Total number of printed pages: 3 **Programme (UG)/Sem.- 8/Paper Code UIE812**

2023

POWER PLANT INSTRUMENTATION

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a).	Explain the term Work and Heat Interaction in First Law of Thermodynamics.	2
	b).	Explain Enthalpy and Specific heat at constant pressure.	2
	c).	Why do we use 2 out of 3 logics in interlock and protection measurement and control logic?	2
	d).	What are the Causes of super heater temperature variation in a boiler?	2
	e).	What is stoichiometric ratio in boiler combustion control?	2
	f).	Explain the Stall phenomena in PA axial flow fan.	2
	g).	How much percentage of Excess air and percentage oxygen is controlled for proper combustion control?	2
	h).	What is the meaning of SAMA used in control loop design?	1
	i).	Which one sector of the four i.e Residential, Commercial, Industrial, Transportation, will be using more fossil fuel in the year 2050?	1
	j).	What are the various constituents of air and gases in combustion process?	1
	k).	Which State is rich in oil production in India?	1
	l) .	Which State is rich in Fossil fuel- coal in India?	1
	m).	What is the installed Generation capacity of NTPC in India?	1
2.	a).	The total input heat content of fuels supplied during a specific period to a boiler is $100{,}000 \times 10^6$ kcals. The output heat content of the steam generated is $75{,}000 \times 10^6$ kcals.	

		i).	Calculate the boiler efficiency.	4
		ii).	If the heat content carried away by the blow down is 2000×10^6 kcals, calculate the boiler thermal efficiency.	3
		iii)	What is the effect of moisture in steam?	1
	b).	Explain with a neat control loop SAMA diagram for the Control of coal mill outlet temperature.		6
	c).	Explain with a neat diagram the output of Proportional, Proportional and Integral Controller and Process (Controlled) variable in a feedback process control loop for a change in **Step flow**.		6
3.	a).	i). The world's coal reserves are estimated to be 24,000 Q. How much is that in EJ?		1
		ii). What will be the lifetime of coal reserves if the present consumption rate of 93 Q/y continues into the future and if the consumption increases by r = 0.5%/y? (The lifetime T of a reserve is calculated from $T = r^{-1}\{\ln[r(Q_T/Q_0) + 1]\}$, where r is the rate of growth of consumption, Q_T is the total reserve, and Q_0 is the present consumption rate.)		7
		OR		
	a).	Explain i) Boiler following up mode of control.		8
	b).	Explain the working of a large utility balance Furnace draft boiler. Draw a neat schematic SAMA diagram for control of furnace draft using ID fan vane damper control.		4
	c).	i).	Explain the Differential Pressure across mills at low flow, high flow when mills are full and empty capacity.	4
		ii).	Explain with a neat diagram a typical forced draft Air and flue Gas circuit/ path in raising the temperature of secondary air.	4
4.	a).	Explain the GAIN adjustment and BIAS adjustment of fuel/Air Ratio control in combustion control of furnace. **OR**		8
	a).	Explain the cross-limiting Feature of combustion air control with oxygen trim in a logical control loop SAMA diagram.		8
	b).	Given a pressure ratio $p_2/p_1 = 12$ across a gas turbine and a specific heat ratio $c_p/c_v = 1.35$ of the working gas fluid, calculate the ideal thermal efficiency of a Brayton cycle gas turbine plant.		4
	c).	Explain with a neat diagram fuel and air supply system of the pressurized ball mill for pulverized fuel.		8
5.	a).	i).	Discuss the significance and criteria in design of 2oo3 voting logic with fault tolerance in protection of a plant trip. (Consider the DCS	6

			logic design in three stages ie. Input section, Processing section and Output section.).	
		ii).	How many combinations of plant not going to a trip are there if each section is a 2oo3 hardware and firmware combination in the above question.	2
	b).	A Carnot engine, whose efficiency is 40%, takes in heat from a source maintained at a temperature at 500K. It is desired to have an engine of efficiency 60%. Then, the intake temperature for the same exhaust (sink) temperature must be?		4
	c).	Explain the basic Superheat steam temperature control with water spray using feed forward control.		8
6.	a).	Explain the steps for ID & FD fans starting using AND-OR-NOT sequential logic and Time delay.		10
	a).	**OR** Draw a neat P& ID diagram of a typical Gas ignitor system. Explain the significance of vent valve.		10
	b).	i).	Explain the importance of Unit Digital Interlocking and Protection with associated mal-operation on the side of the maintenance or operation engineer.	6
		ii).	Discuss the Boiler hazards that can occur in a power generating station if control system is not properly designed.	4
7.	a).	i).	Explain the Swell and Surge phenomena in Steam drum level control.	3
		ii).	Explain the types of control and process parameters measurement being used in 3 element feed water control.	4
		iii).	Explain with a neat diagram Single element feed water drum level control.	3
	b).	i).	Explain with a neat T-S diagram Rankine cycle with application to Steam power plant operation.	4
		ii).	Derive the equation of work produced in the Rankine cycle and its thermodynamic efficiency.	6