

B.E. (EE) Part-IV 8th Semester Examination, 2006

**Thermal Power Plant**  
**(Elective-III) (ME-806/2)**

Time : 3 hours

Full Marks : 100

Use separate answerscript for each half. Answer  
SIX questions, taking THREE from each half.  
The Questions are of equal value. Use of Steam  
table & Mollier Diagram allowed.

FIRST HALF

1. a) Define 'net heat rate' for a power plant. Estimate the net heat rate for a coal fired unit which has an overall efficiency of 40%. If the unit supplies 210 MW net power to the grid, what will be its auxiliary consumption and auxiliary efficiency if the boiler thermal efficiency is 92%, the cycle efficiency is 50%, turbine mechanical efficiency is 94% and generator efficiency is 96%?  
b) Why a Deaerator is required in a steam power plant? How does it differ from a feed water heater?
2. a) Discuss the process of 'natural circulation' in a drum type boiler and mention the factors on which it depends. What is 'circulation ratio'? For a boiler the furnace walls are 18 m high and they receive saturated water from down comer at 90 bar. Assuming a circulation ratio of 12, calculate the pressure head of natural circulation .  
b) Briefly discuss, with the help of a suitable diagram, the balanced draught system for a boiler.
3. a) Why steam temperature control is important in a power boiler and what are the factors that affect the superheat steam temperature? Briefly discuss different types of desuperheaters generally employed in a power plant boiler.  
b) With a neat schematic, describe the control philosophy for a spray desuperheater.
4. a) Mention the shortcomings of a single-element drum level control system and state how they are overcome in a three-element drum level control system. Give a neat sketch of three-element control.  
b) With a neat diagram describe the hot well level control for a steam power plant.

5. Write short notes on any three :
- B.M.S
  - Sliding pressure control for steam power plant
  - Cross-limited combustion control
  - Gas by-pass control of steam temperature
  - Forced circulation in boilers.

### SECOND HALF

6. a) When does reheating of steam become necessary? Explain the effect of re heat on cycle output and efficiency.
- b) Steam at 150 bar and 500°C is supplied to a steam turbine. It expands to 40 bar and 300°C. It is then reheated to 480°C and expands to 8 bar and 280°C. The steam coming out from the second expansion of the turbine is further reheated to 480°C and expands to a condenser pressure of 0.06 bar. The steam entering into the condenser is dry saturated. Assume pressure loss in the first and second heater as 1 bar and 0.5 bar respectively. Obtain the following:
- thermal efficiency of the cycle and power developed if the flow of steam is 8.5 kg/sec, through the turbine and
  - the isentropic efficiencies of the expansion stages.
- Neglect pump work.
7. a) What are the applications of diesel electric power plants?
- b) Enumerate the merits and demerits of diesel engine power plants.
- c) The average indicated power developed in a CI engine is 12.9 kW/m<sup>3</sup> of free air induced per minute. The engine is a 4 litre four stroke engine running at 3500 rpm with a volumetric efficiency of 80% referred to free air conditions of 1.01325 bar and 20°C.
- It is proposed to fit a blower, driven mechanically from the engine. The blower has an isentropic efficiency of 71% and works through a pressure ratio of 1.73. Assume that at the end of induction the cylinders contain a volume of charge equal to the swept volume, at the pressure and temperature of the delivery from the blower. Calculate the increase in brake power to be expected from the engine. Take all mechanical efficiencies as 78%.

8. a) Draw a schematic diagram of a bubbling fluidized bed boiler and explain how it operates. State its advantages, b) Discuss in detail, the advantages of a CFB boiler.

9. a) An input-output curve, of a 12MW power station is expressed as follows :

$$I = (12 + 8L + 0.3L^2) \times 10^6, \text{ where } I$$

is in kJ/hour and L is in MW.

- i) Find the load at which the maximum efficiency occurs, without plotting any curve.  
 ii) Find the increase in input required to augment station output from 5 kW to 7 kW by means of the input output-curve and also by incremental rate curve.

- b) The following data relates to a 12MW power station :

Cost of plant	Rs. 1100 per kW
Interest, insurance and taxes	5% per annum
Depreciation	4%
Cost of primary distribution	Rs. 6,00,000
Interest, Insurance, taxes and depreciation	5%
Cost of coal including transportation	Rs. 40 per tonne
Operating cost	Rs. 4,50,000
Plant maintenance cost	
i) Fixed	Rs. 22,000 per annum
ii) Variable Installed	Rs. 25,000 per annum
plant capacity Maximum	12MW
demand Annual load factor	11MW
Consumption of coal	0.65
Determine the following :	25,000 tonnes

- i) Cost of power generation per kW per year  
 ii) Cost per kWh generated  
 iii) Total cost of generation per kWh.

10. Write short notes on any three of the following :-

- a) Different systems of solid injection in Diesel Engine power plant.

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- b) Pressurized Water Reactor (PWR)
- c) Disposal of bled steam condensation
- d) Advantages and disadvantages of gas turbine over diesel and steam power plants
- e) Characteristic features of a Boiling Water Reactor (BWR).