UNIVERSITY OF GHANA

BSC. ENGINEERING. FIRST SEMESTER EXAMINATIONS: 2018/2019

DEPARTMENT OF FOOD PROCESS ENGINEERING

FPEN 201: INTRODUCTION TO FOOD PROCESS ENGINEERING (2 CREDITS)

INSTRUCTIONS: ANSWER SECTION A AND THREE QUESTIONS FROM SECTION B MAKING A TOTAL OF FOUR QUESTIONS

GRAPH SHEETS WILL BE SUPPLIED AS NEEDED.

TIME ALLOWED: TWO AND A HALF (2½) HOURS

SECTION A (COMPULSORY)

1. A Company processing orange juice in Nsawam decided to provide the market with concentrated orange juice a with fresh taste quality by utilizing evaporation and "cut-back" processes. In a typical operation fresh orange juice with 16% soluble solids content was concentrated to 70% in a multiple effect evaporator. The concentrated juice was mixed with fresh juice to give a mixture of 50% soluble solids.
    a. Draw a flow diagram of the process showing the material streams.
    b. Calculate how much
        i. water will be evaporated per hour.
        ii. fresh juice will be added back.
        iii. final product will be produced.

    Assume a Steady State and an inlet feed flow rate of 12,500 kg/h fresh juice

SECTION B (ANSWER THREE QUESTIONS)

2.
    a. Define unit operation and discuss its characteristics which make them important in the work Food Process Engineer.

    b. What is a Process Flow diagrams (PFD)? Draw the diagram demonstrating the following:
        i. Open steam and Closed Steam

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ii. Continuous and batch operation
iii. Inventory Process
iv. Separation Process
v. Assembly Process
vi. Chemical Change Process

3. A community-based maize processing facility produces dry fermented maize flour. In a typical operation 375 kg of maize (10% moisture) was soaked in water to give 450 kg of soaked maize. This was milled to yield 447.5 kg of flour. Water was added to the flour and mixed into 560 kg of dough (45% moisture content). The 560 kg of the fermented maize dough (45% moisture content) was dried using a solar drier. The material was charged equally unto four trays and kept in the solar drier for 6 days. The moisture content of the resulting dried fermented maize after each of the six days are summarized in the Table below.

DAY	MOISTURE CONTENT % (as is basis)			
	TRAY 1	TRAY 2	TRAY 3	TRAY 4
1	42.75	39.90	40.30	43.72
2	34.60	32.74	34.10	35.41
3	25.41	23.66	23.40	24.30
4	15.50	14.5	14.2	16.00
5	11.40	12.30	10.60	11.60
6	10.80	12.20	10.57	11.45

The products from the four trays were mixed and co-milled in a disc attrition mill to yield 300 kg of flour.

a. Calculate the amount of water needed to make the dough.

b. Following appropriate computations, plot the data to show the drying behaviour of the maize dough. Explain your results.

c. Perform a complete material balance over the drying process.

4. 1000 kg/h of milk is heated in a heat exchanger from 45°C to 72°C. Water is used as the heating medium, it enters the heat exchanger at 90°C and leaves at 75°C. Calculate the mass flow rate of the heating medium, if the heat losses to the environment are equal to 1 kW. The heat capacity of water is given equal to 4.2 kJ/kg°C and that of milk 3.9 kJ/kg°C.

Assumptions:

- The terms of kinetic and potential energy in the energy balance equation are negligible.
- A pump is not included in the system ($W_s = 0$).
- The heat capacity of the liquid streams does not change significantly with temperature.

The system is at steady state

5.

a. The discipline of Food Process Engineering has developed in the past 40 years. Identify two (2) unique processes which have been developed by Scientists and Engineers and have had critical impact in the field. Give reasons for your selection. Delineate the scientific/engineering principles underlying the processes and their applications in the food industry.

b. The specific heat capacity of a food can be given by the equation

$$C_p = 1.424\ m_c + 1.549\ m_p + 1.665\ m_f + 0.837\ m_a + 4.187\ m_w + 2.050\ m_i$$

i. Calculate the specific heat of (a) guava (above freezing point) and (b) frozen guava if the moisture content of guava is 86%.

ii. Calculate the specific heat of snail meat if it has the following composition.
- Water = 72.5 g/100g
- Protein = 20.0 g/100g
- Fat = 6.52 g/100g
- Ash = 0.98

6.

a. Explain the following terms used in thermal and unsteady state processes:

i. Thermal Death Time
ii. Sterilization in retorting
iii. Biot's number and its implications.

b. In canning, apart from sterilizing at 121 °C, a processor can determine other temperatures that can carry out the same effectiveness as at 121 °C. Considering Figure 1 below, given

$$\log t - \log F = m(121 - T) = \log t / F,$$

derive the thermal death time expression, $t_{T=} F \times 10^{\frac{(121-T)}{z}}$

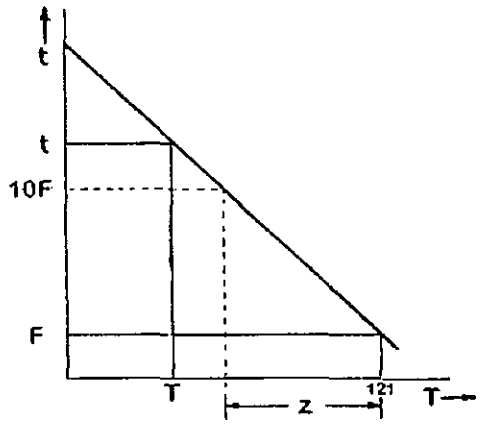

Figure 1