BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSC **SEMESTER : IX**
BRANCH: FOOD TECH. **SESSION : MO/18**

SUBJECT: SAF3023 FOOD PLANT AND EQUIPMENT DESIGN

TIME: 3 Hrs. **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Elaborate methods used to estimate physical properties of food. [6]
Steam is used for peeling potatoes in a semi continuous operation. Steam is supplied at the rate of 4 kg per 100 kg of unpeeled potatoes. The unpeeled potatoes enter the system with a temperature of 17°C, and the peeled potatoes leave at 35°C. A waste stream from the system leaves at 60°C.
The specific heats of unpeeled potatoes, waste stream, and peeled potatoes are 3.7, 4.2, and 3.5 kJ/(kg K), respectively. Latent heat of steam is 2750kJ/kg. Determine the quantities of the waste stream and the peeled potatoes from the process.

Q.1(b) Sketch flow sheet for Vegetable Dehydration Plant and list the Unit operations and equipment required. What brief note on the utilities required for such a plant. [6]

Q.2(a) What are the selection criteria for materials of construction for food processing equipment? Name different types of corrosion. Which type of corrosion is significant for Food processing equipment? How is uniform corrosion reported? [6]

Q.2(b) Classify processes for sheet metal fabrication. Explain with sketch different methods of forming of sheet metal. What are the challenges in welding of Stainless Steel? [6]

Q.3(a) Sketch a typical closed vessel with facilities for agitation and heating/cooling for handling large quantity of liquid. Describe method of construction and types of support system for such vessel. [6]

Q.3(b) What are general design consideration for designing a vessel with internal pressure? Estimate the thickness required for an autoclave, 1.5 m diameter 2 m height. The vessel is to operate at a pressure of 14 bar (absolute) and temperature of 300°C. The material of construction will be plain carbon steel [At Design temperature 300°C, design stress = 85 N/mm^2] Welds will be fully radiographed. Assume design pressure to be 15% above operating pressure and a corrosion allowance of 2 mm. [6]

Q.4(a) What are various types of valves and fittings used in a pipeline to transport a liquid. State equation to estimate energy requirement in pumping through a pipe line. What is an PID? [6]

Q.4(b) Explain with flowsheet operation of a CIP system. Discuss the operating conditions and design considerations for CIP. Discuss design considerations and poor designs to be avoided for high performance of a CIP. [6]

Q.5(a) Describe design and application of following Heat exchangers in Food processing : (a) Scraped surface Heat Exchanger (b) Plate Heat Exchanger (c) triple pipe Heat exchanger. [6]

Q.5(b) Raw whole milk at 7°C is to be pasteurised at 72°C in a plate heat exchanger at a rate of 5000 1/hr and then cooled to 4.5°C. The hot water is supplied at 7500 1/hr at 85°C and chilled water has a temperature of 2°C. Each heat exchanger plate has an available area of $0.79m^2$. The overall heat transfer coefficients are calculated as 2890 W/m^2K in the heating section, 2750 W/m^2K in the cooling section and 2700W/m^2K in the regeneration section . 75% of the heat exchange is required to take place in the regeneration section. [6]
Calculate the number of plates required in each section. (Assume that the density of milk is 1030 kg/m^3, the density of water is 958 kg/m^3 at 85°C and 1000 kg/m^3 at 2°C, the specific heat of water and milk is constant at 4.2 kJ/kgK and 3.9 kJ/kgK respectively)

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Q.6(a) Describe and state energy and mass balance equation for a short tube calendar type evaporator. Sketch and distinguish between a rising film and falling film evaporator. [6]

Q.6(b) Describe type of equipment used for batch heating and cooling. [6]
How long it will take to heat 50 kg of fruit juice by steam at 110^{o}C from 30^{o}C to 90^{o}C in a 1 m diameter jacketed tank? [Density of fruit juice = 1020kg/m^{3}, Heat transfer coefficient= 2000 W/m^{2}K, specific heat of fruit juice= 4.5kJ/KgK, thermal conductivity = 0.63W/mK]

Q.7(a) What are the considerations for selection of Food Plant location? Discuss importance of Territory and community selection. Explain with quantitative examples the following Plant location selection methods (a) Variable weight method (b) Weight cum rating method. [6]

Q.7(b) What are the factors considered in planning equipment layout? What are the different types of flow in a plant? Explain with examples the difference between Inline and Intermittent type plant lay out. [6]

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