Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2018

Subject Code:2151404 Date:20/11/2018

Subject Name:Food Engineering Operations - I

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 **(a)** Calculate the appropriate Grashof Number when the external surface of a heating coil 30 mm diameter having surface temperature 80^0C in water at 20^0C ($\rho = 1000 kg/m^3$, Pr = 6.95, $\beta = 0.227 \times 10^{-3}\ K^{-1}$, $\mu = 1 \times 10^{-3} kg/ms$. **03**

(b) Differentiate between shallow and deep bins used for grain storage. **04**

(c) What is Fourier's law? Derive an expression for heat conductance for composite wall. **07**

Q.2 **(a)** Define the process of diffusion and state the application of Diffusion in food industry. **03**

(b) Discuss the machine and operational factors for the design of air screen cleaners. **04**

(c) (i) Define fineness modulus? What does it indicates? **07**

(ii)The sieve opening and the mass retained on the sieves during sieve analysis is given below in the table. Calculate mass mean diameter and volume surface mean diameter and volume mean diameter.

Sieve opening (mm)	2.032	1.405	1.000	0.500	0.211	Pan
Mass fraction retained	---	0.077	0.424	0.304	0.155	0.040

OR

(c) (i) What are laws for the energy calculation for size reduction? **07**

(ii) How much power is required to crush 2.5 tonne/hour of a material if 80% of feed passes through IS sieve No. 480 (4.75 mm opening) and 80% of the product passes through IS sieve No. 50 (0.5 mm opening)? Given the work index of the material as 6.5.

Q.3 **(a)** Define the followings : **03**

1. Particle and Material density
2. Adhesiveness and Cohesiveness
3. Sphericity and Roundness

(b) Discuss the convective mass transfer. List out the parameters on which convective mass transfer depends upon. **04**

(c) A fruit juice is passing through a hot pipe of 7.5cm diameter and 3.3m long @60 lpm and the wall temperature is 120^0C. The juice is entering at 25^0C and is leaving at 75^0C. Find the heat transfer coefficient and Nusselt number if the fluid properties are assumed to be those of water. Fluid properties are ρ = 1000 kg/m^3, k = 0.6 W/m^{0}C, Cp = 4.2 kJ/kg^{0}C and $\mu = 1x10^{-3}$ Pas **07**

OR

Q.3 **(a)** Calculate Prandtl Number when air at 100^0C **03**

$$\mu = \frac{1.46x10^{-6}.T^{3/2}}{110 + T} \text{ Kg/ms}$$

$C_p = 0.917 + 2.58x10^{-4}T - 3.98x10^{-8}T^2$ kJ/kg K (where T is the absolute temperature in Kelvin), k = 0.03186 w/mK

(b) Discuss with diagram the moisture and temperature changes in stored grain during summer and winter season. **04**

(c) What do you understand by Texture Profile Analysis (TPA). Draw the diagram of TPA in detail. Define Farcturability, Springiness, Gumminess and Hardness of food products. **07**

Q.4 **(a)** A piece of meat carcase is kept in a deep freezer maintained at -21^0C. Calculate the radiative heat transfer if the meat carcase is at 28^0C and has an average area of 0.045m^2. The emissivity of carcase is 0.82. **03**

(b) Define the followings and represents with graph **04**

1. Shear thinning
2. Shear thickening
3. Newtonian fluid
4. Non-Newtonian fluid

(c) A storage structure having smooth wall used for storing rice has diameter of 2.5 m and height 25 m. The characteristics of stored rice are as follows: **07**
Minimum bulk density : 720 kg/m3
Maximum bulk density: 830 kg/m3
Minimum angle of internal friction: 25º
Maximum angle of internal friction: 30º
Minimum angle of friction on smooth wall: 18^0
Angle of repose: 25^0
Calculate the load on the bottom, and the lateral pressure thrust at 12 m depth on walls.

OR

Q.4 **(a)** Describe the process of mass transfer in gas-liquid system. **03**

(b) Write the followings; **04**

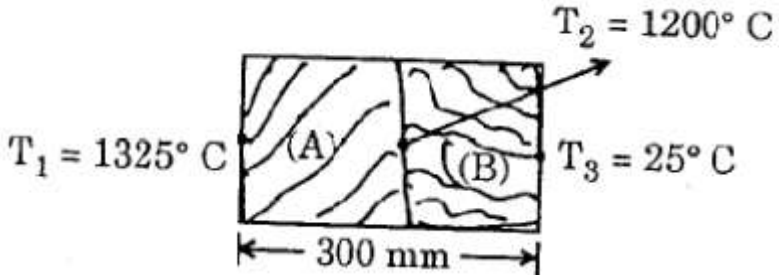
1. Equation of Nusselt Number when flow is laminar
2. Equation of Pecklet, Stamton, Rayleigh and Grashof Number

A composite wall of a furnace has 2 layers of equal thickness having thermal conductivities in the ratio of 3:2. What is the ratio of the temperature drop across the two layers?

(c) What is Kirchhoff's law and Stefan-Boltzmann law? Explain absorbivity, reflectivity, transmissivity and emissivity with diagram. **07**

Q.5 **(a)** What are the features of transition and control zone when grains flow through circular orifice? **03**

(b) A wall as shown below is made up of two layers (A) and (B). The temperatures are also shown in the sketch. The ratio of thermal conductivity of two layers is $k_A/k_B = 2$. What is the ratio of thickness of two layers? **04**



(c) Derive an expression for conduction heat transfer when the pipes are in series. **07**

OR

Q.5 **(a)** Mention the types of belt conveyor idlers used in food industry. **03**

(b) Write the principles for the selection of conveying system. Discuss in brief the construction and working of screw conveyor. **04**

(c) Write short notes on (i) Modified atmosphere storage (ii) Pusa Bin **07**

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