3 hours **80 Marks**

N. B. :

1. Question No. 1 is compulsory
2. Attempt any **THREE from Q2 to Q6** questions
3. Use illustrative diagrams wherever required

Q1) Attempt any **FOUR** questions

a) A shell and tube heat exchanger is used to increase the temperature of furnace oil from a temperature of 60 °C to 120 °C using steam as the heating medium. The oil flow rate is 3500 kl/hr. The density of furnace oil is 0.89 kg/liter. Calculate the amount of steam required in t/hr to heat the furnace oil, if the specific heat of furnace oil is 0.5 kCal/kg°C. The total enthalpy of steam is 2733 kJ/kg. The condensate is leaving the heat exchanger at 397 kJ/kg. **05**

b) State any five factors on which capacity of boiler is decided? **05**

c) A paint drier requires 75.4 m^3/min of air at 93°C, which is heated in a steam-coil unit. How many kg of steam at 4 bar does this unit require per hour? The density of air is 1.2 kg/m^3 and specific heat of air is 0.24 kcal/kg°C. The ambient temperature is 32°C. **05**

Pressure bar	Temperature °C	Enthalpy kcal/kg		
		Water	Evaporation	Steam
4	143	143	510	653

d) State any five benefits of Power Factor (PF) improvement? **05**

e) Illustrate the purpose of using insulation in thermal systems. What are the benefits of providing insulation? **05**

Q2) **a)** Develop a table using a CUSUM technique to calculate energy savings for 8 months period for a production level of 2000 MT per month. Refer to field data given in the table below. **10**

Month	Actual SEC kWh/MT	Predicted SEC kWh/MT
May	1225	1250
June	1227	1250
July	1240	1250
August	1245	1250
September	1238	1250
October	1257	1250
November	1248	1250
December	1264	1250

b) Define Energy Monitoring and Targeting. State the elements of Energy Monitoring and Targeting. Illustrate the role of Monitoring and Targeting towards achieving energy efficiency. **10**

Q3) **a)** A 3 phase, 415 V, 75 kW induction motor is drawing 48 kW at a 0.7 PF. Calculate the capacitor rating requirements at motor terminals for improving PF to 0.95. Also, calculate the reduction in current drawn and kVA reduction, from the point of installation back to the generating side, due to the improved PF at the operating voltage of 415 V. **07**

	b)	An economizer was installed in the furnace-oil-fired boiler. The following are the data monitored after the economizer was commissioned. Air to fuel ratio = 18 Evaporation ratio (Steam generated per kg of fuel) of the boiler = 12.5 Specific heat of flue gas = 0.25 kcal/ kg°C Condensate recovery in the plant = Nil. Calculate the drop in the flue gas temperature for the rise in temperature of feed water in an economizer by 34.2°C.	**07**
	c)	List the steps to evaluate performance of lighting system.	**06**
Q4)	**a)**	Illustrate the main features of Energy Conservation Act-2001.	**10**
	b)	A VFD is to be installed for a fan. The initial investment is 3 lakh rupees, and the cashflow at the end of the 1st, 2nd and 3rd years are 1.2 lakh, 1.5 lakh and 1.5 lakh rupees respectively. Calculate NPV at 10 % discount rate and check whether this project is feasible or not?	**05**
	c)	Define benchmarking. Illustrate the external benchmarking used in Energy Audit Process in brief.	**05**
Q5)	**a)**	Define energy audit. What are the types of Energy Audit? Discuss the steps involved to conduct detailed Energy Audit.	**10**
	b)	State the special desirable properties that energy audit instruments should have in comparison to conventional measuring instruments.	**05**
	c)	Define Green building. Discuss the main features of green building.	**05**
Q6)	**a)**	State the factors which affects the performance of boiler.	**10**
	b)	A 2 MW captive power plant operating at a load factor of 90% consumes 0.8 kg of coal for every kWh of energy generated. The coal contains 40% of carbon with a GCV of 4200 kCal/kg. Now the boiler is being fired with the sawdust containing 30% carbon with a GCV of 3600 kCal/kg. Due to this modification to generate same kWh of energy 0.9 kg of sawdust is being used. Calculate the Annual CO2 emissions reduction that the plant would gain due to this, if the plant operates for 7000 hours/year? (One kg of carbon after complete combustion produces 3.67 kg of CO2)	**10**

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