Uva Wellassa University, Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Program
1st Semester Examination – March/April 2013

Uva Wellassa University

SCT 363 – 2 Food Processing Engineering

Instructions to candidates
Number of questions: Seven (07)
Answer **Four (04)** questions only
Time allocation: Two (02) hours
Total marks allocated: 100

1.

a. Explain **five (05)** Unit Operations in the food industry

b. Explain the Refrigeration Cycle. Draw the diagram and name all the components. Describe function of each component.

c. If you are asked to design a solar hot water generator how do you,
   (i) select the materials?
   (ii) orient the same in installation ?

d. Explain the difference between Freezing and Chilling. What are the applications of them? Which costs more energy, explain why?

e. What do you feel, when some cologne is spread on to your skin? How do you use this phenomenon to design water cooling equipment at home?

2.

a. Describe the Bernoulli's Equation and explain how do you use the same to solve some problems in designing food machinery?
b. Derive an equation to calculate the speed of a water jet flowing out of a large open tank.

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c. Using the above equation that you have derived, calculate the velocity and the flow rate of a jet of water leaving from a reservoir 10 m below the top surface of the water level through a 50 mm diameter pipe.

d.

Air flow under atmospheric pressure

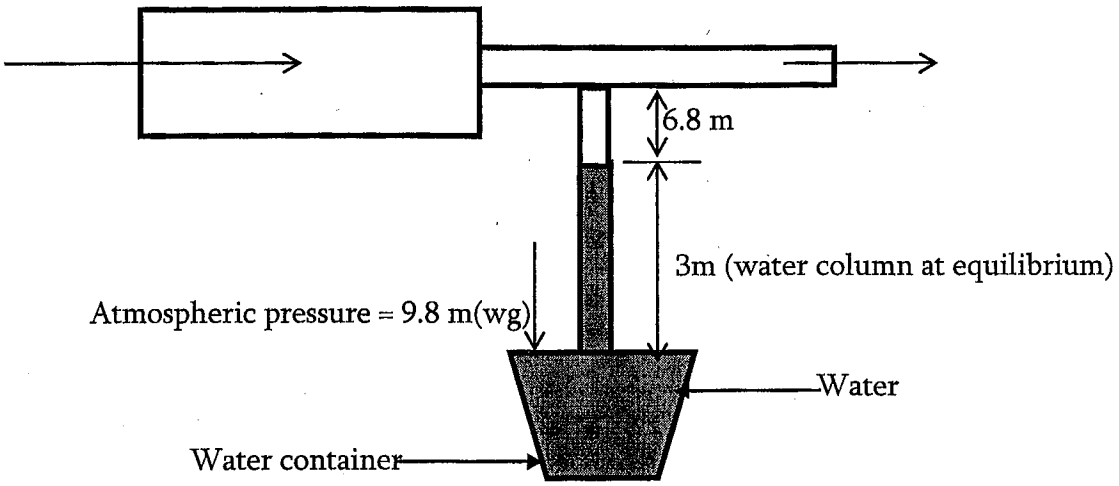

Fig: 01

Above shown (Fig: 01) is a hand sprayer used to spray water. If the velocity of air flow in the larger cylinder is 3 m/sec calculate the ratio of cross sectional areas of the cylinders. Assume the density of air as 1.3 kg / m^3,

If the cross sectional area of the larger cylinder is A m^2, what should be the cross sectional area of the small cylinder if water is to be sprayed out of the small cylinder? (No calculations are required, just comment with explanations).

3.

a. Describe the importance of studying Material and Energy Balance of a system.
b. Assume a processing system on your own and draw the mass and energy balance diagrams.
c. A production system for making butter has been designed so that the final product contains 20 % moisture and 2.3 % salt. In this system salt is added to the input butter as slurry containing 45 % salt and 55% water. Estimate the moisture content of butter prior to the addition of salt.

4.

a. Explain the modes of Heat Transfer and illustrate how these systems are utilized in the food processing industry.

b. A cold store has a wall comprising 10 cm of brick on the outside, then 08 cm of concrete and then 15 cm of cork. The mean temperature within the store is maintained at 14°C and the mean temperature of the outside surface of the wall is 27°C.

$1/U = 1/C1 + 1/C2 + 1/C3$, U = over all conductance

$Q = U A DT$, A = area under heat transfer, DT= temperature gradient

Calculate the rate of heat transfer through the wall. The appropriate thermal conductivities 0.69, 0.76 and 0.043 J m^{-1} s^{-1} $°C^{-1}$ for brick, concrete and cork, respectively.

Determine the temperature at the interfaces between concrete and cork layers, and brick and concrete layers.

5.

a. Explain the Triple Point of water.

b. What is drying? Give four (04) benefits drying of food materials.

c. Illustrate any three (03) types of dryers and explain the advantages, disadvantages and your suggestions to overcome disadvantages.

d. A food containing 70% water is to be dried at 100°C down to moisture content of 20%. If the initial temperature of the food is 25°C, calculate the quantity of heat energy required per unit weight of original material, for drying under atmospheric pressure. The latent heat of vaporization of water at 100°C and at standard atmospheric pressure is 2257 kJ kg^{-1}. The specific heat capacity of food is 3.8 kJ$kg^{-1}°C^{-1}$ and of water is 4.186 kJ kg^{-1} $°C^{-1}$. Find the energy requirement/kg water removed. (Note: all the moisture contents are on wet basis)

6.

a. What is the use of "Evaporation" in food processing?
b. Draw a Single Effect Evaporator and describe the function of the same.
c. How do you improve the efficiency of this single effect evaporator?
d. A single effect evaporator is required to concentrate a solution from 15% solids to 35% solids at the rate of 200 kg of feed per hour. If the pressure in the evaporator is 77 kPa absolute, and if steam is available at 200 kPa gauge. Calculate the quantity of steam required per hour and the area of heat transfer surface if the overall heat transfer coefficient is 1700 J m^{-2} s^{-1} $°C^{-1}$.

   Assume that the temperature of the feed is 18°C and that the boiling point of the solution under the pressure of 77 kPa absolute is 91°C. Assume, also, that the specific heat of the solution is 4.186 x 10^3 J $kg^{-1}°C^{-1}$, and the latent heat of vaporization of the solution is 2164 kJ/kg. Latent heat of steam is 2240 kJ/kg and specific heat of water is same as solution.

7.

a. Why do we do Size Reductions of food materials?
b. What are the equipments used for size reductions. Sketch and explain the functions.
c. Explain the terms Emulsification and Mixing.
d. What are the ways and means of Mechanical Separation of particles?
e. If you are assigned to design a dust separation mechanism for an ECP dryer in Tea Industry draw your design and explain how it works.
f. Calculate the Settling Velocity of dust particles of 60 μm in an air stream at 21 °C and 100 kPa. Assume density of particles as 1280 kg/m^3 and that of air is 1.2 kg/m^3

   Viscosity of air 1.8 x 10^{-5} Ns/ m^2

   Terminal velocity $V = D^2g(\rho_P - \rho_f)/18\mu$