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



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

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| **Code :** | **18FP3005** | **Duration :** | **3hrs** |
| **Sub. Name :** | **DESIGN OF FOOD PROCESSING EQUIPMENTS** | **Max. Marks :** | **100** |
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| **Q. No.** | **Sub Div.** | **Questions** | **Course Outcome** | **Marks** |
| **ANSWER ANY FIVE QUESTIONS (5 x 16 = 80 Marks)** | | | | |
| 1. | a. | Two tons of paddy with 22% moisture content on wet basis is to be dried to 13% moisture content on d.b. Calculate the weight of bone dry products and water evaporated. | CO1 | 6 |
| b. | A food solid was dried from 40 to 10% moisture content in 2 h in a batch drier with constant air conditions. The drying rate remained constant down to a moisture content of 15%. If the equilibrium moisture content is 2%, calculate the total time required to dry from 40 to 4% moisture content. All moisture contents are given on a dry basis. | CO2 | 6 |
| c. | Discuss the various stages in drying curve. | CO2 | 4 |
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| 2. | a. | A 100 kg batch of a food powder contains 28% moisture on a wet basis. It is dried down to 16% moisture at a constant rate of 0.006 kg m−2 s−1. The critical moisture content is 15%. Calculate the batch drying time if the drying surface is 0.03 m2 per kg of dry weight. | CO3 | 8 |
| b. | A wet solid is dried from 25 to 10 per cent moisture under constant drying conditions in 4.17 h. If the critical and the equilibrium moisture contents are 15 and 5 per cent respectively, how long will it take to dry the solid from 30 to 8 per cent moisture under the same conditions? | CO3 | 8 |
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| 3. | a. | Grape juice at a rate of 3 kg/s is concentrated in a single effect evaporator from 18% to 23% solids content. Calculate:  i) the product flow rate,  ii) the evaporation rate,  iii) the steam consumption,  iv) the steam economy,  v) the required heat transfer area of the evaporator.  The juice enters the evaporator at 50°C and boils at 50° C, saturated steam at 100°C is used as heating medium, the condensate exits at 100°C, the heat capacity of the juice is 3.7 kJ/kg° C and 3.6 kJ/kg° C at the inlet and the outlet of the evaporator respectively, and the overall heat transfer coefficient is 1500 W/m2 °C. | CO4 | 16 |
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| 4. | a. | A solution with an initial solid concentration of 10% is being concentrated in a single effect evaporator to a final solid concentration of 40 percent under a vacuum of 40 kPa. The boiling point rise of the solution is negligible. Steam at a pressure of 101 kPa (gauge) is used to concentrate the liquor. The feed is entering at a temperature of 35° C and the temperature of the final liquor is 86°C corresponding to a vacuum of 40 kPa prevailing in the evaporator. If the feed rate is 1000 kg/h, find the quantity of steam required and the heat transfer area of the evaporator. The specific heat of the feed which is reasonably constant is 5 kJ/kg°C, and the overall heat transfer coefficient is 1.9 kW/m2 °C. | CO4 | 8 |
| b. | Illustrate with a neat diagram, the construction and working of falling film evaporator. | CO1 | 4 |
| c. | Calculate the logarithmic mean temperature difference, for both co-current and counter-current ﬂow, in a heat exchanger where one stream rises from 20 to 70°C and the other falls from 95 to 80°C. | C04 | 4 |
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| 5. | a. | The gas phase reaction A→B+C will be carried out isothermally in a 20 dm3 constant volume, well-mixed batch reactor. 20 moles of pure A is initially placed in the reactor. If the rate is –rA=kCA and k=0.865 m-1, calculate the time needed to reduce the number of moles of A in the reactor to 0.2 mol. | CO4 | 8 |
| b. | Derive an expression of basic molar balance eqations for CSTR, PFR and Batch reactors. | CO2 | 8 |
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| 6. | a. | Write in detail about classification of pressure vessels. | CO3 | 4 |
| b. | Enumerate the factors considered in selection of reactors. | CO3 | 4 |
| c. | A spherical vessel 3 metre diameter is subjected to an internal pressure of 1.5 N/mm2. Find the thickness of the vessel required if the maximum stress is not to exceed 90 MPa. Take efficiency of the joint as 75%. | CO2 | 8 |
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| 7. | a. | Describe in detail about the stainless steel used for construction of food processing equipments. | CO1 | 10 |
| b. | Explain the importance of polymer coating in food equipments. | CO4 | 6 |
| **COMPULSORY QUESTION (1 x 20 = 20 Marks)** | | | | |
| 8. | a. | Explain in detail about various roofs available in storage tanks. | CO6 | 10 |
| b. | Illustrate with a neat sketch the parts of any one storage tank and its features. | CO6 | 10 |