UNIVERSITY OF ESWATINI

FINAL EXAMINATION PAPER

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| **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** |

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## QUESTION 1 (COMPULSORY)

(a) A bottled food is thermally treated at 130°C to reduce the microbial load which was 10,000 per bottle. The decimal reduction time (D) of the target microorganism at this temperature was found to be 2.1 min. **(15 Marks)**

    i. If the probability of survival of the organism is targeted to be one in million bottles of products, calculate the time required to reach at this probability.

    ii. If the z-value is 10°C, calculate the time required to reach at the same target at 125°C.

(b) Hot air dryer was used to dry banana. Ambient air at 20 °C dry bulb temperature and 10 g water/kg dry air at 1 atm was heated to 50°C dry bulb temperature. The heated air passed through a dryer, picking up moisture adiabatically, left the dryer at 80% 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) A vegetable soup flowing through a pipe at a rate of 15 kg/min is salted by adding concentrated salt solution (45 % salt) to the pipe line at constant rate. At what rate would the concentrated salt solution be added to provide 15% salt in the product? **(10 Marks)**

**[TOTAL MARKS = 40]**

## QUESTION 2

(a) Write short notes on the following:
    i. D-value
    ii. Cooling load
    iii. Continuous process
    iv. Newtonian fluid     **(4×5 = 20 Marks)**

(b) Explain the drying process using psychometric chart and describe the changes in the properties of the air used for drying. **(10 Marks)**

**[TOTAL MARKS = 30]**

## QUESTION 3

(a) Discuss shear thinning and shear thickening behavior using shear stress-shear rate graph. **(10 Marks)**

(b) Calculate the rate of heat transfer through a composite wall of a processing room made of brick lined with an insulation layer with 10 m$^2$ surface area. The insulation and brick have thickness of 8 cm and 15 cm, respectively. The temperature on the two sides of the composite wall is 15 °C and 30 °C. The thermal conductivity of the insulator is 0.07 W/m°C and that of the brick is 0.6 W/m°C. The system is at steady state. **(10 Marks)**

(c) Describe mass transfer by molecular diffusion and convective mass transfer. **(10 Marks)**

**[TOTAL MARKS = 30]**

## QUESTION 4

(a) Describe how multiple effect evaporation works and name the different configurations. **(10 Marks)**

(b) An air–vapour mixture is at 30°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) Name the units/component parts of a refrigeration system and explain **two (2)** further. **(8 Marks)**

**[TOTAL MARKS = 30]**
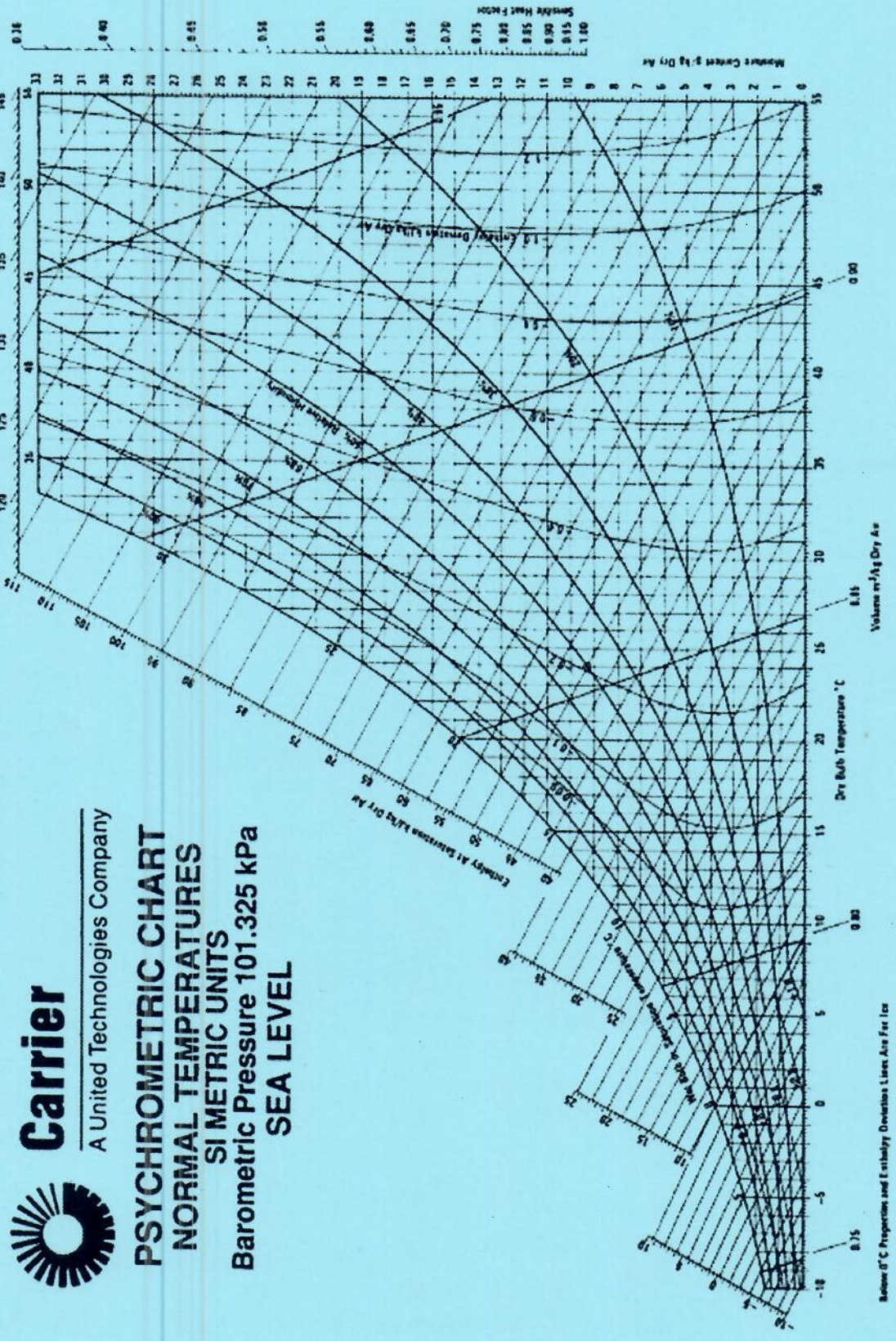
**Carrier**
A United Technologies Company

**PSYCHROMETRIC CHART**
**NORMAL TEMPERATURES**
**SI METRIC UNITS**
**Barometric Pressure 101.325 kPa**
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