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

CLASS: IMSc **SEMESTER : VII**
BRANCH: FT **SESSION : MO/19**

SUBJECT: SAF1005 ADVANCED FOOD ENGINEERING

TIME: 3:00 HOURS **FULL MARKS: 60**

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) Calculate the viscosity of a fluid that would allow a pressure drop of 35 kPa over a 5m length of 3/4 in. stainless steel sanitary pipe if the fluid is flowing at 2 L/min and has a density of 1010 kg/m^3. Assume laminar flow. [6]

Q.1(b) A centrifugal pump is to be located 3 m above the water level in a tank. The pump will operate at a rate of 0.03 m^3/s. The manufacturer suggests a pump with a $NPSH_R$ at this flow rate as 3.5 m. All frictional losses may be neglected except a heat exchanger between the pipe inlet and the pump suction that has a loss coefficient C_f =15. The pipe diameter is 10 cm and the water temperature is 30°C. Is this pump suitable for the given conditions? [6]

Q.2(a) Discuss the principles of microwave heating. Show the diagram of a plate heat exchanger showing alternating paths of processed fluid and heat exchange medium. [6]

Q.2(b) In a concurrent-flow tubular heat exchanger, a liquid food, flowing in the inner pipe, is heated from 20 to 40°C. In the outer pipe the heating medium (water) cools from 90 to 50°C. The overall heat-transfer coefficient based on the inside diameter is 2000W/(m^2 °C). The inside diameter is 5cm and length of the heat exchanger is 10m. The average specific heat of water is 4.181kJ/(kg °C). Calculate the mass flow rate of water in the outer pipe. [6]

Q.3(a) In a humidifier, air at a dry bulb temperature of 40°C and relative humidity of 10% is humidified to a relative humidity of 40%. Determine the amount of moisture added in the humidifier per kg of dry air. [6]

Q.3(b) A wet solid with 28% moisture is to be dried to 0.5% moisture in a tray drier. A laboratory test shows that it requires 8 hours to reduce the moisture content of the same solid to 2%. The critical moisture content is 6% and the equilibrium moisture content is 0.2%. The falling rate of drying is linear in the free moisture. Calculate the drying time if the drying condition are similar to the laboratory test. All moisture content is given in per cent of bone-dry mass of the solid. [6]

Q.4(a) Determine the rate of water evaporated from a tray full of water. Air at a velocity of 2 m/s is flowing over the tray. The temperature of water and air is 25°C. The width of the tray is 45 cm and its length along the direction of air flow is 20 cm. The diffusivity of water vapor in air is D = 0.26 x10^{-4} m^2/s. The relative humidity of air is 50%.
Given: *Vapor pressure of water at saturation = 3.179 kPa* at 25°C and the kinematic viscosity of water at 25°C is 16.14×10^{-6} m^2/s [6]

Q.4(b) Salt is being used to preserve a 4.8 mm slice of salmon muscle. The concentration of salt at the surface is 0.533 kg/kg salt free salmon (SFS), and the initial concentration is 0.012 kg/kg SFS. If the mass diffusivity, D, of salt in salmon muscle is 8.78 x10^{-11} m^2/s, determine the time required for the mass average concentration to reach 0.4 kg/kg SFS. [6]

Q.5(a) Explain the electrodialysis process with schematic diagram. [6]

Q.5(b) Estimate the osmotic pressure of orange juice with 17% total solids at 20°C. [6]
Explain the significance of osmotic pressure in reverse osmosis. Cite the application of reverse osmosis.

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Q.6(a) A liquid is filtered at a pressure of 200 kPa through a 0.2-m^2 filter. Initial results indicate that 5 min is required to filter 0.3 m^3 of liquid. Determine the time that will elapse until the rate of filtration drops to 5×10^{-5} m^3/s [6]

Q.6(b) The damage to blueberries and other fruits during handling immediately after harvest is closely related to the terminal velocity in air. Compute the terminal velocity of a blueberry with a diameter of 0.60 cm and density of 1120 kg/m^3 in air at 21°C and atmospheric pressure. Given: viscosity of fluid=1.828×10^{-5} kg/ms, ρ_f = 1.2 kg/m^3 and drag coefficient is 0.2. [6]

Q.7(a) Cite the application of extrusion process in food industry. [6]
Explain the mechanism of extrusion process.

Q.7(b) With schematics show the single screw and twin-screw extruder. Cite their application. [6]

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