THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

SECOND SEMESTER EXAMINATIONS – 2021

FOOD TECHNOLOGY – SECOND YEAR DEGREE

FT 222 FOOD UNIT OPERATIONS I

MONDAY 01ST NOVEMBER – 12:50 PM

TIME ALLOWED: 3 HOURS

INFORMATION FOR CANDIDATES:

1. You have 10 minutes to read the paper. You must not begin writing in the answer book during this time.
2. **ANSWER ALL QUESTIONS**
3. All answers must be written in the answer books provided.
4. Write your name and number clearly on the front page. **Do it now.**
5. Calculators are permitted in the examination room. Notes and textbooks, laptops and mobile phones are not allowed.
6. Show all workings and calculations in the answer book.

MARKING SCHEME

Question 1	[21 marks]
Question 2	[13 marks]
Question 3	[15½ marks]
Question 4	[16 marks]
Question 5	[21 marks]
Question 6	[13½ marks]

ANSWER ALL QUESTIONS

1. (a) Terminal velocity is an important term used in sedimentation calculations. Explain the situations when terminal velocity is attained. [3 marks]

(b) Determine the uses of Stoke's equation. [2 marks]

(c) Two particles settle in water at the same terminal velocity starting from the same horizontal level. The viscosity of the water is 9×10^{-4} Pa.s and one particle has a density and a diameter of 1412 kgm^{-3} and 560μm respectively, while the other has a diameter of 430 μm.

(i) Calculate the density of the second particle. [4 marks]
(ii) State ALL valid assumptions. [2 marks]

(d) Water is used to wash down an oil-filler plant at the rate of 4 parts water to each part oil, at the flow rate of 550 kgh^{-1}. You are tasked to design a sedimentation tank following the wash down to separate oil from water before the water is discharged. Upon leaving the sedimentation tank, the water is oil-free and the settling velocity of the oil globules is found to be 40μms^{-1}.

(i) Determine the flow rate of the oil from the sedimentation tank, stating any assumptions. [5 marks]
(ii) Determine the flow rate of the water from the sedimentation tank. [2 marks]
(iii) Calculate the effective area of the tank. [3 marks]

(Total = 21 marks)

2. (a) With reference to the solubility and saturation curve for sucrose in water, describe the behaviour of the solution within the following sections:

(i) Above the super-saturation line. [1 mark]
(ii) Within the meta-stable region. [2 marks]
(iii) Along the solubility curve. [2 marks]

(b) Discuss the factors that determine the rate of nucleation. [4 marks]

(c) Explain the working principle of a multi-effect evaporator used for manufacturing of salt crystals. [4 marks]

(Total = 13 marks)

3. (a) Explain ALL the benefits of size reduction. [5 marks]

(b) Using illustrations, describe the THREE main forces involved in size reduction operations. [3 marks]

(c) If you are an engineer responsible for flour milling operation;
(i) what would be your primary consideration and why? [3 marks]
(ii) how would you specify your product and why? [3 marks]

(d) Explain electrostatic charge as a factor affecting screening efficiency. [1½ marks]

(Total = 15½ marks)

4. (a) What is the most important factor that must exist in order for mixing to occur, and how can this factor be created? [2 marks]

(b) Briefly describe the main categories of mixers that exist in the food industry. [3 marks]

(c) HLB numbers of emulsifiers indicate the type of emulsion these emulsifiers can be used in. Explain. [5 marks]

(d) Define the term homogenization and explain the operating principle of a pressure homogenizer. [6 marks]

(Total = 16 marks)

5. (a) Compare and contrast extraction and expression. Include in your Answer ANY advantages one has over another. [4 marks]

(b) What are the stages involved during the extraction process? [3 marks]

(c) Describe the components and the working principle of a cake press. [5 marks]

(d) It was recorded that peanuts contain 45% oil. This is to be extracted using a multi – stage counter-current extraction plant so that the final spent cake contain not more than 5% oil. The rich solution leaving stage 1 has a solute concentration of 60%. A constant underflow of 3700 g of solution adhering to every 2 kg of insoluble solids leaves each stage when fresh solvent is added.

(i) Estimate the number of stages required for this extraction duty. [7 marks]

(ii) What is the concentration of solute in the solution leaving stage 2? [2 marks]

(Total = 21 marks)

6. (a) FULLY discuss wet-cleaning of raw materials. [4 marks]

(b) Differentiate between cleaning in place (CIP) and cleaning out of place (COP). In your answer state their advantages and disadvantages. [5 marks]

(c) The cost of cleaning and sanitation operations form an integral part of food processing, because it can be of a pronounced economic burden to the processor. How can it be minimized? [3 marks]

(c) It is necessary to abate odour that are usually considered pleasant, such as the roast coffee odour in cleaning and sanitation. Why is this so? [1½ marks]

(Total = 13½ marks)

USEFULL DATA

XpA +XpB + XpC=1	$N = -D\frac{dC}{dX}$
$X_B = \frac{k}{(k+1)} - X_A$	$\frac{d_w}{d_t} = DA[C_s - C]$
$X_A = 0,\ X_B = \frac{k}{k+1}$	$F_G = \rho_P V_P . g$
$X_B = 0,\ X_A = \frac{k}{k+1}$	$(Re)p = \frac{\rho_f V_t D}{\mu}$
$V_t = \frac{D^2(\rho_p - \rho_f)g}{18\mu}$	$A_{min} = \frac{S}{\rho_f V_t}$
$S = \rho_f A V$	$A_{min} = \frac{F}{\rho_f V_t}\left[\frac{XS - XF}{XS}\right]$
$A_{min} = \frac{F}{\rho_f V_t}\left[\frac{XU - XF}{XU}\right]$	$S = \frac{F_{XU} - F_{XF}}{XU} = F\frac{XU - XF}{XU}$
$A = \pi dL$ (Cylinder Wall – Curved)	$A = \frac{\pi d^2}{4}$ (Cylinder End - Round)
$\frac{P}{D^5 N^3 \rho} = c\left(\frac{D^2 N \rho}{\mu}\right)^a$	$E = K_R\left[\frac{1}{d_2} - \frac{1}{d_1}\right]$
$E = 2K_B\left[\frac{1}{\sqrt{x_2}} - \frac{1}{\sqrt{x_1}}\right]$	$E = K_k . Ln\left[\frac{d_1}{d_2}\right]$
$Q = \frac{\pi . Dr . N . Dp . L}{60}$	$E_O = \frac{X_F - X_R}{X_P - X_R}$
$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$	$E_{REC} = \frac{P_{xp}}{F_{XF}}$