

Name: _____ Student ID _____

**Prince of Songkla University
Faculty of Engineering**

**Exam: Final Exam, Semester I
Date: October 13, 2006
Subject: 230-591 - Special Topic
(Food Unit Operations)**

**Academic Year: 2006 – 2007
Time: 13:30 – 16:30
Room: A401**

ทฤษฎีในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทฤษฎี และพักรการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 2 parts. After you have completed the CLOSED BOOK SECTION, you may obtain the OPEN BOOK SECTION from the instructor. Place your name and the student ID number on every page. Students are allowed to use only a pen or pencil. Students may use only class notes and homework materials in the Closed Book Section of the exam. No exams are allowed to leave the room. No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Part	Points Value	Score
I	15	
II	13	
III	52	
IV	20	
V	30	
VI	70	
Total	200	

**Exam prepared by
Ram Yamsaengsung
October 7, 2006**

**PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 10 PAGES OF THE CLOSED BOOK SECTION BEFORE
BEGINNING
(not including the cover sheet).
GOOD LUCK!**

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CLOSED BOOK SECTION (100 points)

Part I. True and Faults (T/F) (15 points), If the statement is false, make it true.

- 1. The thermal resistance constant can be obtained by plotting a semi-log plot between the decimal reduction time and temperature.
- 2. Conduction heat flux is proportional to the thickness of the material and inversely proportional to the thermal conductivity of the material.
- 3. The metabolic activity of microorganisms can decrease the pH of foods.
- 4. It is easier for material with low yield stress to achieve turbulence.
- 5. For turbulent flow to occur in Power-Law and Bingham Plastic fluids, the Reynolds ($N_{Re,PL}$ or $N_{Re,B}$) number must be more than the Critical Reynolds number.
- 6. Under ideal conditions, some Newtonian fluid can become turbulent at Reynolds number of 1,350.
- 7. Sterilized products do not require refrigeration.
- 8. During thermal processing, the population of the microorganisms is reduced in a linear manner.
- 9. Most microorganisms can grow best at intermediate pH and high a_w .
- 10. The decimal reduction time is the time required to cause a 10% reduction in the thermal resistance constant.
- 11. The negative sign in the heat conduction equation indicates that heat flows from high temperature region to low temperature region.
- 12. Products in glass containers require quick heating and cooling for an effective thermal treatment.
- 13. The friction loss coefficients (k_f) values decrease with increasing pipe diameter.
- 14. For laminar flow, the kinetic energy correction factor (α) is always 1.0.
- 15. Rapid freezing increases the number of nuclei formed.

7. Name 4 advantages of vacuum frying? Mention 4 products that can be fried using this type of system. **(6 points)**

8. Discuss the heat and mass transfer processes that take place during the frying of French fries. Draw a diagram and use arrows to show direction of heat and mass transfer. What are some major differences between French fries and potato chips? Which contains more oil? **(12 points)**

Part IV. Short Calculations (20 points)

1. For the pasteurization of orange juice, a regenerative heating/cooling section is used. After the “starter” raw juice has been heated to 85°C, it is passed through a holding loop and into a regeneration section. The juice then heats up the incoming raw juice from 24°C to 68°C. While the “starter” juice temperature decreases to 35°C. Compute the % regeneration of the system. **(4 points)**

2. For problem 1, what is the flow rate of the chilled water required to reduce the temperature of pasteurized juice from 35°C to 2°C? The specific heat of guava juice is 3.67 kJ/kg°C and the specific heat of the chilled water is 4.18 kJ/kg°C, and the mass flow rate of the guava juice is 200 kg/hr. Chilled water enters the heat exchanger counter-currently at 2°C and leaves at 8°C. **(6 points)**

3. What does LMTD stand for? For a countercurrent flow regime, if milk enters the heat exchanger at 28°C and leaves at 65°C, while hot water enters at 85°C and leaves at 50°C, what is the LMTD of the system? Draw the temperature distribution in the heat exchanger. **(6 points)**

4. If the decimal reduction time at 108°C, D_{108} , is 4.5 minutes, how long does it take to reduce the number of microorganisms from 505,350,000,000 to 1 at 126°C if the thermal resistance constant equals 9°C. **(4 points)**

3. If raising the temperature in problem 3 by 7.5°C caused a 90% reduction in the decimal reduction time, how long would it take to **safely** process a can of pineapple at 125.5°C? If a can of pineapple originally contained 6.5×10^{15} microbes/g of product, how many microorganisms would be left after 150 seconds of processing at this temperature? What is the probability of spoilage? A can of pineapple contains 400 g of product. **(10 points)**

4. If the thermal death time is $F_{115}^{6.5}$, what is the spoilage probability of a 250-second process at 128°C, when $D_{115} = 30$ minutes and the initial population is 10^9 per container. **(6 points)**

5. What is the freezing point depression if 400 g of sucrose is added to 2 kg of water? Sucrose is $C_{12}H_{22}O_{11}$. **(4 points)**

Part VI. Long Answers (70 points)

1. You and your business partner just bought an orchard in Trang. The orchard is able to provide 2,000 kg of pineapple, 1,500 kg of pumpkins, 1,500 kg of rambutan, and 500 kg of bananas per month. Assuming you have the capital (money for investment) to construct a food processing facility, describe at least 5 different products that you would produce and the major equipment that you will need. **(30 points)**

2. You just won the Thailand lottery worth 10,000,000 baht and have inside news that countries in the Middle East, Europe, and China are very interested in Thai desserts and snacks. Since you live in the Southern region of Thailand, you have plans to develop products that you can find raw materials easily and at low cost. Discuss your new dessert or snack products that you plan to export to Europe, China or the Middle East. List the major ingredients, how to make it, what processes will you need, how to package it, the price per unit, the units per package, etc. Finally, discuss additional **marketing strategies** that could be used to increase profit. **(40 points)**