

**EXAMINATION INFORMATION PAGE**

**Written examination**

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| Subject code:  **FM3117** | Subject name:  **Industrial Optimization** | |
| Examination date:  **22/11/2017** | Examination time:  **From** **9:00 to 13:00** | Total hours:  **4 hours** |
| Responsible subject teacher:  **Dr. Carlos F. Pfeiffer** | | |
| Campus:  **Porsgrunn** | Faculty:  **Faculty of Technology, Natural Sciences and Maritime Sciences** | |
| No. of assignments:  **5** | No. of attachments:  **None** | No. of pages incl. front page  and attachments: **4** |
| Permitted aids: **Personal notes, exercises, print-outs, printed books (all hand notes and printed material).**  **Calculator.**  **NOT ACCEPTED: Cell phones, laptops, tablets, etc.** | | |
| Information regarding attachments: | | |
| Comments: all assignments (problems) have the same value. For problems with multiple tasks, the value of the problem is equally divided among its tasks. | | |

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| Select the type of examination paper | |
| Spreadsheets | Line sheets |

**Problem 1 (one task).** For safty reasons, the pressure inside a reactor is meassured using three different sensors. The readings of the sensors and their reported variances are included in the following table:

Reactor

P2

P1

P33

|  |  |  |  |
| --- | --- | --- | --- |
|  | P1 | P2 | P3 |
| Pressure bar | 15.28 | 15.2 | 15.02 |
| Variance  bar2 | 0.2 | 0.21 | 0.12 |

**Task:**  Calculate the best estimate for the pressure inside the reactor, usign the information provided by the three sensors. Write the detailed procedure.

**Problem 2 (two tasks)**.

The inovation department of a company has been allotted $60000 to spend on the development and promotion of a new product. It is estimated that if x thousand dollars is spent on development and y thousand on promotion, approximately units of the new product will be sold. How much money should be allocated to development and how much to promotion, in order to maximize sales? Notice that x + y = 60, since x and y are given in thousands of dollars.

**Tasks:**

1. Solve the problem using Lagrange multipliers. Indicate all steps.
2. Suppose the department’s allocation is increased to $61000 to spend on the development and promotion of the new product. Estimate how the additional $1000 will affect the maximum sales level (how much the sales are increased).

**Problem 3 (one task)**. A company invests $ 1000 000 dollars in a new control system for a plant. The estimated reductions in operation costs because of the new system is estimated to be $162 000 dollars in each of the next 10 years, which is the useful life of the control system.

**Task:** Calculate the net present value for the project, using an interest rate of 12%. Is the project economically viable, according with your results?

**Problem 4 (two tasks).** A person is interested in buying a house in the Grenland area. After checking finn.no, he choosed several options within his finantial possibilities, and built the following table containing the price, the distance to downtown, and the size of the lot. All other characterisitcs of the house are similar (number of bedrooms, bathrooms, etc.) or not relevantat for the buyer.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| House | A | B | C | D | E | F | G | H | I |
| Price (thousands nok) | 1780 | 2500 | 1800 | 2300 | 2200 | 1500 | 2100 | 3280 | 4250 |
| Distance to downtown  (km) | 2 | 1.5 | 3 | 8 | 12 | 2.7 | 4 | 12 | 18 |
| Lot size (m2) | 300 | 250 | 800 | 750 | 450 | 900 | 2000 | 1728 | 500 |

**Task a:** Assuming that the buyer *does not care* about the lot size, make a plot indicating the distance to downtown in one axis, and house price in the other. Mark with a circle the houses that are not dominated by any other, and with a triangle the ones that are dominated. Explain how this plot can help you to make a decision.

**Task b:**  Assuming that the buyer prefers a house that is *close to downtown*, with *a big lot size* and *a low price* as ***equaly important buying criteria***, indicate what houses options are NOT dominated by any other.

**Problem 5 (one task).** Assume you want to solve the following problem using an available **non-linear programming** code that *only minimizes*, and that only accepts *equality linear constraints* and bounds on simple variables (for example, -10 ≤ x1 ≤ 25 ; x2 ≥ 0 ).

Maximize: f(**x**) = 0.5 (x1x4 – x2x3 + x3x9 – x5x9 + x5x8 – x6x7)

subject to:

5x1 + 2 x2 + 2x3 + 1x6 ≥ -1000

x1 /(x1 + x2 + x3 + x9 ) ≥ 20

|x1 + x2 – x3 – x4| ≤ 2000

1– x32 – x42 ≥ 0

1 – (x2 - x7)2 – (x4 - x8)2 = 0

-1000 ≤ x1 ≤ 2000

-500 ≤ x2 ≤ 1500

-200 ≤ x8 ≤ 250

-150 ≤ x9 ≤ 150

**Task:** Transform the problem so you that can use the existing code. (Hint: consider first transforming the nonlinear constraints to linear when possible, and using slack variables after. Consider using penalty functions for the remaining non-linear constraints.)

1A

Sorting function. The program sorts the array M after the size of the numbers in the array with the biggest number first. The array starts at [2, 1, 11, 7]. After one iteration of i its [11, 1, 2, 7], second iteration [11, 7, 1, 2], third iteration [11, 7, 2, 1].