Written Exam for the B.Sc. or M.Sc. in Economics, Winter 2011/2012

Operations Research

Elective Course

24 January 2012

3-hour open book exam

Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. I.e. if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by “eksamen på dansk” in brackets, you must write your exam paper in Danish.

If you are in doubt about which title you registered for, please see the print of your exam registration from the students’ self-service system.

Part 1

The American Brunchhouse in Central Copenhagen is famous for its pancakes and French toasts. The real secret is the maple syrup that they import themselves from a small producer in the USA, and from where an order requires 3 weeks for delivery.

The syrup costs them $4 per bottle as well as a fixed cost of $75 for shipping and handling and for bookkeeping expenses. The storage costs is based on a required interest rate of 20% p.a. of capital invested in the inventory.

The Brunchhouse estimates that the weekly demand is 12 bottles with a variance on $16 = 4^2$ $bottles^2$ per week. For the purpose of your calculations, you may assume that there are 52 weeks in a year and that all excess demand is back-ordered.

Question 1.1:
How large an order should the American Brunchhouse place with the supplier and when should those orders be places?

Question 1.2:
What service level measure of type 2 is being provided by the policy found in Question 1.1? (if none is found, you may choose an arbitrarily policy)

Part 2

A company currently produces 5 different products at a production plant. The production is planned considering 3 different constraints. A newly employed operational researcher analyzes the situation. The production plan can undoubtfully be modelled as a linear program, but the operational researcher is puzzled by the current production scheme. He claims that the production plan probably isn't optimal.

Question 2.1:
Is the operational researcher right? Why?

After talking to the sales department, the operational researcher discovers that the LP model before was not adequate. In fact, the quantities in which the 5 products are produced is exactly the maximum quantity that can be sold. Hearing this, the operational researcher claims that the 3 original constraints most likely are not binding.

Question 2.2:
Is the operational researcher right in this new claim? Why?

Part 3

A company produces 4 different products on 3 different factories (1, 2 and 3). The maximum sales of the 4 products, A, B, C and D, is 20, 30, 30 and 40, respectively, and the maximum production quantity of the 3 factories 1, 2 and 3 is 50, 50 and 20, respectively.

The company wishes to maximize its profits. The profit per unit is given in the following table:

Profit per unit	Product			
Factory	A	B	C	D
1	41	27	28	24
2	40	29	42	23
3	37	30	27	21

Question 3.1:
Which production plan would you suggest when it is allowed to produce more than one different product per factory?

Question 3.2:
The company wants to analyze a proposed simplification of the production plan. The simplification consists in requirering that each factory is assigned to produce only one product. Which production plan would then be optimal? Which product is no longer produced?

Part 4

A student has 7 days for studying before her final 4 examinations. She wants to allocate this time as effectively as possible. She needs at least one day for each course and she wants to concentrate on just one course each day, so she wants to allocate 1, 2, 3 or 4 days to each course.
Since she recently took an OR course, she decides to use dynamic programming o make these allocations to maximize the total grade points to be obtained from the four courses. She estimates that the alternative allocations for each course would yield the number of grade points shown in the following table:

Study days	Estimated grade points Course			
	1	2	3	4
1	3	5	2	6
2	5	5	4	7
3	6	6	7	9
4	7	9	8	9

Question 4.1:
Formulate a recursion formula to use in dynamic programming for solving this problem and explain how the Principle of Optimality can be expressed in this case.

Question 4.2:
Solve the problem using dynamic programming.