

**THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION – 2008/2009
THERMAL POWER GENERATION – MEX6335**



DATE : 17th MARCH 2009
TIME : 0930 HRS – 1230 HRS
DURATION : THREE HOURS

035

ANSWER FIVE QUESTIONS ONLY.
ALL QUESTIONS CARRY EQUAL MARKS.
YOU MAY OBTAIN TABLES OF THERMODYNAMICS AND TRANSPORT PROPERTIES OF FLUIDS OR ENTHALPY-ENTROPY CHART ON REQUEST.

- (1) (i) The records maintained at a 110 MW diesel power plant indicate the following in respect of a particular year.
- Total power generated – 400 GWh
 - Duration of planned maintenance - 24 days

Period	Lost time due to breakdown maintenance (Hours)
January – March	140
April – June	165
July – September	130
October – December	95

Calculate

- (a) Gross plant factor
(b) Net plant factor
(c) Availability of the plant.

(08 marks)

- (ii) In a power plant terminology, what do you mean by combined cycle operation?. Does Cogeneration make sense?. If yes, explain briefly.

(05 marks)

- (iii) What are the types of thermal plants suitable for daily peaking duties?. Discuss the reasons for certain types of thermal plants that are incapable of daily peaking operations.

(07 marks)

- (2) (i) Describe the gas turbine power cycle comparing with other power cycles used in electricity generation. How could the efficiency of gas power cycle be improved?

(08 marks)

- (ii) In a gas turbine plant compression is carried out in two stages with perfect inter cooling and expansion in one stage turbine. If the maximum temperature (T_{\max} K) and minimum temperature (T_{\min} K) in the cycle remain constant, show that for maximum specific output of the plant, the optimum overall pressure ratio is given by

$$r_{opt} = \left[\eta_T \eta_C \frac{T_{\max}}{T_{\min}} \right]^{\frac{2\gamma}{3(\gamma-1)}}$$

γ - Adiabatic index

η_T - Isentropic efficiency of the turbine

η_C - Isentropic efficiency of compressor

(12 marks)

- (3) (i) What is 'excess air' and why is it required for 'combustion' in a boiler?

(05 marks)

- (ii) What is the function of 'draft' in a boiler? Enumerate the different types of draft available for a boiler?

(10 marks)

- (iii) Why boiler blow-down is required?

(05 marks)

- (4) (i) Why is superheating of steam essential in a steam power plant?

(05 marks)

- (ii) It has been decided to operate a steam power plant with a relatively high condenser pressure of 8 bar, so that the condenser cooling water can be used for a process heating scheme. The steam pressure and temperature at exit from the boiler plant are 100 bar and 600 °C respectively. If 500 MW are required for process heating calculate the rate of steam required to flow through the condenser. Assuming that the plant operates on the ideal Rankine cycle, determine the power output from the plant. Include feed pump work in your calculations.

The plant is a part of a nuclear power station and the heating fluid for the steam boiler is carbon dioxide gas. The gas having value of C_p equal to 1.14 kJ/kgK enters the boiler at 620 °C and leaves at 310 °C with negligible change of kinetic energy. Calculate the rate of flow of carbon dioxide required.

(15 marks)

- (5) (i) What are the two main types of steam turbines?. Explain the differences between their operating principle. (10 marks)
- (ii) What is the important characteristic that distinctly highlights a good burner design?. (03 marks)
- (iii) Briefly explain the important factors which must be taken into consideration in designing the combustion chambers of gas turbine plants. (07 marks)
- (6) (i) Explain the concept of a nuclear power plant on the basis of 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?. (10marks)
- (7) (i) Discuss the problem of health hazard from nuclear radiation. Briefly enumerate different instruments used in nuclear power plant to measure radioactive dose. (12 marks)
- (ii) What do you understand by the "redundancy" in a safe reactor design?. (08 marks)
- (8) (i) Write a note on the nuclear fuel cycle, explaining in detail the different stages of the cycle. (10 marks)
- (ii) What are the main mechanisms of interaction of gamma rays with matter?. Explain. (10 marks)

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