Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(New) EXAMINATION – SUMMER 2016

Subject Code:2141407 **Date:08/06/2016**

Subject Name:Food Drying & Dehydration

Time:10:30 AM to 01:00 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 **Short Questions** **14**

1 Define free moisture.
2 Write expressions for moisture content on dry and wet basis.
3 What is equilibrium moisture content?
4 Name techniques of food moisture measurement.
5 What is meant by moisture diffusion?
6 If m.c. on wet basis is 90%, calculate the % m.c. on dry basis.
7 Name the model for sorption isotherm which is valid for largest range of a_w?
8 Name techniques by which water activity of foods can be decreased.
9 What factors affect drying rate of foods?
10 Define specific drying rate.
11 Name some food products which are spray dried?
12 What is the role of porosity in grain drying?
13 What is convective heat transfer coefficient?
14 What basic measures can improve dryer performance?

Q.2 **(a)** Explain the following in short giving examples: **03**

1. Spray drying
2. Drum drying

(b) Discuss the concept and application of following: **04**

(i) Super heated steam drying.
(ii) Solubility index of food powders.

(c) Define EMC and water activity and explain their thermodynamic basis. How do you express water activity mathematically? State their importance in establishing shelf-life of foods. Calculate the water activity of 26% sodium brine solution.[k_{NaCl} = 15.8], M for NaCl = 58.5 amu]. **07**

OR

(c) Discuss variation of water activity with temperature. Explain different types of moisture sorption isotherms and hysteresis phenomenon. Calculate the resultant water activity of a solution prepared by mixing pure solutions of 60% sucrose with 40% fructose. **07**
[$k_{sucrose}$ = 2.7, $k_{glucose}$ = 0.7, $M_{sucrose}$ =342, $M_{glucose}$ = 180].

Q.3 **(a)** Explain thin layer drying of foods giving examples. **03**

(b) A propriety food mix having a moisture content of 88% (w.b.) is dried in a HP dryer at a constant rate of 0.30 kg/minute/kg dry matter until its critical moisture content. Determine the total drying time if it is dried to a final moisture content **04**

of 6% (wb). Take X_c = 1.21 kg/kg dry matter

(c) Explain constant and falling rate drying of foods with the help of drying curves. A pasty food having 50% moisture content & bulk density of 650 kg/m^3 is drawn into spheres of 2cm diameter. 200 such spheres are transferred to a vacuum dryer for drying at an air inlet temperature of 80°C. After constant rate drying, the moisture of the product reduces to 10%. Calculate the constant drying rate in kg/s. Assume that the size of the product remains constant during the entire drying period. WBT temperature of air in the dryer is 32 ^{0}C. Take h = 150 W/m^{2}K & h_{fg} of water at 32 ^{0}C = 2132 kJ/kg **07**

OR

Q.3 (a) Explain deep bed drying with the help of a neat diagram. Give examples. **03**

(b) Prove that specific drying rate during falling rate drying period is given by $R = \frac{\Pi^2 M_s D_L X}{4 A x_1^2}$. Clearly state the nomenclature of the symbols used and mention their standard units. Suggest practical measures to reduce drying time for such type of drying? **04**

(c) Explain the mechanism of mass transfer during constant and falling rate drying of hydrophilic foods. A 150 μm diameter spherical droplet of concentrated fruit juice of 950 kg/m^3 density is injected into a spray dryer where it is dried from initial m.c. of 40% (w.b) to 5% (w.b). The inlet drying air temperature is 165 ^{o}C and its WBT is 50 ^{o}C. The convective heat transfer coefficient is 262 W/m^2/K and the latent heat of vaporization of water at 50 ^{o}C is 2259 kJ/kg. Calculate the drying rate and drying time. **07**

Q.4 (a) Describe heat transfer in a dryer by conduction, convection and radiation modes. **03**

(b) State quality attributes of dried food products. Discuss the desirability/undesirability of nutritional and colour changes that occur during drying. **04**

(c) What is solar drying? Discuss its techno-economic potential for fruits and vegetables drying. Illustrate the working of LSU dryer with a neat diagram. **07**

OR

Q.4 (a) Answer briefly: **03**

I. Define rehydration ratio.
II. What is the purpose of agglomeration of powders?
III. What thermal properties of food are important?

(b) Classify dryers and state their specific applications. Discuss the characteristics and properties of various types of dry food powders. **04**

(c) Explain briefly: **07**

A. Need for environment conservation.
B. Dryer design parameters.
C. Freeze drying of foods.

Q.5 (a) Explain the parallel, series and Krisher models for thermal conductivity. **03**

(b) Calculate the specific heat of Water, Carbohydrate, Protein and Fat at 40^{0}C. Make necessary assumptions and list them. **04**

(c) Explain and differentiate between direct and indirect fired dryers. State the criteria for the selection of industrial dryers. **07**

OR

Q.5 **(a)** A dryer reduces the moisture content of 10 tons of soybean from 70% to 12% in 12 hours using hot air at 80 ^{o}C. The ambient air and dryer exit temperatures are 27 ^{o}C and 40 ^{o}C respectively. The net heat available for moisture removal in the dryer is 4.4 x 10^6 kJ. Calculate **03**

(i) COP of the dryer

(ii) SMEC of the dryer

Given: Inlet temperature of soybean = 27 ^{o}C,

Sp. Heat of soybean = 2.7 kJ/kgK,

h_{fg} of water at 40 ^{0}C = 2130 kJ/kg

(b) Explain the principle and operation of fluid bed dryers. Also list the classification of fluidized bed dryer. **04**

(c) Explain briefly: **07**

A. Dryer efficiency and measures to improve it.
B. Basic steps for dryer design.
C. Hybrid dryers and their relevance for foods.

****