UNIVERSITY OF GHANA

BSC ENGINEEING SECOND SEMESTER EXAMINATIONS: 2016-2017
DEPARTMENT OF FOOD PROCESS ENGINEERING
FPEN 304: ENGINEERING AND DESIGN OF FOOD PROCESSES II (3 CREDITS)

INSTRUCTIONS:
ANSWER ANY FIVE QUESTIONS

TIME ALLOWED: THREE (3) HOURS

1.

a. Discuss the following terms as they apply to commercial sterilization of food preservation:
   i. Pouch Processing Systems,
   ii. Aseptic Processing Systems,
   iii. Continuous Retort Systems,
   iv. Lethality rate

b.
   i. A conduction-heating food product is being thermally processed in a can; the slowest-heating location has f_h = 40 min, j_h = 1.602 and j_c = 1.602. The retort temperature is 125°C, the initial product temperature is 24°C, and the retort come-up-time is 5 minutes. The spoilage microorganism has a D_{121} = 1.1 min and z = 10°C. The acceptable spoilage rate has been established as one can per one million processed. The initial microbial population is 10^3 per can. Determine the operator or processing time.
   ii. If the D_{121} for the spoilage microorganism is 0.7 min and the z is 10 °C, estimate the lethality (F_{121}) for the heating portion of the process.

2.

a. In the design of a modern refrigeration system for food preservation, the selection of a refrigerant is crucial to the success of the design system. Discuss five considerations you will make in the choice of a suitable refrigerant

b. A food storage chamber requires a refrigeration system of 16.5-ton capacity operating at an evaporator temperature of - 5° and a condenser temperature of 35°C. If the condenser

temperature is raised to 35 °C, determine the influence of raising the condenser temperature to 40 °C by calculating the percentage changes in the following;

i. C.O.P.
ii. Refrigerant flow rate
iii. Heat of compression
iv. Rate of heat removed by condenser

Assume refrigerant R-134a is used and the system operates under saturated conditions with compressor efficiency of 87%

[Note: Credit will be given for showing the paths of the refrigerant on the given p-H diagram]

3.

a. As water constitutes a significant proportion of food, the freezing process has a dramatic effect on the thermal properties of food.
   i. Discuss with curves any five thermal properties of food as it is subjected to freezing
   ii. Briefly Compare the thermodynamic transitions that occur when water and potato is subjected to freezing
b. A 5 cm-thick beef steak is being frozen in a -30°C room. The product has 73% moisture content, density of 970 kg/m^3, and thermal conductivity (frozen) of 1.1 W/(m K). Estimate the freezing time. The product has an initial freezing temperature of -1.75 °C, and the movement of air in the freezing room provides a convective heat-transfer coefficient of 5 W/(m^2 K).
   (P' = 1/6 & R' =1/24)

4. The poor stability of enzymes under process conditions is a major obstacle to their widespread application as industrial catalysts. Immobilized enzymes are powerful process catalysts, stable and recoverable, making for an increased efficiency of use and thus reducing their impact on total operating costs. Membrane enzyme reactors on the other hand can also be employed to allow the use of soluble enzymes in a continuous mode of operation.
   a. With the aid of label diagrams distinguish between immobilized and membrane soluble enzymes.
   b. Using appropriate material balance and sound kinetic equations and curves, describe an enzyme bioreactor ((batch stirred-tank reactor (BSTR) or Continuous stirred-tank reactor (CSTRs)) for the processing of a known food

5.

a. The following data were obtained from a thermal resistance experiment conducted on a spore suspension at 112 °C.
Determine the D value of the microorganism and comment on its significance to the preservation process

Time (min)	Number of survivors
0	10^6
4	1.1×10^5
8	1.1×10^4
12	1.2×10^3
16	1.3×10^2

b. Determine the z value for a microorganism that has the following decimal reduction times: $D_{110} = 6$ minutes, $D_{116} = 1.5$ minutes, $D_{121} = 0.35$ minutes, and $D_{127} = 0.09$ minute

6.

a. Discuss the following types of fermenters: batch, fed-batch and continuous fermentations under the heading;
   i. Design and construction,
   ii. Differences between reactors and
   iii. Appropriate area of application
b. Describe how to design and develop a bio-fermenter for processing a locally fermented food product.