

B. Power Engineering 3RD YR 1ST SEM. EXAMINATION – 2019**Subject: Steam Generator****Time: 3 hours****Full Marks: 100**

Brief and to the point answer will be credited. Sketches should be drawn neatly along with labeling.

GROUP – A (15 Marks)

1. Answer any **three** questions **3×3=9**
 - a) Write three differences between a fire tube and a water tube boiler.
 - b) What are the differences between field-erected and packaged boilers? Which of these types is the utility steam generator?
 - c) When does a natural circulation boiler cease to work and why?
 - d) How do you classify coal fired steam generators based on coal firing methods? Which of these types is most commonly found in Indian Thermal Power Stations?
 - e) When is the slagging bottom furnace used in a steam generator and why?

2. Answer any **one** question **6**
 - a) Draw a schematic diagram to show the air and flue gas flow path layout of a steam generator with balanced draft.
 - b) Differentiate between Tower type layout and Two pass layout of steam generators.

Group – B (20 Marks)

3. Answer any **two** questions **5×2=10**
 - a) What is proximate analysis of coal and how does it differ from ultimate analysis? What is the importance of these analyses in a thermal power plant firing coal?
 - b) What is unit system of pulverization of coal and what are the advantages and disadvantages of this system?
 - c) What is tangential firing of pulverized coal? What are the advantages of this firing system?
 - d) With a sketch explain the working of cyclone firing of coal.

4. Answer any **one** question **10**
 - a) The ultimate analysis of an air-dried coal sample gives C: 55%, H₂ : 2.8%, O₂ : 5.6%, N₂ : 1.5% and rest ash. If the air-dried coal is burnt in 25% excess air, find out the air-fuel ratio of the reactant mixture by mass.
 - b) With the help of a neat schematic, explain the working of a circulating fluidized bed boiler and discuss its merits and demerits.

GROUP – C (30 Marks)

5. Answer any **five** questions **6×5=30**
 - a) Describe the working principle of a low NO_x burner using suitable sketch.
 - b) What are the functions of steam drum? Illustrate the utility of blow down from the steam drum.
 - c) Discuss the constructions of different types of water wall tubes in steam generator.
 - d) Discuss two methods of main steam temperature control in steam generator.
 - e) Explain how flue gas desulfurization is done in steam generator.

- f) What is slagging in steam generator and what are its effects? Which property of coal gives the indication of slagging?
- g) Explain the differences between convective and radiative superheaters and justify the reason behind combining them.

GROUP – D (15 Marks)

6. With a neat sketch show the different regimes of forced flow boiling in a vertical tube due to uniform incident heat flux on the outer wall. Using it, discuss the phenomenon of dry out in the tube. 10
7. Answer any **one** question 5
- a) What do you mean by DNB? When can it happen in the steam generator?
- b) How does circulation ratio of a steam generator depend on steam pressure?

GROUP – E (20 Marks)

8. Answer any **one** question 20
- a) Feedwater enters the economizer of a power station steam generator at 180 bar 230 °C and leaves as saturated water. The flue gas flow rate is measured to be 3.3×10^4 kg/min and the temperatures of the flue gas entering and leaving the economizer coil are 500 °C and 340 °C, respectively. The overall heat transfer coefficient based on the inside area of the economizer tube is 80 W/m² K. If the velocity of water leaving the economizer is 1 m/s and the internal diameter of the tube is 60 mm, find out the number of coils in the economizer and the length of one coil. Take specific heat of flue gas as 1.1 kJ/kg °C. If the vertical pitch of the coils is 80 mm, thickness of the tube is 5 mm and the clearance on the two sides of the duct having width 7.5 m is 6 mm, find the vertical height of the economizer.
- b) In a boiler trial following observation have been made:
- Ultimate analysis of moisture free coal: C – 58%, H – 3%, O – 6.2%, N – 1% and rest ash. The analysis of dry flue gas at the boiler exit gives CO₂: 14.2% and CO: 0.9%. Free moisture in the as fired coal is 4%, carbon in refuse is 1.5% and excess air supplied is 20%. If the flue gas leaves at 140 °C and the ambient temperature is 30 °C, determine the dry flue gas loss per kg of coal fed. Take the specific heat of dry flue gas as 1.1 kJ/kg-K. If the calorific value of air-dried coal is 19500 kJ/kg, determine the percentage loss due to incomplete combustion and unburnt carbon. The heat liberated in forming CO₂ and CO from carbon are 393.8 MJ/kmol and 110.6 MJ/kmol respectively.