



1<sup>ST</sup> SEM. 2016/17

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**UNIVERSITY OF SWAZILAND**  
**FINAL EXAMINATION PAPER**

**PROGRAMME** : **BACHELOR OF SCIENCE IN FOOD SCIENCE,  
NUTRITION AND TECHNOLOGY YEAR II**

**COURSE CODE** : **FNS201**

**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**

**DO NOT OPEN THIS PAPER UNTIL PERMISSION HAS BEEN GRANTED BY  
THE CHIEF INVIGILATOR**

**QUESTION 1 (COMPULSORY)**

(a) The decimal reduction time  $D$  at  $121^{\circ}\text{C}$  ( $D_{121}$ ) and the value  $z$  for a thermophilic spore in whole milk were determined experimentally to be equal to 30 sec. and  $10^{\circ}\text{C}$  respectively.  
(15 Marks)

- i. Calculate the  $D$  value at  $150^{\circ}\text{C}$  ( $D_{150}$ )
- ii. Determine the required heating time at  $121^{\circ}\text{C}$ ,  $F_{121}$  value for a 9 log cycles population reduction.
- iii. Determine the required heating time at  $150^{\circ}\text{C}$ ,  $F_{150}$  value for a 9 log cycles population reduction.

(b) Air with  $20^{\circ}\text{C}$  dry bulb temperature and 12 g water/kg dry air at 1 atm was heated to  $50^{\circ}\text{C}$  dry bulb temperature. The heated air passed through a dryer, picking up moisture adiabatically, and left the dryer at 90% relative humidity. Show the process on a psychrometric chart and determine the properties of the heated air and the air leaving the dryer.  
(15 Marks)

(c) Apple juice was clarified using centrifugal clarifier. Apple juice with 25% solids was fed to the clarifier at the rate of 200 kg/min. The solid stream that leaves the clarifier has 65% solids whereas the clarified apple juice has 2% solids. Determine the rate of flow of the clarified and the solid streams.  
(10 Marks)

[TOTAL MARKS = 40]

**QUESTION 2**

(a) Write short notes on the following:

- i. Coefficient of performance
- ii. Batch operation
- iii. Continuity equation
- iv. Sorption Isotherms

(4×5 = 20 Marks)

(b) Explain the importance of energy balance in food processing operations. (10 Marks)

[TOTAL MARKS = 30]



**QUESTION 3**

- (a) Discuss laminar and turbulent flow. (10 Marks)
- (b) Describe the mechanism of heat transfer through a tube conveying hot fluid and show how resistance to heat transfer is computed. (10 Marks)
- (c) Describe ways of measuring heat resistance of micro-organisms. (10 Marks)

**[TOTAL MARKS = 30]**

**QUESTION 4**

- (a) Explain the shear thinning and shear thickening behaviours of fluids. (10 Marks)
- (b) An air-vapour mixture is at 25°C dry bulb temperature and 55% relative humidity. Using the psychrometric charts provided on pages 4 and 5, determine all other properties. (12 Marks)
- (c) With the help of a sketch, describe shell and tube heat exchangers. (8 Marks)

**[TOTAL MARKS = 30]**



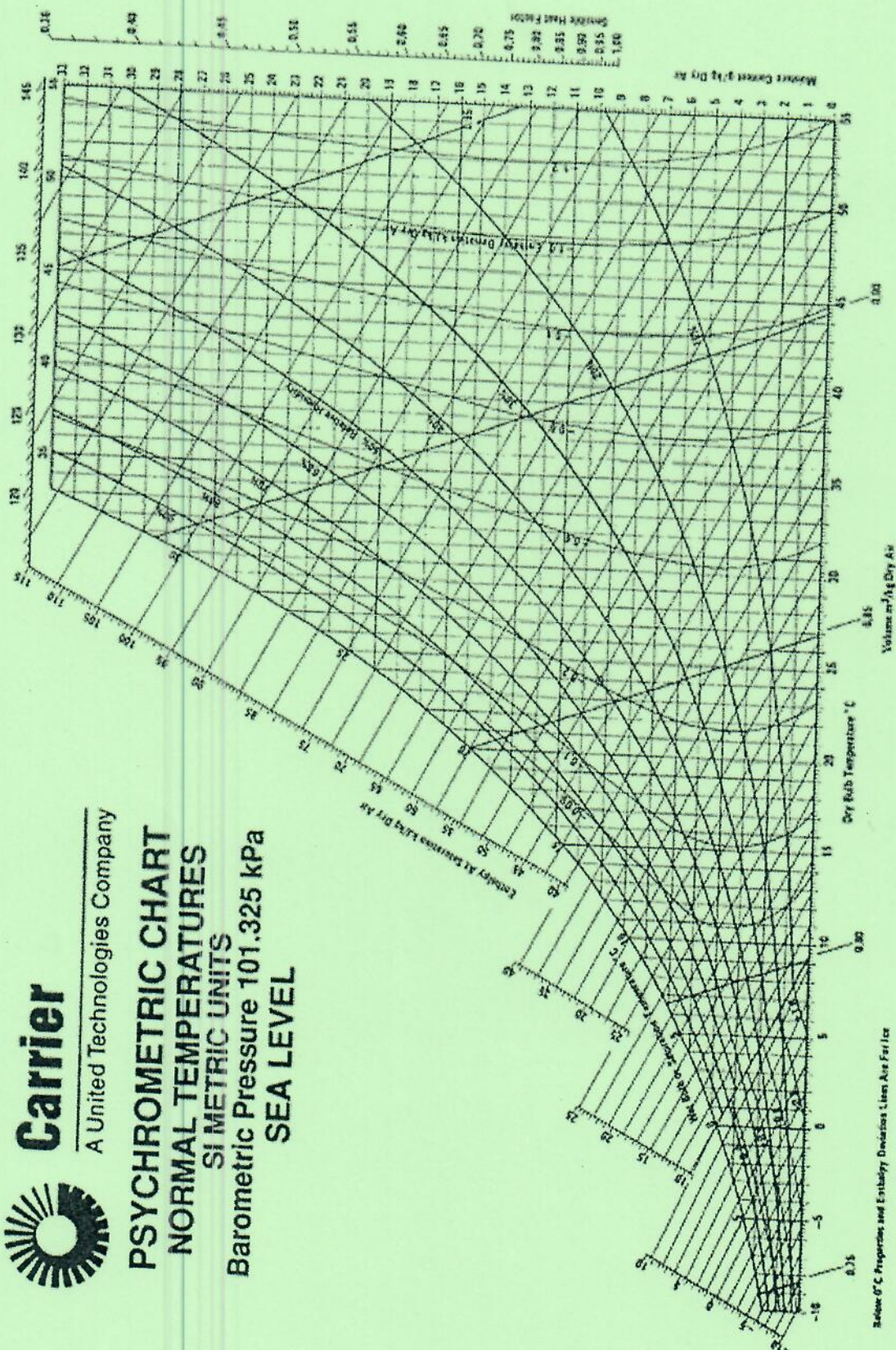


**Carrier**

A United Technologies Company

**PSYCHROMETRIC CHART  
NORMAL TEMPERATURES  
SI METRIC UNITS**

Barometric Pressure 101.325 kPa  
SEA LEVEL







PSYCHROMETRIC CHART  
HIGH TEMPERATURES  
SI METRIC UNITS  
Barometric Pressure 101.325 kPa  
SEA LEVEL

