Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2022

Course: Performance Analysis of Thermal Equipment **Semester: III**

Program: B Tech (RSEE) **Time : 03 hrs.**

Course Code: EPEG 2017 **Max. Marks: 100**

Instructions:

S. No.		Marks	CO
	SECTION A **(5Qx4M=20Marks)**		
Q 1	What is a heat exchanger? Describe co-current, counter current and cross flow heat exchangers.	**4**	**CO1**
Q 2	Explain major modes of heat transfer in a boiler, furnace and a heat exchanger system.	**4**	**CO1**
Q 3	Find out the boiler efficiency and evaporation ration by direct method from the data given below. Type of boiler: Coal fired Quantity of steam (dry) generated: 8 TPH Steam pressure (gauge) / temp: 10 kg/cm^2(g)/ 180°C Quantity of coal consumed: 1.8 TPH Feed water temperature: 85°C GCV of coal: 3200 kCal/kg Enthalpy of steam at 10 kg/cm^2 pressure: 665 kCal/kg (saturated) Enthalpy of feed water: 85 kCal/kg	**4**	**CO2**
Q 4	When it is beneficial to apply logarithmic mean temperature difference (LMTD) and when it is convenient to use effectiveness-NTU methods in the analysis of a heat exchanger.	**4**	**CO1**
Q 5	Describe the fluidization process in FBC boilers and their three main advantages over conventional firing boilers.	**4**	**CO2**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	Explain the features of a good steam distribution system.	**10**	**CO2**
Q 7	Explain the purpose of performance test of boilers. Define boiler efficiency and evaporation ratio and factors affecting these parameters during operations. Provide a detailed explanation of methods to evaluate boiler's efficiency with their merits and demerits.	**10**	**CO2**

Q 8	Calculate the amount of heat required to convert 5.00 kg of ice at -10°C to steam at 100°C at atmospheric pressure. Given that: The specific heat capacity of ice = 2.10 kJ/(kg K) Latent heat of fusion of ice = 336 kJ/kg The specific heat capacity of water = 4.20 kJ/(kg K) Latent heat of vaporization of water = 2250 kJ/kg **OR** Superheated steam at an average temperature 200°C is transported through a steel pipe (k = 50 W/m·K, D_o = 8.0 cm, D_i = 6.0 cm, and L = 20.0 m). The pipe is insulated with a 4-cm thick layer of gypsum plaster (k = 0.5 W/m·K). The insulated pipe is placed horizontally inside a warehouse where the average air temperature is 10°C. The steam and the air heat transfer coefficients are estimated to be 800 and 200 $W/m^2 \cdot K$, respectively. Draw equivalent thermal resistance diagram and calculate the daily rate of heat transfer from the superheated steam to the room.	**10**	**CO3**
Q 9	List major sources of heat loss and fuel economy/energy efficiency measures for an industrial furnace. (**5 Marks**) Find out the efficiency of reheating furnaces by direct method from the following data: Dimension of hearth of reheating furnace = 2m × 4m Rate of heating of stock = 125 kg/m^2 /hr. Temperature of heated stock = 1030°C Ambient air temperature = 30°C Calorific value of fuel oil = 10200 kCal/kg Specific gravity of fuel oil = 95 Fuel consumption during 8 hrs. of shift = 1980 liters. Mean specific heat of stock = 0.6 kCal/kg/K (**5 Marks**)	**10**	**CO3**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	Describe various sources of waste heat, benefits of waste heat recovery, technologies available to recover waste heat and the end use of recovered heat. (**10 Marks**) Explain Cogeneration and Trigeneration systems and their benefits over conventional power plants. (**10 Marks**)	**20**	**CO4**
Q 11	In a parallel flow heat exchanger, hot fluid enters the heat exchanger at a temperature of 150°C and a mass flow rate of 3 kg/s. The cooling medium enters the heat exchanger at a temperature of 30°C with a mass flow rate of 0.5 kg/s and leaves at a temperature of 70°C. The specific heat capacities of the hot and cold fluids are 1.15 kJ/kg·K and 4.18 kJ/kg·K, respectively. The convection heat transfer coefficient on the inner and	**20**	**CO4**

	outer side of the tube is 300 $W/m^2 \cdot K$ and 800 $W/m^2 \cdot K$, respectively. For a fouling factor of 0.0003 $m^2 \cdot K/W$ on the tube side and 0.0001 $m^2 \cdot K/W$ on the shell side, determine (a) the overall heat transfer coefficient, (b) the exit temperature of the hot fluid and (c) surface area of the heat exchanger. **OR** Hot water (c_{ph} = 4.18 kJ/kg-K) with mass flow rate of 2.5 kg/s at 100°C enters a thin-walled concentric tube counterflow heat exchanger with a surface area of 23 m^2 and an overall heat transfer coefficient of 1000 W/m^2-K. Cold water (c_{pc} = 4.18 kJ/kg-K) with mass flow rate of 5 kg/s enters the heat exchanger at 20°C, determine (*a*) the heat transfer rate for the heat exchanger and (*b*) the outlet temperatures of the cold and hot fluids. After a period of operation, the overall heat transfer coefficient is reduced to 500 W/m^2K, determine (*c*) the fouling factor that caused the reduction in the overall heat transfer coefficient. Use *effectiveness-NTU* correlation provided below wherever required. Counter-flow $\varepsilon = \dfrac{1 - \exp[-NTU(1 - c)]}{1 - c\exp[-NTU(1 - c)])}$ (for $c < 1$) $\varepsilon = \dfrac{NTU}{1 + NTU}$ (for $c = 1$)		