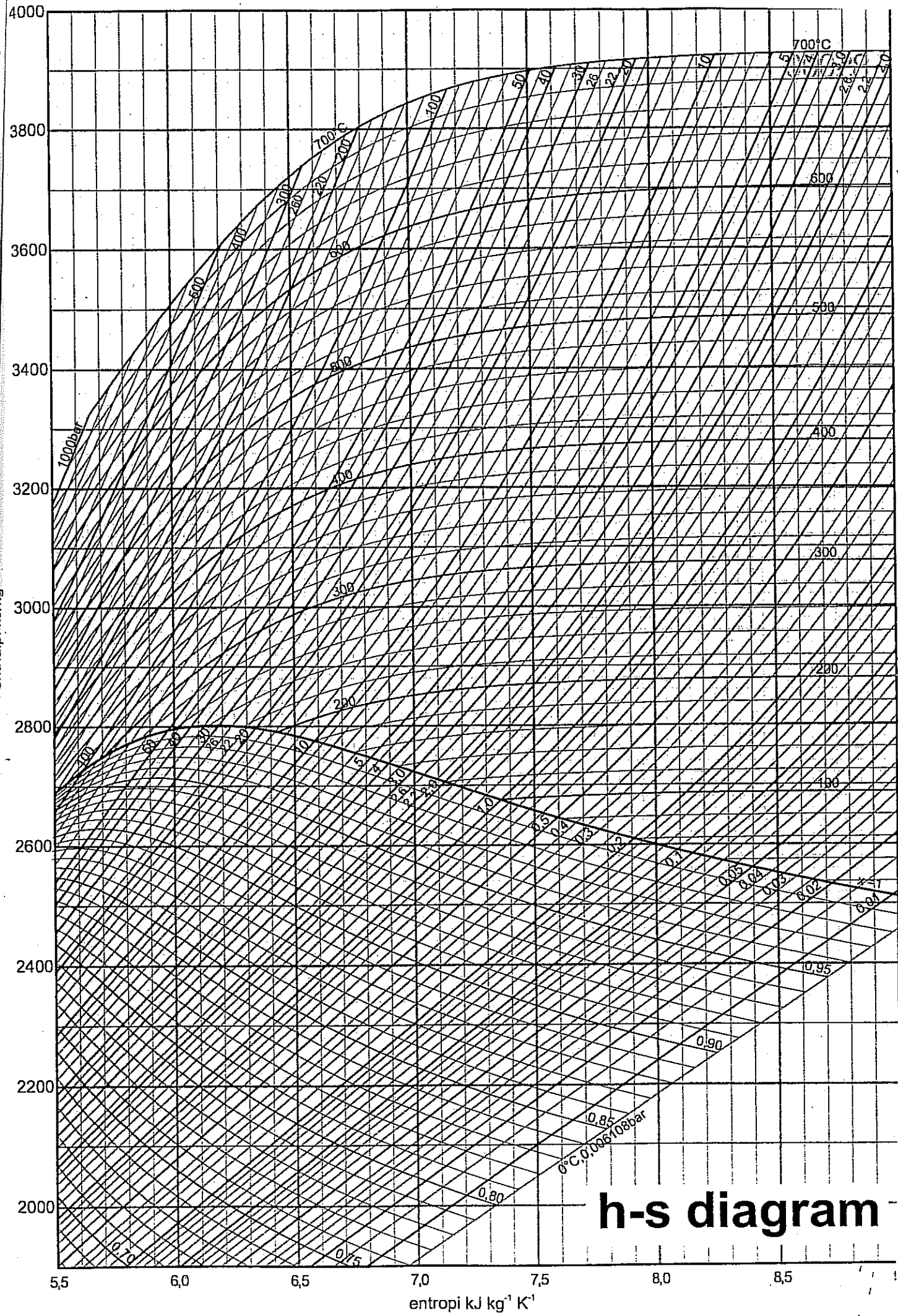
(10 marks)

(ii) Explain the functions of

(a) reflector
(b) control rods
(c) thermal shield
(d) biological shield
(e) containment building of a nuclear reactor plant.

(10 marks)

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h-s diagram
entropi kJ kg⁻¹ K⁻¹
entalpi kJ/kg
0°C,0,006108bar
1000bar
700°C
5,5
6,0
6,5
7,0
7,5
8,0
8,5
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000