

	Answer any FIVE questions.	Use of steam Table is allowed	Marks
1	A steam generator operates on following condition. Coal composition (% weight): Carbon-50.10, Hydrogen- 2.65, Oxygen-6.4, Nitrogen-1.0, Sulfur-0.50, Moisture-2.75, Ash-36.60, GCV-4710 kCal/kg. Other parameters: Moisture in air-0.016 kg/kg of dry air, Ambient temperature – 25°, Back end Temperature- 145°, Sp. Heat of the flue gas-1.05 kJ/kg K. GCV of carbon-33820 kJ/kg, Unburnt carbon loss- 1.5% of GCV of coal. Excess air –20%. Determine dry gas loss and moisture losses of the unit.		20
2 (a)	What do you mean by equivalent evaporation? Calculate Equivalent Evaporation from following parameters. Main steam: flow Rate-700 Tons/ Hour, Pressure-138.0 bar, Temperature-540 °C, Feed water Temperature - 247 °C Cold Reheat: Flow- 605 Tons/ Hour Pressure of 30 bar, Temperature 327 °C hot reheat outlet Temperature. -540 °C		2+10
(b)	Certain coal having GCV of 20 MJ/KG contain 4% Hydrogen and 5% moisture is to be fired in a furnace at a rate of 32 kg per second. If net heat input per unit of plan area= 4.8 MW/m <sup>2</sup> , width: depth = 6:5 and volumetric Heat Release Rate = 120 KW/m <sup>3</sup> , estimate plan area, width depth and height of the furnace. (neglect other losses and heat credit)		8
3.	How boilers are classified according to circulation, coal firing mode and working pressure. Sketch and label a <i>II</i> shaped once through steam generator showing all the heat transfer surfaces.		6 14
4.(a)	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?		6+4
(b)	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.		10
5.(a)	What makes boiler water Hard? What is the measure of water hardness? What are the other constituent present in boiler water and what is their limit?		2+2+2
(b)	What measures are taken to minimise scale formation and corrosion in boiler tubes?		6
(c)	What is condensate polishing. In which type of boiler it is necessary and why?		8

6 (a)	What is the purpose of boiler insulation? Write short note on different types of insulating material used in boiler.	2 10
(b)	The wall of a boiler consists of a 300 mm thick insulating brick layer and a slag wool insulation layer. $t_w$ = Wall temperature i.e. hot surface temperature = $400^\circ\text{C}$ . $t_c$ = Cladding temperature or cold surface temperature = $60^\circ\text{C}$ . Thermal conductivity of fire bricks and wool are 1.0 w/m.K and 0.05 w/m.K respectively. If heat loss through the insulating surface is 130 W/m <sup>2</sup> , determine the thickness of wool and temperature at the layer interface.	8
7	Briefly describe about the factors are to be considered for selecting material for boiler pressure parts. Write a short note on the constituent of boiler tube material and their properties.	10 10
8 (a)	What do you mean by fatigue strength and creep strength? On a creep curve show the short creep, long creep and accelerated creep zone. What is the creep limit for boiler steel tube?	4+5+1
(b)	Calculate thickness of inlet leg of a superheater situated in convection zone with the following data Drum working Pressure – 180 bar, Maximum Steam Temperature -- $519^\circ\text{C}$ Tube outside diameter – 44.5 mm, Tube manufacturing tolerance - + 7.5 % Thinning allowance for bends - 10 % , Stress value $E t$ =Yield point stress (0.2 % proof stress) at $550^\circ\text{C}$ =168 N/mm <sup>2</sup> and at $600^\circ\text{C}$ =140 N/mm <sup>2</sup> $S_r$ = Average stress to produce rapture in 100,000 hours at $550^\circ\text{C}$ =72 N/mm <sup>2</sup> And at $660^\circ\text{C}$ = 61 N/mm <sup>2</sup> $R$ = Minimum tensile stress at room temperature = 275 N/mm <sup>2</sup>	8