Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER – VI EXAMINATION – WINTER 2015

Subject Code:161404 **Date:14/12/ 2015**

Subject Name: Food Drying and Dehydration

Time:2:30pm to 5:00pm **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) **07**

Calculate a specific heat of rice grain at 22^0C with the following compositions

Component	Water	Carbohydrate	Protein	Fat	Ash
Weight (%)	8.5	75.3	14.1	0.7	1.4

Also calculate the specific heat of potatoes containing 85% water. Specific heat of water and non fat solids are 4186.80 J/kg K and 837.36 J/kg K.

(b) Discuss food moisture, their types and the need for their measurement. What are the methods for measurement of food moisture content? Explain the principle of moisture measurement by spectroscopic methods. 100 kg food product having an initial total solids content of 60% was dried in a drum dryer to yield a dried product of 6% (d.b) moisture content in 30 minutes. Calculate the mass of water evaporated in the drying process in kg/h. Express the total water evaporated in terms of per kg solids content present in the food. **07**

Q.2 (a) Define water activity. How is it expressed numerically? State the significance of water activity in food processing and shelf- life studies. The EMC data are given below for food at 35^0C against water activity values: **07**

EMC (% db)	a_w
24	0.8
18	0.7
16	0.6
13	0.5
12	0.4
10	0.3
8	0.2
6	0.1

(i) If % ERH air at 35^0C is 45%, calculate the water activity.
(ii) Plot equilibrium moisture isotherms on % dry basis and % wet basis.
(iii) Estimate wet basis EMC values for a_w values of 0.33 and 0.55.

(b) Why selection of dryer is important for an engineer give reasons? List the criteria for selection of typical dryer. **07**

OR

(b) Discuss the followings in detail **07**

1. Sun drying
2. Mechanical drying
3. Superheated Steam Drying (SSD)

Q.3 **(a)** Explain moisture sorption isotherm with neat curves and state their importance in food processing. How do EMC and water activity vary with temperature? Calculate the water activity of a solution prepared by mixing pure solutions of 60% sucrose with 2% NaCl. [k(sucrose) = 2.7, M(sucrose) =342, k(NaCl) = 15.8, M(NaCl) = 58.44] **07**

(b) Explain thin layer drying of foods and discuss its applications. List drying kinetics models applicable to thin layer drying and explain any one in detail. **07**

OR

Q.3 **(a)** Differentiate between **07**

1. Liquid diffusion and Vapour diffusion
2. Knudsen diffusion and Hydrostatic pressure difference
3. Thermal conductivity and Thermal diffusivity
4. Direct dryer and Indirect dryer

(b) Explain Fick's second law of unsteady state liquid diffusion With the help of drying kinetics curves explain constant and falling rate drying. Show that the specific drying rate during falling rate drying is given by $R = \frac{\Pi^2 M_s D_L X}{4 A x_1^2}$. State the nomenclature of symbols in this expression and their SI units. **07**

Q.4 **(a)** List the importance of quality attribute of dried products. Discuss the physical quality attributes in details. **07**

(b) Discuss the set up and mechanism of deep bed drying with a labeled diagram. Explain the variation of moisture with bed depth for different inlet air velocities. Suggest measures that can decrease the drying time in such dryers. **07**

OR

Q.4 **(a)** Write the details about the selection of fluidized bed dryer and spray dryer. Give the flow diagram of classification of fluidized bed dryer based on different criteria. **07**

(b) What do you understand by constant and falling rate drying? Write an expression for drying rate when drying proceeds at constant rate and state the SI units of the terms used in the expression. A 300 μm diameter spherical droplet of maltodextrin of 900 kg/m^3 density is injected into a nozzle type spray dryer. The moisture content of the droplet reduces from 55% (w.b) to 3% (w.b). The inlet drying air temperature is 200 ^oC and its WBT is 72 ^oC. The convective heat transfer coefficient is 300 W/m^{2}K. Assuming that drying occurs at constant rate, determine: **07**

(i) Drying rate in kg H_2O/s
(ii) Drying time in seconds.
[Given h_{fg} at 72 ^oC = 2330 kJ/kg]

Q.5 **(a)** What are the unique features of drying? Discuss the advantages of drying. **07**

(b) Write meaningful notes on the following: **07**

(i) Dryer efficiency and COP.
(ii) Recuperative dryers
(iii) Design considerations for a fluid bed dryer

OR

Q.5 **(a)** Discuss the principles of conduction of heat in metal, non metal and food products. Explain the different predictive models for thermal conductivity. **07**

(b) Write explanatory notes on the following: **07**

(i) Hybrid dryers for foods. Give examples.
(ii) Flash dryers and their applications
(iii) Measures to improve dryer efficiency