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



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

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| **Code :** | **18FP3001** | **Duration :** | **3hrs** |
| **Sub. Name :** | **MASS TRANSFER AND SEPARATION PROCESSES IN FOOD ENGINEERING** | **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. | Draw the figure of Pitot tube and express its principle. Derive the expression to compute the velocity of flow in pipe by using Pitot tube. | CO1 | 8 |
| b. | A liquid food is conveyed in a pipe of diameter 50 cm and converges into 40 cm diameter at the other end. Then, it branches into two pipes of diameters 20 cm and 30 cm respectively. If the average velocity in the 50 cm pipe is 8 m/s, compute the following : a) the discharge in the 50 cm diameter pipe, b) the velocity at the converging end and c) the velocity in the 30 cm pipe if the average velocity in the 20 cm pipe is 2.5 m/s. | CO1 | 8 |
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| 2. | a. | Elucidate the steam distillation process and its applications in food processing. | CO2 | 8 |
| b. | A single effect evaporator is to be used to concentrate a food solution containing 15% dissolved solids (by mass) to 50% solids. The feed stream enters the evaporator at 291 K with a feed rate of 1 kg/s. Steam is available at a pressure of 2.4 bar and an absolute pressure of 0.07 bar is maintained in the evaporator. Assuming that the properties of the solution are the same as those of water and taking the overall heat transfer coefficient to be 2300 W/m2 K, calculate the rate of steam consumption and the necessary heat transfer surface area.  The specific enthalpy data obtained from the steam tables are given below:  Enthalpy of steam (hS) = 2715 kJ/kg  Enthalpy of condensate(hC) = 530 kJ/kg  Enthalpy of feed (hF) = 75.5 kJ/kg  Enthalpy of vapour (hV) = 2572 kJ/kg  Enthalpy of concentrated liquor (hL) = 163 kJ/kg  The temperature of steam (TS) at 2.4 bar is 126.1℃ and the temperature of the saturated liquid water (TE) at the evaporator at a pressure of 0.07 bar is 39℃. | CO4 | 8 |
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| 3. | a. | Explain the working of screw press with a neat diagram. | CO3 | 6 |
| b. | Explain the process of super critical fluid extraction with neat figure. Also enlist the applications of that in food processing. | CO6 | 10 |
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| 4. |  | Discuss the filtration process with diagram. Derive the formulae for constant rate and constant pressure filtration processes. | CO2 | 16 |
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| 5. | a. | Describe in detail the principle and working of Basket centrifuge and Tubular centrifuge with neat figures. Also, enumerate the applications of centrifugation in food processing. | CO2 | 12 |
| b. | A bowl centrifuge is used for separation of cream from milk which has the discharge diameters of 10 cm and 14 cm. If the density of milk is same as that of water and the cream density is 840 kg/m3, calculate the radius of the neutral zone in the centrifuge. | CO5 | 4 |
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| 6. | a. | Derive the formulae to determine the pressure acting on the wall of the centrifuge(ΔP), radius of the neutral zone(rn) and residence time(tr) of the particle in the centrifuge. | CO5 | 10 |
| b. | A basket centrifuge with solid walls of 0.7 m height contains 80 kg of liquid. The centrifuge rotates at 3000 rpm. Consider the density of liquid as 900 kg/m3.  Calculate the following :   1. Angular Velocity 2. Inner radius of the annular liquid mass (r22 – r12) 3. Pressure (ΔP) developed at the walls of the centrifuge. | CO5 | 6 |
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| 7. | a. | Explain the working of rotary vacuum filter press with a neat sketch. | CO3 | 8 |
| b. | A quantity of 5000 kg of soya bean contains 15% of oil and is crushed in an oil expeller. The crushed cake has an oil content of 5%. It is then extracted with hexane to produce a meal containing 0.6% oil. Calculate the quantity in each process. | CO4 | 8 |
| **ANSWER ANY FIVE QUESTIONS (5 x 16 = 80 Marks)** | | | | |
| 8. | a. | Discuss the configuration and function of the following membranes with figures.   1. Tubular membrane. 2. Plate and frame membrane. | CO6 | 10 |
| b. | The microscopical examination of a micro filtration membrane revealed that about 3,00,000 pores were present with an average diameter of 0.6 μm per mm square of membrane surface. The thickness of the membrane is 200 μm. Apply Hagen–Poiseuille capillary model and estimate the hydraulic permeability of the membrane to water. | CO6 | 10 |