THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION – 2007/2008
THERMAL POWER GENERATION – MEX6335

DATE : 18th MAY 2008
TIME : 0930 HRS – 1230 HRS
DURATION : THREE HOURS

028

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

(1) (i) Thermal power plant of rated capacity 65 MW had an "availability" of 92% and a gross plant factor of 0.4 during its operation in a particular year. The plant had scheduled maintenance hours of 10% of the total hours available for power generation in the year. In addition certain number of down time hours was observed due to breakdowns in the same year.

Calculate,
(a) Total time lost due to breakdowns
(b) Total power generated in the year
(c) Net plant factor of the plant. (12 marks)

(ii) 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. (08 marks)

(2) (i) Describe with sketches the working of a simple constant pressure open cycle gas turbine. What methods are adopted for improving the thermal efficiency? Explain your answer.
(08 marks)

(ii) A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610 °C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively.

(a) Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 16kg/s and the efficiency of electric generator is 60%.

Take $C_p = 1.005$ kJ/kgK and $\gamma = 1.4$ for the compression process and take $C_p = 1.11$ kJ/kgK and $\gamma = 1.333$ for the expansion process.
(08 marks)

(b) Calculate the thermal efficiency and work ratio of the plant assuming that Cp for the combustion gas is 1.11 kJ/kgK
(04 marks)

(3) 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)

(4) A trial was done in a steam power plant to investigate the effects of superheating the steam to a higher temperature and raising the boiler pressure on efficiency of the power plant.

Steam enters the turbine at 3MPa and 350°C and is condensed in the condenser at a pressure of 10 kPa. Determine,

(i) thermal efficiency of this power plant. (05 marks)

(ii) thermal efficiency if steam is superheated to 600 °C instead of 350 °C (05 marks)

(iii) thermal efficiency if the boiler pressure is raised to 15 MPa while the turbine inlet temperature is maintained at 600 °C. (05 marks)

(vi) What conclusions can be made from the results? (05 marks)

(5) (i) Describe the two main types of steam turbines and their operating principles with clear illustrations. (10 marks)

(ii) Explain in detail , pressure compounding and velocity compounding as applied to steam turbine. (10 marks)

(6) (i) What are the main components of a nuclear reactor? Briefly describe each of them. (10 marks)

(ii) Write an account of Boiling Water Reactors (BWR), discussing their core construction, moderators, control and cooling features. (10 marks)

(7) (i) Describe the main mechanisms by which alpha particles, beta particles and gamma rays interact with matter (08 marks)

(ii) What is meant by fissile fuel and fertile fuel? Explain the reaction involved in the conversion of the fertile isotope Th - 232 and U - 238 to fissile isotopes U - 233 and Pu - 239 respectively. (12 marks)

(8) (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)

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