Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-IV Remedial Examination Nov/ Dec. 2010

Subject code: 141405 **Subject Name: Principles of Food Engineering**

Date: 08 / 12 / 2010 **Time: 03.00 pm – 05.30 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** List out different engineering properties of food material. Discuss the purpose to study the physical properties of food material. **04**

(b) Prove that $MC_{wb} = \frac{MC_{db}}{MC_{db}+1}$ **04**

A product contains initial moisture content 45% (w. b.). Find the moisture content in dry basis.

(c) Fresh orange juice with 12% soluble solid content is concentrated to 60% in a multiple effect evaporator. To improve the quality of the final product, the concentrated juice is mixed with an amount of fresh juice so that the concentration of the mixture is 42%. Calculate how much water per hour must be evaporated in the evaporator. How much fresh juice per hour must be added back and how much final product will be produced if the inlet feed flow rate is 10,000 kg/h fresh juice? **06**

Q.2 **(a)** Mention various indicators of "food spoilage". How do temperature, moisture and enzymes contribute to food spoilage? Give suitable control measures to prevent food spoilage. **07**

(b) Graphically explain the hysteresis of moisture sorption and desorption isotherms in food products. Consider the following equilibrium moisture content data for a food product: **07**

Equilibrium moisture content (g water/ g product)	0.060	0.085	0.110	0.122	0.125	0.148	0.173	0.232
Water activity (a_w)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8

(i) Develop a neat indicative plot (on your answer sheet itself) of equilibrium moisture isotherm. What can you conclude from this plot?

(ii) Predict the value of equilibrium moisture content of the food for a_w value of 0.55.

OR

(b) Explain the "Ross" equation for determining resultant water activity of food mix. Calculate the water activity of a food mix containing 70% starch, 15% glucose and 15% water. **07**

(Given that a_w (17.65% starch solution) = 0.9;
a_w (50% glucose solution) = 0.91)

Q.3 **(a)** What are the requirements an effective food packaging must serve? Mention various types of packaging materials for food products and their applications. **03**

(b) Define the following terms: **05**
Thermoplastics and Thermosets Write atleast five applications and limitations of plastics packaging in food industry.

(c) Which order kinetics is followed by the rate of killing microorganism by heat application? Derive the equation $log\left(\frac{N}{N_0}\right) = \frac{-k\,t}{2.303}$ using the first principles. What do various variables in the above equation stand for and what are their units? **06**

OR

Q.3 **(a)** Describe various forms of water present in food products. Explain the concept of water activity and its relationship with moisture content. Show graphically, how does enzymatic activity in food varies with water activity? **07**

(b) What are the factors which affect the heat resistance of microorganisms in foods? Assuming that death of microorganism in foods follows first order kinetics, how much time in minutes will be required to bring down the microbial population to 50% of its initial population? Take k = 0.05 $(minute)^{-1}$ **07**

Q.4 **(a)** Write down the advantages of drying and Differentiate among the followings: Drying, evaporation, distillation and crystallization. **07**

(b) What is food irradiation? Define 1 rad. Discuss the effect of γ- rays on microorganisms, enzymes and nutrients present in the food products. **04**

(c) Give processing steps that are taken prior to irradiation of foods. Mention the factors on which bactericidal efficiency of a given dose of irradiation depends. **03**

OR

Q.4 **(a)** State the law of conservation of mass. Milk containing 3.7% fat and 12.8% total solids is to be evaporated to produce a product containing 7.9% fat. What is the yield of product from 100 kg of milk and what is the total solid concentration in the final product. **05**

(b) Calculate the amount of cooling water required to cool a liquid food paste @ 100 kg/h containing 40% solids from 85 ^{o}C to 20 ^{o}C in a counter flow heat exchanger. The increase in temperature of water is not allowed to exceed 8 ^{o}C. The specific heat of liquid food paste is 2.85 kJ/kg ^{o}C and water is 4.18 kJ/kg ^{o}C. **03**

(c) Explain with appropriate examples the following heating processes involved in food preservation: **06**

(i) Cooking (ii) Blanching (iii) Pasteurization (iv) Sterilization

Q.5 **(a)** Define conduction. Derive an equation for conduction heat transfer in slab. Also show the electrical analogy of the equation. **05**

(b) Explain the purpose of heat exchanger. List out different types of heat exchanger. **03**

(c) Differentiate between **06**

(i) Thin layer drying and deep bed drying (ii) Bound and unbound moisture
(iii) Sun drying and mechanical drying

OR

Q.5 **(a)** Define the followings: **05**

(i) Sphericity (ii) Roundness (ii) Reynolds number (iv) Nusselt number
(v) Prandtl number

(b) One face of a stainless steel plate of 1cm thick is maintained at 110 ^{o}C, while the other face is at 90 ^{o}C. Assuming a steady state condition, calculate the rate of heat transfer per unit area through the plate. Thermal conductivity of stainless steel is 17 W/m ^{o}C. **04**

(c) Derive the expression for conductive heat transfer through a tubular pipe. **05**

$$q_r = \frac{2\,\pi\,L\,k\,(T_i - T_0)}{\ln\left(\frac{r_o}{r_i}\right)}$$

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