Reg. No. \_\_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov / Dec – 2019**

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| **Code :** | **14FP2021** | **Duration :** | **3hrs** |
| **Sub. Name :** | **FOOD PROCESS EQUIPMENT DESIGN** | **Max. Marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | What are the steps involved in process equipment design and explain with example. | CO1 | 5 |
| b. | Illustrate the importance of mechanical properties to be considered for material selection. | CO3 | 15 |
| **(OR)** | | | | |
| 2. | a. | A 100-kg batch of granular solids containing 30% moisture is to be dried in a tray dryer to 16% moisture by passing a current of air at 350 K across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.7x10-3 Kg/ (m2. s) and the critical moisture content is 15%, calculate the drying time. Drying surface = 0.03 m2/kg dry weight. | CO2 | 14 |
| b. | Define equilibrium moisture content, critical moisture content and free moisture content | CO1 | 6 |
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| 3. | a. | What are the classifications of heat exchangers, explain the construction, operation, merit and demerits of double pipe heat exchanger. | CO3 | 15 |
| b. | Define effectiveness of heat exchanger and state its significance | CO1 | 5 |
| **(OR)** | | | | |
| 4. | a. | Crude oil flows at a rate of 1000 kg/h through the inside pipe of a double pipe heat exchanger and is heated from 30°C to 90°C. The heat is supplied by kerosene initially at 200°C flowing through the annular space. If the temperature of approach (minimum temperature difference) is 10°C, determine the heat transfer area for co-current flow and the kerosene flow rate. Cp for crude oil = 0.5 kcal/kg°C and for kerosene = 0.6 kcal/kg°C and Uo = 400 kcal/h.m2°C. | CO2 | 14 |
| b. | Why log mean temperature difference (LMTD) is preferred over ordinary temperature difference in heat exchanger calculations?. State LMTD for both co current and counter current flow through a double pipe heat exchanger with neat sketches. | CO1 | 6 |
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| 5. | a. | Derive the material and energy balance equation for single effect calendria type evaporator. | CO1 | 6 |
| b. | A single effect evaporator is to be designed to concentrate 9000 kg/h of a solution from 12% to 20% solids. Feed enters at 25°C. Saturated steam at 110°C (latent heat = 540 kcal/kg) is available and the condensate leaves at the condensing temperature. Saturation temperature of vapor to the condenser is 40°C (latent heat = 580 Kcal/kg). Specific heats of all solutions may be taken as 1.0. Boiling point of the solution is negligible. The evaporator has an overall heat transfer coefficient of 1900 kcal/hrm2°C. Calculate i) the steam consumption, kg/h. ii) the area of heating surface required. | CO2 | 14 |
| **(OR)** | | | | |
| 6. | a. | Derive the design equation for the ideal plug flow reactor under steady state condition. | CO3 | 8 |
| b. | A specific enzyme E acts as a catalyst in the fermentation of substrate A (the reactant), at a given enzyme concentration in the aqueous feed stream of 25 lit/min. Find the volume of plug flow reactor required to achieve 95% conversion of reactant A (CAo = 2 mol/lit). The kinetics and stoichiometry of the fermentation reactions are given by  Enzyme  A R, (mol/lit.min). | CO2 | 12 |
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| 7. | a. | Explain in detail various storage vessels used traditionally with example. | CO1 | 10 |
| b. | What are the criteria to be considered for the design of rectangular tank with and without stiffeners. | CO3 | 10 |
| **(OR)** | | | | |
| 8. | a. | Discuss in detail about the criteria to be considered during the design of pressure vessel. | CO1 | 10 |
| b. | A thin cylindrical pressure vessel of 1.2 m diameter generates steam at a pressure of 1.75 N/mm2. Find the minimum wall thickness, if (a) the longitudinal stress does not exceed 28 MPa; and (b) the circumferential stress does not exceed 42 MPa. | CO2 | 10 |
|  | | **Compulsory**: | | |
| 9. | a. | |  | | --- | | Apple juice is being concentrated in a natural-circulation single-effect evaporator. At steady-state conditions, dilute juice is the feed introduced at a rate of 0.67 kg/s. The concentration of the dilute juice is 11% total solids. The juice is concentrated to 75% total solids. The specific heats of dilute apple juice and concentrate are 3.9 and 2.3 kJ/(kg °C), respectively. The steam pressure is measured to be 304.42 kPa. The inlet feed temperature is 43.3°C. The product inside the evaporator boils at 62.2°C. The overall heat-transfer coefficient is assumed to be 943 W/(m2°C). Assume negligible boiling-point elevation. Calculate the mass flow rate of concentrated product, steam requirements, steam economy, and the heat-transfer area. The latent heat of steam is 2162.49 kJ/kg. Saturated steam temperature is 134°C. | | CO2 | 14 |
| b. | Explain with neat sketch the construction and operation of single effect calendria type evaporator. | CO1 | 6 |