UNIVERSITY OF GHANA

B.Sc SECOND SEMESTER FINAL EXAMINATION, 2014/2015

FPEN 304: ENGINEERING AND DESIGN OF FOOD PROCESSES (3 credits)

INSTRUCTIONS **TIME: 2HRS**

(i) Answer FOUR questions
(ii) Refrigerant R134a P-H chart provided

1. A thermal process is being used to reduce the microbial population on product contact surfaces of the packages needed for aseptic packaging of the liquid product. The spoilage micro-organism has a D_{121}=10 min and a z=8°C. The microbial population on the surface is 100 per cm^2 and the product contact surface area is 10 cm^2 for each package. A 9D process has been recommended.

a) What do 'D' and 'z' mean?

b) Determine the process time for the containers at 141°C.

c) Estimate the number of containers with spoilage based on survivors on the package surface when 10 million packages have been filled.

2. A cold storage room is being maintained at 2°C using a vapour-recompression refrigeration system that uses R-134a. The evaporator and condenser temperatures are -10 and 40°C, respectively. The refrigeration load is 10 tons. Calculate

a) the mass flow rate of refrigerant
b) the compressor power requirement at an efficiency of 80%
c) the C.O.P.
d) and the refrigeration effect

Assume the unit operate under saturated conditions

(One ton of refrigeration load = 303,852 kJ/24h)

3. a) List the four components of a refrigeration system and represent their paths on a temperature-entropy (T-S) diagram.

b) Using Planck's equation, determine the freezing time for a potato shaped as an infinite cylinder with a moisture content of 80%. The potato will be frozen in a blast freezer where air is available at -45°C and the convective heat transfer coefficient is 50 W/(m^2.°C). The thermal conductivity of frozen potato is estimated to be 1.1 W/(m °C) and its density is 900 kg.m^3. The initial freezing temperature of potato is -2°C. The diameter of the potato is 3cm. Take the latent heat of water as 333.2 kJ/kg.

4. a) Discuss the different stages of drying a wet solid.

A dry food has been exposed to a 35% relative humidity environment at 15°C for 5 h without a weight change. The moisture content has been measured and is 8.5% (wet basis). The product is moved to a 50% relative humidity environment and a weight increase of 0.15 kg/kg product occurs before equilibrium is reached.

b) Determine the water activity of the product in the 1st and 2nd environments.

c) Compute the moisture content of the product on a dry basis in both environments.

5. a) List key differences between sterilization and pasteurization. When is one preferred to the other?

b) The initial moisture content of a food product is 70% (wet basis), and the critical moisture content is 28% (wet basis). If the constant drying rate is 0.12 kg H_2O/m^2s, compute the time required for the product to begin the falling-rate drying period. The product has a cube shape with 6-cm sides, and the initial product density is 950 kg/m^3.