EXAMINATION QUESTION PAPER - Written examination

GRA 62274
Business Optimisation

Department of Accounting, Auditing and Business Analytics

Start date:	07.06.2019	Time 09.00
Finish date:	07.06.2019	Time 12.00

Weight:	70% of GRA 6227
Total no. of pages:	4 incl. front page
Answer sheets:	Lines
Examination support materials permitted:	All printed and handwritten support materials BI-approved exam calculator Simple calculator Bilingual dictionary
Re-sit	Ordinary

Problem 1 (30%)

A laboratory consists of four departments; A, B, C and D.

The laboratory offers three types of analyses. Each type of analysis requires resources from all four departments.

The following table gives the number of hours required from each department per analysis, capacity per department, demand for each analysis, and price (revenue) per analysis:

Department	Analysis type 1	Analysis type 2	Analysis type 3	Number of hours available
A	12 hours per analysis	16 hours per analysis	25 hours per analysis	1800 hours
B	30 hours per analysis	10 hours per analysis	17 hours per analysis	2300 hours
C	20 hours per analysis	40 hours per analysis	18 hours per analysis	2700 hours
D	35 hours per analysis	26 hours per analysis	22 hours per analysis	3000 hours
Demand for each type of analysis	45	30	40	
Price per analysis	10000 EUR	12000 EUR	15000 EUR	

a) Total demand for analyses is higher than the capacity and the laboratory needs to decide how many of each type of analysis to perform.
Formulate an AMPL model that can be used to maximize the total revenues. Include the given data.

b) The laboratory considers reducing the number of analyses to offer. It is estimated that each type of analysis incurs a fixed costs that can be saved if that type of analysis is not provided anymore. The following table show the estimated fixed costs that can be saved:

Analysis type 1	Analysis type 2	Analysis type 3
300000 EUR	400000 EUR	500000 EUR

Assume that the capacity of each department (number of hours available) remains the same even if the laboratory stops providing some of the analyses.

Modify the AMPL model so that it takes into account fixed costs and the possibility of not providing some of the analyses. (You do not need to re-write the whole model. Just show the modifications.)

c) Another possibility for improving the profitability of the laboratory is to optimize the prices. Assume that demand for each type of analysis is a function of the price of the analysis, and that the demand function for analysis type *j* is given by

$$Demand_j = alfa_j - (beta_j \times price_j),$$

where the parameters of the demand functions are given in the following table:

	***j* = 1**	***j* = 2**	***j* = 3**
$alfa_j$	195	270	415
$beta_j$	0,015	0,020	0,025

Modify the AMPL model from a) so that it takes into account the given demand functions and maximizes the total profit of the laboratory.
(You do not need to re-write the whole model. Just show the modifications.)

Problem 2 (35%)

A chemical company produces five types of intermediary chemicals at a factory. The intermediary chemicals are then combined into finished products with specific quality measures.

The following types of intermediary chemicals are available:

Intermediary chemical	**Quality index 1**	**Quality index 2**	**Cost per liter**
T1	99	210	48
T2	70	335	43
T3	78	280	58
T4	91	265	46
T5	85	250	54

A specific finished product must be produced in a volume of 500 liters. The product must have Quality index 1 between 85 and 90 and Quality index 2 between 260 and 285.

a) Formulate an AMPL model that can be used to find the optimal mix of intermediary chemicals to produce the finished product, i.e., the mix that minimizes the cost of the finished product. Include the given data.

b) Add the following constraint:
If T4 is used in the mix then its minimum quantity is 60 liters.

c) Add the following constraint:
If T1 is used in the mix then T3 cannot be used.

d) Add the following constraint:
If both T2 and T3 are used in the mix then T4 cannot be used.

e) Add the following constraint:
If both T4 and T5 are used in the mix then T3 must also be used.

Problem 3 (25%)

A company needs to compose a portfolio of investment projects, where each project has a given future value and a given amount that must be invested if the project is to be included in the portfolio. Each project is of the 0/1 type; that is, investment in a fraction less than 100% of the project is not possible. The total investment amount is limited by a given budget.

Below is a small example, where the future value and the amount that must be invested are given for three projects.

Project	Investment	Future value
1	6 mill. EUR	13 mill. EUR
2	7 mill. EUR	14 mill. EUR
3	4 mill. EUR	7 mill. EUR

The budget is EUR 12 million.

Find the optimal portfolio (which maximizes the total future value) by applying the Branch and Bound technique. Show each step in the Branch and Bound procedure.

Problem 4 (10%)

(Use maximum two pages for problem 4*. Only two pages will be taken into account in the grading process.)*

Give an example of a successful "real-life" optimisation project and summarize briefly:
- The motivation behind the project.
- The proposed solution.
- How the solution is being used in the organization.
- The impact of the project.