

|       | Use of steam Table is allowed                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Marks |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|       | <b>CO1 (25 marks)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| 1 (a) | State the advantages and disadvantages of high pressure utility boiler                                                                                                                                                                                                                                                                                                                                                                                                          | 3+2   |
| (b)   | Show the water-steam circuit of a high pressure utility boiler with block diagram. Consider three stages of superheaters.                                                                                                                                                                                                                                                                                                                                                       | 6     |
| (c)   | Sketch and label a $\Pi$ shaped once through steam generator showing all the heat transfer surfaces.                                                                                                                                                                                                                                                                                                                                                                            | 14    |
|       | OR                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
|       | What do you mean by equivalent evaporation?                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2     |
|       | Calculate equivalent evaporation from the following parameters:                                                                                                                                                                                                                                                                                                                                                                                                                 | 12    |
|       | Main steam: flow rate 670 TPH, pressure 135 bar, temperature 540°C. Feed water temperature 247°C.                                                                                                                                                                                                                                                                                                                                                                               |       |
|       | Cold reheat flow 600 TPH, pressure 30 bar, temperature 325°C, hot reheat temperature 540°C. Drum pressure 140 bar. Blowdown: 1% of main steam flow rate                                                                                                                                                                                                                                                                                                                         |       |
|       | <b>CO2 (25 marks)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| 2.(a) | On a creep curve show the short creep, long creep and accelerated creep zone.                                                                                                                                                                                                                                                                                                                                                                                                   | 2+5   |
| (b)   | Briefly describe about the factors are to be considered for selecting material for boiler pressure parts.                                                                                                                                                                                                                                                                                                                                                                       | 8     |
|       | Write a short note on the constituent of boiler tube material and their properties.                                                                                                                                                                                                                                                                                                                                                                                             | 10    |
|       | OR                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
|       | What do you mean by fatigue strength and creep strength? What is the creep limit for boiler steel tube?                                                                                                                                                                                                                                                                                                                                                                         | 4+1   |
|       | An alloy steel steam drum works under 75 Kg/ cm <sup>2</sup> g pressure. Drum inside diameter is 1524 mm, tube hole diameter- 57.2 mm, longitudinal pitch of tube hole-101.6 mm, circumferential pitch of tube hole 7.15°, Corrosion allowance as per code – 0.762 mm Et =Yield point stress (0.2 % proof stress) at temperature 300°C =315 N / mm <sup>2</sup> and at 350° C =306 N / mm <sup>2</sup> R = Minimum tensile stress at room temperature = 595 N / mm <sup>2</sup> | 15    |
|       | Calculate: i) design stress value to be adopted ii) ligament efficiency in longitudinal and circumferential direction, iii) desired drum thickness before and after stress value correction                                                                                                                                                                                                                                                                                     |       |

| CO3 (25 marks) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                            |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| 3 (a)          | Why proximate analysis for the coal used in Pulverized fuel boiler is important, when ultimate analysis of same coal is available? Write in detail.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 5                                          |
| (b)            | <p>A steam generator operates under following condition. Determine its thermal efficiency. (Coal Composition by wt %): Carbon-60.0%, Hydrogen -4.0%, Oxygen- 3.0%, Nitrogen - 2.0%, Sulfur- 1.0%, Moisture- 5.0% and ash-25%. GCV of coal = 23.8 MJ/kg, Other Parameters: Air Moisture = 0.014 Kg/Kg of dry air<br/>Excess Air = 20%, backend temp.- 125°C, backend gas pressure- 0.08 bar, Air inlet temperature - 25°. Un-burnt carbon Loss (UBC) = 1% of GCV, Radiation Loss – 0.3 % of GCV, Minor loss – 0.2 % of GCV, GCV of Carbon – 33820 KJ/kg, Specific Heat of Flue Gas – 1.05 KJ/kg °C<br/>If 680 TPH steam at 140 bar pressure and 540°C temperature is produce from feed water of 240°C using above coal, calculate the amount of coal required?</p> <p style="text-align: center;"><b>OR</b></p> <p>State the location of deposits in boiler and the harmpul effects of that.<br/>What measures are taken to minimise scale formation and corrosion in boiler tubes?<br/>What is condensate polishing. In which type of boiler it is necessary and why?</p> | <p>20</p> <p>5+5<br/>7<br/>8</p>           |
| CO4 (25 marks) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                            |
| 4.(a)          | Certain coal having GCV of 18 MJ/KG contain 3% Hydrogen and 5% moisture is to be fired in a furnace at a rate of 35 kg per second. If net heat input per unit of plan area= 4.8 MW/m <sup>2</sup> , width: depth = 11:10 and volumetric Heat Release Rate = 130 KW/m <sup>3</sup> , estimate plan area, width depth and height of the furnace. (neglect other losses and heat credit)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 5                                          |
| (b)            | <p>What are the main difference between a subcritical and a super critical boiler? Show the cycles of both in T-s diagram. What are the other differences?<br/>With diagram show the difference between straight tube and spiral tube furnace construction of a once through supercritical boiler. What are major advantages and disadvantages of spiral tube construction?</p> <p style="text-align: center;"><b>OR</b></p> <p>What is the purpose of boiler insulation?<br/>Write short note on different types of insulating material used in boiler.<br/>The wall of a boiler consists of a 280 mm thick insulating brick layer and a slag wool insulation layer. <math>t_w</math> = Wall temperature i.e. hot surface temperature = 430° C. <math>t_s</math> = Cladding temperature or cold surface temperature= 50°C. Thermal conductivity of fire bricks and wool are 1.0 w/m.K and 0.04 w/m.K respectively. If heat loss through the insulating surface is 120 W/m<sup>2</sup>, determine the thickness of wool and temperature at the layer interface.</p>       | <p>6+4</p> <p>10</p> <p>2<br/>10<br/>8</p> |