

GUJARAT TECHNOLOGICAL UNIVERSITY**BE – SEMESTER V • EXAMINATION – WINTER - 2012****Subject code: 151404****Date: 11-01-2013****Subject Name: Food Engineering Operations-I****Time: 02:30 pm to 05:00 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 terminal velocity of a particle of animal feed having an intermediate diameter of $22\mu\text{m}$ falling through standard air (density 1.22kg/m^3). Assume the particle is spherical and that is a piece of corn endosperm at 17% moisture content (density 1350kg/m^3). The viscosity of standard air is $1.81 \times 10^{-5} \text{ kg/ms}$. Assume the flow is laminar when the particle will reach to its terminal velocity. Drag Coefficient $C_d = 24/\text{Re}$. **07**

- (b)** What do you understand by conductive heat transfer coefficient? Derive the following expression for multilayered system of rectangular slab and also show its electrical resistance analogy; **07**

$$q = \frac{T_2 - T_1}{\frac{\Delta x_B}{K_B A} + \frac{\Delta x_C}{K_C A} + \frac{\Delta x_D}{K_D A}}$$

- Q.2 (a)** Discuss the followings; **07**
1. Newtonian and Non-Newtonian fluids
 2. Angle of repose
 3. Mass transfer coefficients
 4. Kirchhoff's law
 5. Stefan-Boltzmann law
 6. Newton's law of viscosity
 7. Textural Profile Analysis
- (b)** Explain the structure and composition of maize grain and give the reasons to study the chemical composition of food. Also prove that; $\Phi = \frac{(lbt)^{1/3}}{l}$ **07**

OR

- (b)** What do you understand by rheological properties? Give the application of TPA in food processing. With the help of graph explain Gumminess, Adhesiveness, Cohesiveness, Hardness, Chewiness and Springiness **07**

- Q.3 (a)** Calculate the convective heat transfer coefficient when air is at 90°C are passed through a deep bed of green peas. Assume surface temperature of a pea to be 30°C . The diameter of each pea is 0.5cm . The velocity of air through the bed is 0.3m/s . Given; $\rho = 1.025\text{kg/m}^3$, $C_p = 1.017\text{KJ/kg}^\circ\text{C}$, $K = 0.0279 \text{ W/m}^\circ\text{C}$, $\mu = 19.907 \times 10^{-6} \text{ PaS}$, $\text{Npr} = 0.71$ **07**
- (b)** Define screen effectiveness and Write the formula for screen effectiveness indicating each variable. **07**
- Determine the screen effectiveness for an IS 50 mesh (opening size 0.5 mm) for which the cumulative mass fractions of feed, overflow and underflow is given as 0.16, 0.615 and 0.03 respectively.

OR

- Q.3 (a)** Define an ideal screen. How is it different from an actual screen? Explain the difference with help of suitable diagram. **05**
- (b)** Calculate the opening size (Aperture) in mm of a 150-mesh screen of Tyler **02**

- standard screen series with a wire of 0.064 mm diameter.
- (c) Explain briefly CAP storage. What rotational speed, in revolutions per minutes, would you recommend for a ball mill 1200 mm in diameter charged with 75 mm balls? Assume operating speed of ball mill as 50 – 75% of the critical speed. **07**
- Q.4** (a) Explain briefly Rittinger's law and kick's law for size reduction. A certain crusher accepts a feed material having a volume – surface mean diameter of 20 mm and gives a product of volume – surface mean diameter of 4 mm. The power required to crush 10 tonnes per hour is 8 kW. What will be the power consumption if the product of volume – surface mean diameter of 2 mm is to be obtained with the same feed rate? Use Rittinger's law. **07**
- (b) Derive the expression for Janssen's formula of lateral pressure exerted by granular materials against the wall in vertical deep bins. **07**
- OR**
- Q.4** (a) Define plane of rupture and angle of rupture. Differentiate shallow bin and deep bin on the basis of plane of rupture with help of suitable diagram. **04**
- (b) Wheat weighing 750 kg/m^3 is loaded in a circular concrete silo of 3 m internal diameter and a clear height of 8 m. The angle of internal friction for wheat is 26° and that for wheat and concrete is 24° . Applying Airy theory, calculate the maximum lateral pressure at the bottom of the bin section. **03**
- (c) Explain briefly different size reduction procedures with suitable examples. A product of definite shape and size can be obtained by which size reduction procedure? **07**
- Q.5** (a) In a bucket elevator for lifting paddy, each bucket is 25 cm long and has a cross – section which is a section of a circle having a radius of 20 cm and subtending an angle of 80° at the centre. The buckets are 40 cm apart, the lift is 20 m and the head wheel has a diameter of 60 cm. Calculate (i) belt speed so that the discharge is centrifugal. **07**
- (ii) Capacity of lifting paddy weighing 580 kg/m^3 .
- (iii) Horsepower required assuming an overall efficiency of 85%.
- (b) Explain the principle, construction and working of an indented cylinder separator. **07**
- OR**
- Q.5** (a) Explain briefly direct and indirect damages by insects/pests of stored grain. What are the sources of infestation? Explain briefly. **07**
- (b) A horizontal screw conveyor mounted on a 5 cm diameter shaft has screw pitch and diameter both equal to 40 cm. Estimate its actual capacity (in kg/h) of conveying wheat weighing 850 kg per m^3 while operating at 150 rpm. Assume actual capacity is 50% of theoretical capacity. **07**
- For a screw length of 8 m, what horsepower motor will be required if the coefficient of resistance 0.75?
