

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- VIth SEMESTER–EXAMINATION – MAY- 2012****Subject code: 161401****Date: 09/05/2012****Subject Name: Food Process Equipment Design****Time: 10:30 am – 01:00 pm****Total Marks: 70****Instructions:**

- I. Attempt all questions.**
- II. Make suitable assumptions wherever necessary.**
- III. Figures to the right indicate full marks.**

Q.1	(a)	i. List different types of agitators used in the food processing industry. ii. Which type of agitator you will recommend when solid-liquid mixing progresses, the viscosity of mix increases. Why?	03
	(b)	What do you mean by NTU? Derive the following equation for parallel flow: $\varepsilon_h \frac{1 - \exp[-NTU(1 + C)]}{1 + C}$	04
Q.2	(a)	Show the different types of pressure vessel head with sketch? Also state which is? (a) Strongest; (b) Ease in fabrication and (c) Commonly used in the food processing industry. State the procedure of its design.	07
	(b)	Describe the followings in brief: i. Capacity ratio ii. Steam economy iii. Cross flow (both the fluids are mixed) iv. Fouling factor v. Purposes of baffles in heat exchanger vi. Regeneration vii. Chevron angle	07
	OR		
	(b)	Design a pressure vessel to sterilize the 5 KL liquid food of specific gravity 1.03 at 0.15 N/mm ² and 62°C. The safe permissible stress at operating temperature, considering all efficiency and safety factor is 36 N/mm ² . Sheets available in the stock are: Length any size. Width: 1250, 1800 and 2000 mm and Thickness: 5.5, 6.0 and 7.0 mm	07
Q.3	(a)	What is the purpose of the agitator in the food processing industry? Discuss the role of baffles in an agitator? What are the dimensional limitations of baffles?	07

	(b)	Air flowing at a rate of 5kg/s is to be heated in a shell and tube heat exchanger from 20°C to 50°C with hot water entering at 90°C and exit at 60°C. The overall heat transfer coefficient 400 W/m ² K. The length of heat exchanger is 2m. Determine the surface area of the heat exchanger, number of tubes required, temperature effectiveness and heat capacity ratio by using 1 to 2 shell and tube , 2 to 4 shell and tube type. Given: Cp (air) = 1005 J/kgK, Diameter of tube = 0.02667m, F ₁₋₂ =0.90, F ₂₋₄ =0.975	07
OR			
Q.3	(a)	List the points to be considered for the selection of an agitator. With neat sketch explain paddle type agitator.	07
	(b)	Solution of organic colloids in water is to be concentrated from 10-15% solid in case of single effect evaporator. Steam is available at a gauge pressure 1kg/cm ² (120°C). A pressure of 100 mm Hg absolute is to be maintained in the vapour space which corresponds to the boiling point of water of 51°C. The feed rate to the evaporator is 25000kg/hr. The overall heat transfer coefficient is 2500 Kcal/m ² hr°C. the solution has negligible boiling temperature and heat of dilution. Calculate steam consumption, economy and heating surface required if the temperature of the feed is (a) 51°C (b) 21°C (c)93°C. The specific heat of feed solution is 0.90Kcal/gm°C and latent heat of vaporization of solution may be taken equal to that of water. Given : λ at 120°C is 525 Kcal/gm, λ at 51°C is 563 Kcal/gm	07
Q.4	(a)	A pressure vessel is designed considering safe permissible stress as 54 N/mm ² at 60°C. If the joint efficiency and joint checking efficiency are 0.75 and 0.85 respectively and the material has allowable stress at 25 and 170°C as 190 and 134 N/mm ² respectively. Find the safety factor for the design of pressure vessel.	07
	(b)	What is the difference between single effect and multiple effect evaporators? Explain the working of falling film and rising film evaporator with diagram.	07
OR			
Q.4	(a)	A tray dryer is used to dry onion slices from 272% to 5% moisture content with hot air of 65°C. Ambient air (22°C) is heated to 65°C by an electric heater and forced in the drying chamber through blower. If the air leaving the drying chamber has temperature of 54°C. The wet bulb temperature of the ambient air, heated air and air coming out of the dryer are 15, 32 and 32°C respectively. What is the performance of the dryer?	07
	(b)	Give the advantages of PHE with its application in food industry. Draw the detailed plate diagram and list out its maximum limit of different parameters for performance.	07
Q.5	(a)	Calculate the rate of air flow require to cool the polished rice in a rice mill of 2 t/h from 47°C to 40°C. The temperature and density of the incoming air is 22°C and 1.13 kg/m ³ . The specific heat of rice and air is 1.63and 1.0 kJ/kg°C respectively. The maximum possible rise in the air	07

		temperature will be 5°C. Also calculate the power requirement of the blower if maximum pressure drop is expected to be 3cm of water.	
	(b)	Explain the following passes and flow arrangements in plate heat exchanger with diagram; i. U- arrangement ii. Z- arrangement iii. 2x4/1x8 arrangement	07
		OR	
Q.5	(a)	Discuss possible material hazards in fruits and vegetable processing industry. Suggest precautions should be taken to overcome the same.	07
	(b)	Derive the following equation: $R_{si} = \frac{1}{A_i h_{si}}$ The design of a water cooled steam condenser has been made by presuming that the $U = 5000 \text{ W/m}^2\text{K}$. While deciding this value, the engineer presumed that flowing water is very clean and accordingly he neglects the fouling resistance. Later it is found that the cooling water is not clean at all and that it has a fouling resistance of the order of 0.0006 to 0.002 m^2/KW. Should the design calculation remade?	07
