Session 3

Exercise 1

Max Havelaar Coffee sells two types of gourmet coffee: a deluxe blend, which sells for € 4.50 per kg, and a premium blend, which sells for € 6.00 per kg. For both types of coffee, Max Havelaar Coffee needs a mix of three types of beans (Haitian, Colombian and Peruvian) to make a kilo coffee. The composition of this mix varies per type of coffee and needs to meet pre-defined requirements as defined in the following table:

Coffee	**Blends of beans**
Premium	Maximum 30% Haitian
Premium	Minimum 30% Columbian
Premium	Maximum 50% Peruvian
Deluxe	Minimum 40% Haitian
Deluxe	Minimum 40% Columbian
Deluxe	Maximum 20% Peruvian

For example, if Max Havelaar Coffee makes 1 kg of Premium coffee, at most 30% of the total mix of beans required to make Premium coffee consists of Haitian beans, at least 30% of the total mix consists of Colombian beans and at most 50% consists of Peruvian beans. In total 300 kg of Haitian, 500 kg of Colombian and 350 kg of Peruvian are available.

The costs per kilo for each type of bean are given in the following table:

Type of bean	**Cost per kilo**
Haitian	€1.00
Colombian	€2.50
Peruvian	€3.00

Max Havelaar Coffee wants to sell at least 400 kilos of premium blend and 500 kilos of deluxe blend.

Formulate this problem as a linear programming model assuming the objective is to maximize profit (no solution is required). Explain your answers briefly.

Exercise 2

The Electronic Device Company (EDC) makes three types of products on four available workstations. The production time (in minutes) per unit produced varies from workstation to workstation (due to different manning levels) as shown below:

	Workstation 1	Workstation 2	Workstation 3	Workstation 4
Product 1	5	7	4	10
Product 2	6	12	8	15
Product 3	13	14	9	17

The profit contribution per unit varies from workstation to workstation as below:

	Workstation 1	Workstation 2	Workstation 3	Workstation 4
Product 1	10	8	6	9
Product 2	18	20	15	17
Product 3	15	16	13	17

In one week there are 35 working hours (= 2100 minutes) available at each workstation. At least 100 units of product 1, 150 units of product 2 and 100 units of product 3 are needed. EDC tries to maximize profit. Formulate this problem as a linear programming model (again, no solution is required). Explain your answer briefly.

Exercise 3

A company is planning its production schedule over the next six months (it is currently the end of month 2). The demand (in kg) for its product over that timescale is as shown below:

Month	3	4	5	6	7	8
Demand	5000	6000	6500	7000	8000	9500

The company currently has in stock: 1000 kg which were produced in month 2; 2000 kg which were produced in month 1; 500 units which were produced in month 0. The company can only produce up to 7000 kg per month and the managing director has stated that stocks must be built up to help meet demand in months 5, 6, 7 and 8. Each unit produced costs £15 and the cost of holding stock is estimated to be £0.75 per kg per month (based upon the stock held at the beginning of each month).

The company has a major problem with deterioration of stock in that the stock inspection which takes place at the end of each month regularly identifies perished stock (costing the company £25 per kg). It is estimated that, on average, the stock inspection at the end of month t will show that 11% of the kg in stock which were produced in month t are ruined; 47% of the kg in stock which were produced in month t-1 are ruined; 100% of the kg in stock which were produced in month t-2 are ruined. The stock inspection for month 2 is just about to take place.

The company wants a production plan for the next six months that minimizes costs and avoids stockouts.

a) Formulate their problem as a linear program. Clearly define the objective function and constraints. Tip: use as decision variables $P_{i,j}$; This variable represents the amount of kg produced on month i which are meant to be used to satisfy demand on month j. For example, if $P_{3,4} = 50$, then it means that 50 kg produced in month 3 that are meant to be used to satisfy demand on month 4.Note that due to the deterioration, some of those 50 kg will perish, which should be taken into account in the constraints that ensure that the demand is satisfied.

Because of the stock deterioration problem, the managing director is thinking of directing that customers should always be supplied with the oldest stock available.

b) How would this affect your formulation of the problem?

Exercise 4

Consider the model formulated in Exercise 1 of the homework exercises Tutorial 1. Implement this model in Excel and solve it.

Exercise 5

Consider the model formulated in Exercise 4 of the homework exercises Tutorial 1. Implement this model in Excel and solve it.

Exercise 6

Consider the model formulated in Exercise 3 of this homework exercises set (i.e., the one on the previous page). Implement this model in Excel and solve it.

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