

THE OPEN UNIVERSITY OF SRI LANKA  
FACULTY OF ENGINEERING TECHNOLOGY  
BACHELOR OF TECHNOLOGY – LEVEL 06  
FINAL EXAMINATION – 2005/2006  
THERMAL POWER GENERATION – MEX6335/MEU4305



039

DATE : 10<sup>TH</sup> APRIL 2006  
TIME : 0930 HRS – 1230 HRS  
DURATION : THREE HOURS

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ANSWER FIVE QUESTIONS ONLY. ALL QUESTIONS CARRY EQUAL MARKS. YOU MAY OBTAIN TABLES OF THERMODYNAMICS AND TRANSPORT PROPERTIES OF FLUIDS OR MOLLIER DIAGRAM ON REQUEST.

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- (1) i. Thermal plants can be broadly classified into three groups, based on the operating principles. What are these groups?. Explain. (06 marks)
- ii. What are the types of thermal plants suitable for daily peaking duties?. Explain. Discuss why certain types of thermal plants are not capable for daily peaking operations. (08 marks)
- iii. What is Cogeneration?. How does it save money?. (06marks)
- (2) i. Compare and contrast the fire tube and water tube boilers. Write an account of the classification of the fire tube boilers. (06 marks)
- ii. What type of boiler should be used in applications where high pressure and high capacities are required?. Give reasons. (05 marks)
- iii. Why are the following components used in water tube boilers?. (09 marks)
- (a) Baffles
  - (b) Economisers
  - (c) Reheaters.
- (3) A factory requires 2250 kW from its electric motors for driving machinery, 15,000 kW of heat at a temperature of 139 °C from process steam. Two alternative options are considered.

Option I

The power is taken from the main electricity grid with an overall thermal efficiency from fuel to motors of 20%. The process steam is raised in a special boiler plant with an overall efficiency of 80%. (04 marks)

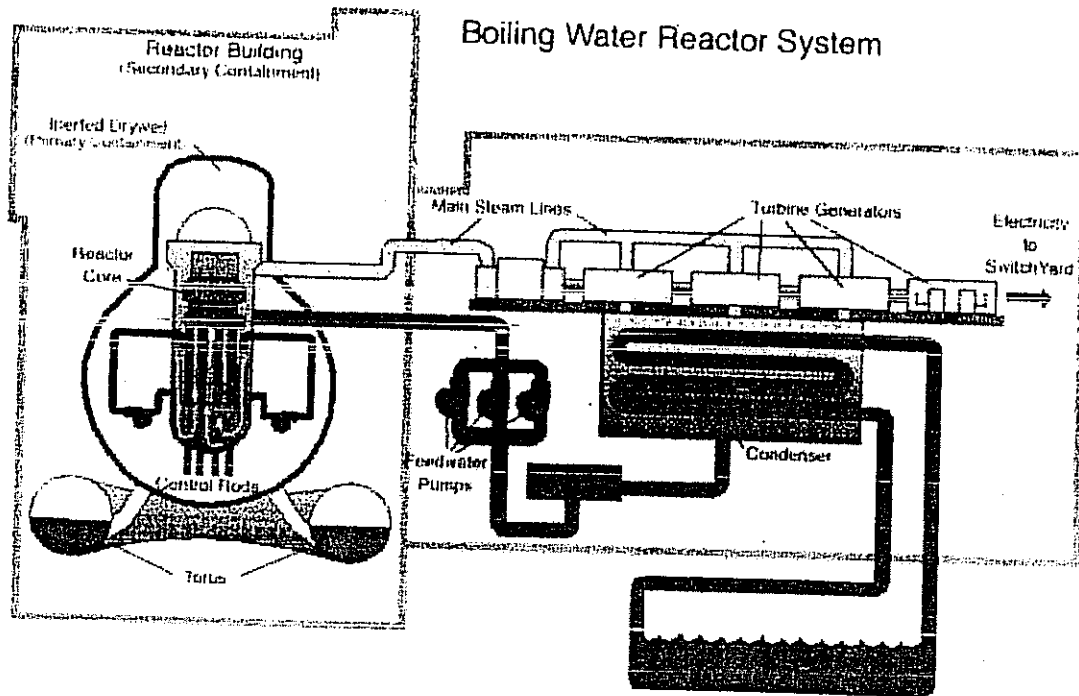
### Option II

The power is generated in the factory's steam power plant; the initial steam conditions are 27 bar and 320 °C and the condenser temperature is 29 °C. The overall efficiency from turbine rotor output to electric motor output is 70%. The internal isentropic efficiency of the turbine is 80%; the boiler efficiency is 85%. Process steam is obtained by bleeding off the required amount of steam from the appropriate intermediate stage of the turbine. Neglect the feed pump work.

Estimate the relative merits of the two options from the point of view of fuel economy. (16 marks)

- (4) i. How can steam turbines be classified? (04 marks)
- ii. Discuss the differences between operating principles of impulse type and reaction type steam turbines. (08 marks)
- iii. How is velocity compounding is accomplished in an impulse turbine? (08 marks)
- (5) 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 an High Temperature Gas cooled Reactor (HTGR) before expanding through the turbine. The pre-cooler returns the hot turbine exhaust to the temperature at the compressor inlet. Assume 2% pressure loss through both the HTGR and the pre-cooler and that the turbine is to be 85% efficient and the compressor is 85% efficient. (Assume for helium,  $C_p = 5.1926 \text{ kJ/kgK}$ , Ratio of specific heats = 1.667 ) Determine,
- i. the temperature at the end of compression and expansion.
- ii. the heat supplied, the heat rejected and the net work per kg of helium.
- iii. the thermal efficiency.
- iv. the flow rate if the plant is to have a net output of 1000 MW. (20 marks)
- (6) i. Write an account of the "Levels of Safety" of a nuclear power plant. Explain how accidents occurred in nuclear power plants in the past despite the enforcement of tight safety measures. (12 marks)
- ii. Write short notes on the following parameters encountered in nuclear reactor technology. (08 marks)
- (a) Neutron multiplication factor
- (b) Photo electric effect
- (c) Inelastic scattering
- (d) Pair production

- (7) Figure shows the concept of Boiling Water Reactor (BWR). Discuss constructional and operational functions of BWR. You may include similarities and dissimilarities compared with other types of reactors in your answer. (20 marks)



- (8) i. What is the reason for using moderators?. Why isn't it possible to use natural uranium as a fuel in reactors moderated by light water?. (05 marks)
- ii. Explain how the Pressurized Water Reactors are refueled while in operation. What are the advantages of on load refueling?. (05 marks)
- iii. Explain the difference between external and internal exposure to radiation. (05 marks)
- iv. What is meant by "nuclear fuel cycle"?. Discuss. (05 marks)

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