Seminar 1:

Linear programming, building the model

Problem 1: Build the mathematical problem of the problem:

a) Marketing campaign problem

The advertising agency has to design marketing campaign using 5 media channels (television, internet, radio, newspaper, banners) in order to maximize the overall marketing effect expressed by the number of people reached by the campaign. Advertising is primarily focused on certain categories of persons by age, income and education. The sponsor's requirements are as follows:

- At most 50 % of the amount would be allocated to the TV and internet campaign.

- We have to allocate at least 10% but no more than 30 % of total budget in each media

- We need to reach at least 2,5 mil. people 30-50 years old, at least 0,8 mil. people with monthly income 40,000 CZK or more and at least 1,5 mil. people with higher education.

The total amount of funds for the campaign is CZK 10 million. Based on regular surveys conducted by the advertising agency, it has been estimated that when spending CZK 1,000 in the media, the following numbers of people from the respective categories will be reached by the media channel:

media channel	TV	internet	radio	newspaper	banners
total	750	420	300	360	180
age 30 - 50	320	280	140	240	120
income > 40,000 CZK	120	90	60	60	50
higher education	350	200	120	140	60

Design a marketing campaign maximizing number of reached respondents and meeting the requirements of the sponsor and the budget constraints.

b) Portfolio diversification problem

Management of a financial institution plans to invest 50 million Czech crowns in securities. There are five options: three types of shares A_1, A_2, A_3 and two types

of bonds O_1, O_2. Each of these five variants is characterized by the expected yield in per cent per year and an index expressing the investment risk, see the table:

	A_1	A_2	A_3	O_1	O_2
yield [%]	25	18	20	14	12
risk index	9	5	7	3	1

The company 's investment strategy assumes:

- to invest at least 50% of the total amount in bonds

- the overall risk index (the weighted average risk of each option) does not exceed 5

- none of the options will be purchased in less than 5 million Czech crowns

The aim of the model is to design a portfolio structure that will maximize the expected return on investment, while respecting the investment strategy.

c) Hillier and Lieberman, 3.4-7.

Ralph Edmund loves steaks and potatoes. Therefore, he has decided to go on a steady diet of only these two foods (plus some liquids and vitamin supplements) for all his meals. Ralph realizes that this isn't the healthiest diet, so he wants to make sure that he eats the right quantities of the two foods to satisfy some key nutritional requirements. He has obtained the following nutritional and cost information:

Ingredient	Grams of Ingredient per Serving		Daily Requirement
	Steak	Potatoes	(Grams)
Carbohydrates	5	15	≥ 50
Protein	20	5	≥ 40
Fat	15	2	≤ 60
Cost per serving	4	2	

Ralph wishes to determine the number of daily servings (may be fractional) of steak and potatoes that will meet these requirements at a minimum cost. Formulate a linear programming model for this problem. and use the graphical method to solve this model.

Problem 2: Use the graphical method to solve the LP problem:

$z = 2x_1 - x_2 \to min.$

subject to

$x_1 - x_2 \geq -2$

$x_1 + x_2 \leq 6$

$x_1 - x_2 \leq 0$

$x_1 \geq 1$

$x_2 \geq 0$

And answer following questions:

- Would the solution be the same if the inequalities are strict?

- Find the solution of the same problem with opposite inequality in the second constraint: $x_1 + x_2 \geq 6$?

- Does the corresponding maximization problem have solution?