University of Ruhuna- Faculty of Technology

Bachelor of Biosystems Technology Honours Degree
Level 2 (Semester I) Examination, June/July 2023
Academic year 2021/2022

Course Unit: BST 2123 Engineering properties of biomaterials (Theory)

Duration: 2 hours

. Instructions:

- Answer **Four (4)** questions only.
- Use the separate book for answering the questions.
- Each question should be started with a new page.

1) Knowledge of the thermal properties of biomaterial is important for biosystems and related industries.

   a. State the thermal properties of materials that you may consider when fabricating a cereal storage tank. [10 marks]

   b. Discuss the importance of these thermal properties in industrial applications. [30 marks]

   c. Two materials X & Y were tested for thermal conductivity using a thermal conductivity meter. Accordingly, the mean values of the heat flux and the temperature gradient obtained are given in Table 01.

   Table 01

Material	Heat Flux (W/m^2)	Temperature Gradient (K/m)
X	7.60	152
Y	12.50	25

   i. Write an equation relating heat flux, temperature gradient, and thermal conductivity. Define all the terms. [10 marks]

   ii. Calculate the thermal conductivities of X and Y. [20 marks]

   iii. Write which material is most suitable for a thermal insulation coating on a storage tank. Explain your answer. [15 marks]

   d. Estimate the specific heat of potatoes containing 70% water. State any assumption you used for this calculation. (Specific heat of water - 4186.80 J/kg K, Specific heat of non-fat solid - 837.36 J/Kg K) [15 marks]

[Total-100 marks]

2) Ohmic heating, pulsed electric field (PEF) processing and microwave heating are novel processing techniques that operate based on the electrical properties of biomaterials.

a. Identify and list the electrical property involved in each technique. [15 marks]

b. Discuss the similarities and differences between ohmic heating and PEF processing techniques. [20 marks]

c. A simplified circuit diagram of an ohmic heating setup used to heat a cylindrical sample is shown in figure 01. Dimensions of the cylindrical sample are given in table 02.

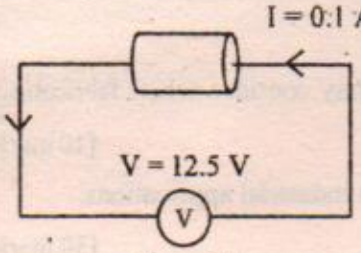

Figure 01

Table 02

Length (cm)	5.0
Cross-sectional area (cm^2)	0.8

i. Calculate the resistance of the sample. [05 marks]

ii. Calculate the electrical conductivity of the sample material. [15 marks]

iii. In a fruit processing unit, apples and strawberries are subjected to ohmic heating until they reach a temperature of 50 ^{0}C. Predict which fruit will take the least time for the process considering their electrical conductivities. Justify your answer by giving reasons. (Electrical conductivity of Apple and Strawberries are 0.067 S/m and 0.186 S/m, respectively).

[15 marks]

d. Explain the following terms using **one** or **two** sentences **only**.

i. Electrical Permittivity.

ii. Dielectric constant.

iii. Dielectric loss factor.

[10 marks x 3]

[Total – 100 marks]

3) Beer production involves malting, milling, mashing, extract separation, hop addition and boiling, removal of hops and precipitates, cooling and aeration, fermentation, separation of yeast, aging, maturing, and packaging. The entire process focused on producing the alcoholic, lightly carbonated beverage by converting starch to alcohol.

a. Briefly discuss the quality parameters which are important to maintain the quality of beer.

[25 marks]

b. Explain the importance of the maturation/aging process of green beer. [25 marks]

c. The grist composition is an important parameter to increase the extraction efficiency of fermentable sugar. Briefly discuss the physio-chemical conditions of the process which affect the extraction efficiency of fermentable sugar starting from barley to grist production. [50 marks]

[Total – 100 marks]

4) The primary and major products of natural rubber latex (NR) are very useful as it contains about 25-45% rubber by weight and can be processed into secondary products such as crepe rubber, crumb rubber, and sheet rubber for onward processing into finished goods.

a. Briefly explain the importance of the vulcanization process of natural rubber.

[25 marks]

b. Discuss the importance and composition of the cleaning tank and coagulant tank in NR glove production. [35 marks]

c. Pinhole and web hole defects in surgical rubber gloves may pose higher risks of infection in both healthcare workers and patients. Discuss latex testing parameters that are used to minimize the pinhole and web holes of the NR gloves.

[40 marks]

[Total – 100 marks]

5) Answer all parts.

a. Explain the effect of mechanical damage on fruit for their post-harvest life.

[25 marks]

b. Distinguish the thermoplastic polymer and thermosetting polymer by providing suitable examples. [25 marks]

c. Write a short note on the differential scanning calorimeter (DSC). [50 marks]

[Total – 100 marks]

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