Name:

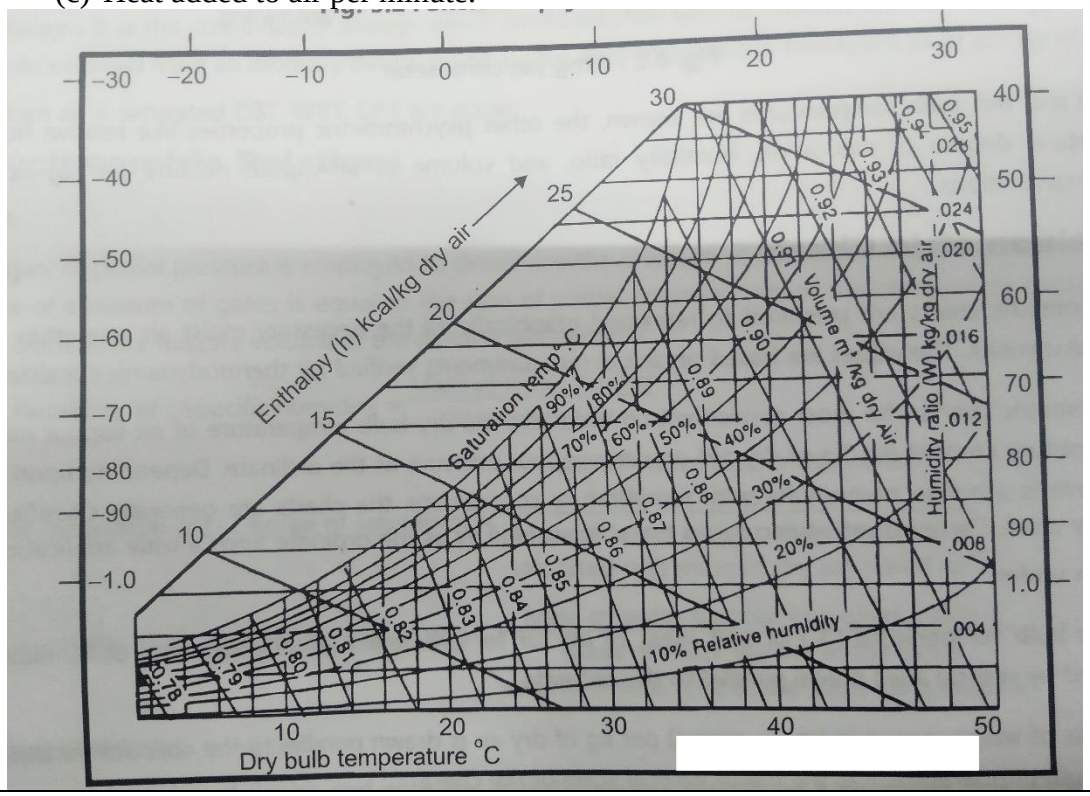
Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2023

Programme Name: M Tech (Chemical Engineering) **Semester : II**
Course Name : Plant Utility Equipment and Systems **Time : 03 hrs**
Course Code : CHPD7017P **Max. Marks: 100**
Nos. of page(s) : 3
Instructions: Assume the values of parameters logically where necessary

SECTION A

S. No.		Marks	CO
Q 1	Discuss the different properties and uses of industrial water.	**4**	**CO1**
Q 2	Why is scale and sludge formation in boilers detrimental for proper functioning. Mention four techniques to remove scales and sludges	**4**	**CO1**
Q 3	Explain the major classifications of steam boilers? Mention four components integral to steam boiler.	**4**	**CO1**
Q 4	Elaborate concisely at least four drying methods of industrial air.	**4**	**CO2**
Q 5	Discuss the specifications of fuel gas for industrial use.	**4**	**CO2**
	SECTION B		
Q 6	Draw the PFD of Fuel gas system mentioning the pressure and temperature profile	**10**	**CO3**
Q 7	60 ml of standard hard water containing 2 mg of pure $CaCO_3$ per ml consumed 30 ml of EDTA. 60 ml of a water sample consumed 20 ml of same EDTA solution using Eriochrome black-T indicator. Calculate the total hardness of water sample in ppm.	**10**	**CO3**
Q 8	Superheated steam at 3 bar g with 10 °C of superheat (154 °C) is to be used as the primary heat source for a shell and tube process heat exchanger with a heating load of 250 kW, heating an oil-based fluid from 80 °C to 120 °C (making the arithmetic mean secondary temperature (ΔT_{AM}) 100 °C). Estimate the area of primary steam coil required. Consider saturated temperature of steam at 3 bar g =144 °C. 'U' value for new carbon steel = 500 W/m^2 °C.	**10**	**CO4**
Q 9	Explain dryness fraction of steam. Derive the expression of Enthalpy and specific volume respectively for wet and superheated steam. **Or** Steam with a dryness fraction (χ) of 0.95 is reduced from 6 bar g to 1 bar g, using a pressure reducing valve. Determine the steam conditions (dryness fraction) after the pressure reducing valve. Below data are provided. At 6 barg h_f=697.5 kJ/kg; h_{fg} = 2066.0 kJ/kg At 1 barg h_f=505.6 kJ/kg; h_{fg} = 2201.1 kJ/kg	**10**	**CO4**

	SECTION C		
Q 10	A boiler generates 1000 kg/hr steam at 12 bara with 30ºC superheat by burning 200 5 kg/sec coal. Calorific value of coal is 35 kJ/gm and feed water temperature is 45ºC, calculate 1. The factor of equivalent evaporation 2. Actual evaporation per kg of coal 3. Equivalent evaporation from and at 100 ºC per kg of coal 4. The boiler efficiency Specific heat of superheated steam = 2.1 kJ/kg K and specific heat of water =4.2 kJ/kg K. Enthalpy of saturated steam at 12 bara = 2.7782 kJ/g. **Or** 300 m^3 of air per minute at 20 ºC dry bulb temperature and 80% Relative Humidity is heated until its temperature is 40 ºC. Find (a) Relative Humidity of heated air (b) Wet bulb temperature of the heated air (c) Heat added to air per minute.  	**20**	**CO5**

Q 11	A plant is being laid out in a restricted-water locality. The total heat load to be removed from several processes by the cooling tower is 26,000,000 Btu/hr. The locality has a 5 per cent wet-bulb temperature of 75°F. The water will leave the tower with a 10° approach to the wet bulb, or 85 °F. Being water of ordinary air and mineral content, it will emerge from equipment at a maximum temperature of 120 °F. The water equivalent to this range is 1500 gpm. A tower 24x24 (ftxft) has been erected with a fan capacity of 187,000 cfm. How many diffusion units must the tower be capable of performing to fulfill the process requirements? Determine (a) by numerical integration and (b) by using the log mean enthalpy difference. The following data are provided.	**20**	**CO5**

T	H′	H
85	50.0	39.1
90	56.7	43.7
95	64.2	48.4
100	72.7	53.1
105	82.5	57.7
110	93.8	62.4
115	106.7	67.0
120	121.5	71.6