UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER

PROGRAM	:	BACHELOR OF SCIENCE IN FOOD SCIENCE, NUTRITION AND TECHNOLOGY YEAR II
COURSE CODE	:	FSNT 205
TITLE OF PAPER	:	PRINCIPLES OF FOOD ENGINEERING
TIME ALLOWED	:	TWO (2) HOURS
INSTRUCTIONS	:	ANSWER QUESTION ONE (1) AND ANY OTHER TWO (2) QUESTIONS. ILLUSTRATE YOUR ANSWERS WITH DIAGRAMS WHERE NEEDED

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QUESTION 1 [COMPULSORY]

(a) Canned food is thermally treated in a sterilizer whose processing temperature is 135°C. If the initial microbial load is 1000 CFU/container and it is desired to reduce it to 10^{-6} CFU/container, calculate the processing time. The target microorganism for this thermal process has a decimal reduction time of 3 min for a reference temperature of 121°C, and to reduce the process time to the tenth part (reduce by 90%) it is required to increase the temperature by 10°C. (j_h = 2, f_h = 35, Initial product temperature is 25 °C). **(15 Marks)**

(b) Orange juice flowing through a pipe at a rate of 30 kg/min is sweetened by adding concentrated sugar solution (30 % sugar) to the pipe line at constant rate. At what rate would the concentrated sugar solution be added to provide 10% sugar in the product? **(10 Marks)**

(c) The wall of a cold store is made of concrete lined with insulator. The temperature of the inner wall surface is 5°C and that of the outer surface is 25°C. The thickness of the concrete layer is 10 cm and the thickness of the insulation is 8 cm. The thermal conductivity of concrete and the insulator is 1.5 W/m°C and 0.056 W/m°C respectively, Calculate the total resistance of the wall to heat transfer and the heat transfer losses through the wall if the wall area is 16 m^2. **(15 Marks)**

[TOTAL MARKS = 40]

QUESTION 2

(a) Explain the following: **(20 Marks)**

i. Lethal rate
ii. Constant rate drying period
iii. Hysteresis
iv. Decimal reduction time
v. Thermal Death Time (TDT) curve

(b) Explain why one has to be concerned about micro-organisms during thermal processing of foods. **(10 Marks)**

[TOTAL MARKS = 30]

QUESTION 3

(a) Outline the advantage of multiple effect evaporation system and show a three-effect backward feed type evaporation system. **(10 Marks)**

(b) For a continuous counter current multi stage (with n – stages) extraction system, write the mass balance equation **(10 Marks)**

i. for the whole system
ii. between the first stage and any intermediate stage *"i"*

(c) Outline the advantages of continuous operation. **(10 Marks)**

[TOTAL MARKS = 30]

QUESTION 4

(a) Explain the principle behind separation by filtration and centrifugation. **(10 Marks)**

(b) With the help of sketch, explain the constant rate and constant pressure filtration systems. **(10 Marks)**

(c) Define psychrometry and describe the drying or adiabatic saturation process. **(10 Marks)**

[TOTAL MARKS = 30]

Relationships f_h/U:g for Values of $z = 10$ °C

f_h/U	Values of g (°C) when j is:								
	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.2	2.27×10^{-5}	2.46×10^{-5}	2.64×10^{-5}	2.83×10^{-5}	3.02×10^{-5}	3.20×10^{-5}	3.39×10^{-5}	3.58×10^{-5}	3.76×10^{-5}
0.4	7.39×10^{-3}	7.94×10^{-3}	8.44×10^{-3}	9.00×10^{-3}	9.50×10^{-3}	1.00×10^{-2}	1.06×10^{-2}	1.11×10^{-2}	1.16×10^{-2}
0.6	4.83×10^{-2}	5.24×10^{-2}	5.66×10^{-2}	6.06×10^{-2}	6.44×10^{-2}	6.83×10^{-2}	7.28×10^{-2}	7.67×10^{-2}	8.06×10^{-2}
0.8	0.126	0.136	0.148	0.159	0.171	0.182	0.194	0.205	0.217
1	0.227	0.248	0.269	0.291	0.312	0.333	0.354	0.376	0.397
2	0.85	0.92	1.00	1.07	1.15	1.23	1.30	1.38	1.45
3	1.46	1.58	1.69	1.81	1.93	2.04	2.16	2.28	2.39
4	2.01	2.15	2.30	2.45	2.60	2.74	2.89	3.04	3.19
5	2.47	2.64	2.82	3.00	3.17	3.35	2.53	3.71	3.88
6	2.86	3.07	3.27	3.47	3.67	3.88	4.08	4.28	4.48
7	3.21	3.43	3.66	3.89	4.12	4.34	4.57	4.80	5.03
8	3.49	3.75	4.00	4.26	4.51	4.76	5.01	5.26	5.52
9	3.76	4.03	4.31	4.58	4.86	5.13	5.41	5.68	5.96
10	3.98	4.28	4.58	4.88	5.18	5.48	5.77	6.07	6.37
20	5.46	5.94	6.42	6.89	7.37	7.84	8.32	8.79	9.27
30	6.39	6.94	7.56	8.11	8.72	9.33	9.89	10.5	11.1
40	7.11	7.72	8.39	9.06	9.72	10.4	11.1	11.7	12.4
50	7.67	8.39	9.11	9.83	10.6	11.3	12.0	12.7	13.4
60	8.22	8.94	9.72	10.5	11.2	12.0	12.7	13.5	14.3
70	8.67	7.78	10.2	11.1	11.8	12.6	13.4	14.2	15.0
80	9.01	9.89	10.7	11.6	12.3	13.2	14.0	14.8	15.6
90	9.44	10.28	11.2	12.0	12.8	13.7	14.5	15.3	16.2
100	9.78	10.7	11.6	12.4	13.3	14.1	15.0	15.8	16.7