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University Examinations 2024/2025

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY

AFT 3200: FOOD ENGINEERING I

DATE: JANUARY 2025 **TIME: 2 HOURS**

INSTRUCTIONS:

- *Answer Question ONE and any other TWO questions. Psychometric chat provided*

QUESTION ONE (30 MARKS)

a) Differentiate the following terms as used in food engineering.

i. Extensive and intensive property (2 Marks)

ii. Shear thinning and shear thickening (2 Marks)

iii. Rising and falling film evaporator (2 Marks)

iv. D-value and Z-value (2 Marks)

v. Electroporation and cavitation (2 Marks)

b) A food sample had 380% moisture content in dry basis. Determine the moisture content on wet basis and the percentage dry matter. (3 Marks)

c) A 1000kg fruit pulp contains 10% of suspended fruit solids. After filtration, a juice and wet solids were obtained. The wet solids contained 20% moisture. Determine the amount of juice and wet solids obtained (3 Marks)

d) A layer of fat 5 mm thick underneath the skin covers a part of a human body. If the temperature of the inner surface of the fat layer is 36.6 ^{o}C and the body loses heat at a rate of 200 W/m^2, what will be the temperature at the surface of the skin? Assume that the thermal conductivity of fat is 0.2 W/m ^{o}C. (3 Marks)

e) Highlight three sustainable energy sources of generating steam in food processing. (3 Marks)

f) Determine the relative humidity and wet bulb temperature of air with 30 ^{o}C dry bulb temperature and moisture content of 20.5 g water/kg dry air at 1 atm. (2 Marks)

g) Plot a well labelled diagram showing the relationship between drying rate and moisture content of a product during drying process. (3 Marks)

h) Highlight 3 applications of artificial intelligence (Al) in food processing. (3 Marks)

QUESTION TWO (20 MARKS)

a) Using an appropriate illustration, discuss the principle of operation of the following equipment listing one application in each case.

i. Solar drier (5 Marks)

ii. Pulsed electric fields electroporation chamber. (5 Marks)

iii. Counter current tubular heat exchanger (5 Marks)

iv. Peristaltic pump (5 Marks)

QUESTION THREE (20 MARKS)

a) After completing your degree, you are employed as a supervisor in a food processing industry. The company wants to build a cold store with 100mm thick outer wall of concrete and a 10 mm thick inner wall of wood with a 120 mm space in between filled with polyurethane foam. If the inner temperature is 2 ^{o}C and the outer wall is maintained at the ambient air temperature of 25 ^{o}C.

Calculate the rate of heat penetration and temperature at interfaces. Thermal conductivity of concrete is 0.80, insulation 0.025 and wood 0.17 ($WM^{-1}K^{-1}$). The dimension of the wall are 2.5 x 4 metres. (15 Marks)

b) Define 3D printing and discuss 3 applications of 3D printing in food processing. (5 Marks)

QUESTION FOUR (20 MARKS)

a) Ultrasound is a non-thermal food processing technology. Discuss the principle it employs to preserve the food and list 3 applications. (10 Marks)

b) Determine the time required to dry a product from 80 to 20% moisture (wet basis) in a dryer where 2.5 kg dry solid/m^2 surface area is exposed to the air. The critical moisture content is 5 kg water/ kg dry solid, the equilibrium moisture content is 0.025 kg water/ kg dry solid, and the drying rate at the critical moisture content is 3 kg water/m^2 h. (10 Marks).