Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI(NEW) – EXAMINATION – SUMMER 2019

Subject Code:2161401 **Date:10/05/2019**

Subject Name:Food Process Equipment Design

Time:10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Draw the diagram of plate with all notations. **03**

(b) List out different material handling equipments. Discuss the working of any one of them. **04**

(c) What is power number? Develop its equation and discuss its significance in the process of agitation. **07**

Q.2 **(a)** Discuss the followings; **03**

1. Rising film evaporator with advantages and disadvantages
2. Falling film evaporator with advantages and disadvantages

(b) When two fluids of the heat exchanger are separated by a plane wall, then derive the following equation. **04**

$$U = \frac{1}{\frac{1}{h_i} + \frac{\delta}{k} + \frac{1}{h_o}}$$

(c) Derive the equation of effectiveness for parallel flow. **07**

OR

(c) Why counter flow arrangement is more effective than parallel flow? Prove that **07**

$$T_{h2} - T_{c1} = (T_{h1} - T_{c2})\, e^{-UA\left(\frac{1}{C_c} + \frac{1}{C_h}\right)}$$

Q.3 **(a)** What do you understand by factor of safety? Explain with example? **03**

(b) Ambient air (dry bulb 27°C and wet bulb 18 ^{0}C) is heated to 70°C and fed in to the drying chamber of LSU dryer to dry parboiled paddy. If the air coming out of the dryer has temperature of 54°C and its wet bulb temperature is 37°C. Evaluate the LSU dryer performance? How it can be improved. **04**

(c) Discuss possible material hazards in fruits and vegetable processing industry. Suggest precautions should be taken to overcome the same. **07**

OR

Q.3 **(a)** Differentiate between AMTD and LMTD. Give the limitations of AMTD **03**

(b) What are factors affecting overall heat transfer coefficient? **04**

(c) A solution containing 5% solute by weight is to be concentrated to 15% at the rate of 2000 kg/hr. The feed solution is introduced in the evaporator at 40^{0}C and steam at **07**

110^{0}C. Product boils in the evaporator at 100^{0}C. Determine heat transfer area of the evaporator. The overall heat transfer is 1220.63 kCal/m^2 ^{0}C.

Q.4 **(a)** What are different subsidiary loads considered while designing pressure vessels? What is their influence in Indian condition? **03**

(b) Discuss turbine agitator and what are its dimensional limitations? **04**

(c) What are the different types of an agitator used in the food industry? Which type of agitator you will recommend for the bakery kneading purpose and why? **07**

OR

Q.4 **(a)** Sketch different types of pressure vessel heads used for low pressure. **03**

(b) Why boiling point elevation is? Describe the Duhring lines with help of diagram. **04**

(c) In an open heart surgery under hypothermic conditions, the patient's blood is cooled before the surgery and rewarmed afterwards. The task is accomplished by a concentric tube counter flow heat exchanger of length 500mm with a thin walled inner tube of 60mm diameter. The blood entering the heat exchanger at 20^{0}C and 0.05 kg/s is warmed by water at 60^{0}C and 0.12 kg/s. Determine the temperature of blood at exit from the heat exchanger and the heat flow rate. Assume the following data; **07**

C_p of blood = 3500 J/KgK , C_p of water = 4186 J/KgK, U_0 = 475 W/m^{2}K

Q.5 **(a)** Discuss the followings **03**

1. Temperature profile for crossed flow (mixed type)
2. Steam economy

(b) Discuss U and Z arrangement of Plate heat exchanger with diagram. **04**

(c) Derive the energy balance equation for single effect evaporators. **07**

$$m_f + H_f + m_s + H_{vs} = m_v H_{v1} + m_p H_{p1} + m_s H_{cs}$$

OR

Q.5 **(a)** Describe Heat Capacity ratio, Steam economy and Fouling factor. **03**

(b) Calculate the safe stress for stainless steel operated at 106^{o}C with randomly checked butt joint and safety factor of 1.8. The material has allowable stress at 25, 70 and 120^{o}C as 200, 142 and 106 N/mm^2 respectively. **04**

(c) A steel pipe of 25mm of internal diameter and 30mm outer diameter is carrying a steam at 121^{0}C. The convective heat transfer coefficient due to steam flow is 5000 w/m^{2}K. The steel pipe has a glass wool insulation of 10mm thickness on the outer side. The near stagnant air is at 30^{0}C on the outer side insulation provides a heat transfer coefficient of 10W/m^{2}K. The thermal conductivity of steel and insulation are 43 and 0.031 W/mk respectively. Calculate the overall heat transfer resistance based on inside surface area of pipe at every meter length. **07**