SF2812 Applied Linear Optimization, 2019/2020
Project assignment 2A
Due Tuesday February 25 2020 23.59

Instructions for the project assignments are given in the course PM. Additional clarifications are given below.

- Discussion between the groups is encouraged, but each group must individually solve the assignments. It is *not* allowed to use solutions made by others in any form.
- Instructions for the report:
  - The report should have a leading title page where the project name and the group members' names, personal number and e-mail addresses are clearly stated.
  - The report should be written using a suitable word processor.
  - The contents should be such that another student in the course, who is not familiar with the project, should be able to read the report and easily understand:
    1. What is the problem? What it the problem background? This does *not* mean a copy of the project description, but rather a suitable summary of necessary information needed in order to understand the problem statement.
    2. How has the group chosen to formulate the problem mathematically? What assumptions have been made? If these assumptions affect the solution, this should be noted.
    3. What is the meaning of constraints, variables and objective function in the mathematical formulation?
    4. What is the solution of the formulated optimization problem? If suitable, refer the mathematical solution to the terminology of the (non-mathematical) problem formulation. (There could be more than one optimization problem.)
  - Most project descriptions contain a number of questions to be answered in the report. The report *must* contain the answers to these questions. They should, however, in a natural way be part of the content of the report and not be given in a "list of answers". The purpose of the questions is to suggest suitable issues to consider in the part of the report where the results are interpreted and analyzed. Make use of your knowledge from the course when formulating the problem and analyzing the results. Additional interpretations are encouraged as well as generalizations and other ways of modeling the problem.
  - A suggested outline of the report is as follows:
    1. Possibly a short abstract.
    2. Problem description and background information.
    3. Mathematical formulation.
    4. Results and analysis (interpretation of results).
    5. A concluding section with summary and conclusions.

    Deviations from the outline can of course be done.
  - GAMS code should not be part of the report, and should not be referred to in the report.

- Each group should upload the following documents via the Canvas page of the course no later than by the deadline of the assignment:
  - The report as a pdf file.
  - GAMS files.

  Please upload your documents as individual pdf and gms files, and not as zip files.
- Each student should fill out a paper copy of the self assessment form and hand in at the beginning of the presentation lecture.

The company Varme runs a power plant with three units. They are now in the process of planning the production for a 24 hour period.
The 24 hours are divided into five time periods for which the expected power demand is given by the following table:

Time period	Expected demand (MW)
00-05	50
05-10	60
10-15	80
15-20	70
20-24	60

For the power units, the costs are as follows:

Unit	Initial cost (kkr)	Running cost (kkr per MW and hour)
1	10	2.5
2	13	2.5
3	16	2.4

Each unit can be running at most three time periods in a row, then it has to switched off during at least one time period. The inital cost in the table refers to a "warm start", i.e., the case when the unit has been switched off during one period. If the unit has been switched off during two or more periods, the initial cost increases by 50%.
A running unit can only produce between given lower and upper levels as depicted in the following table:

Unit	Minimum level (MW)	Maximum level (MW)
1	10	50
2	12	45
3	15	55

Basic exercise

1. Assist Varme in making a production plan that minimizes the expected cost. For technical reasons, the plan has to be cyclic (with period 24 hours).

Advanced exercises

2. Now assume that the stochastics is to be taken into account. The demand during the time periods is assumed to be normally distributed with the above mean values and standard deviation 5 MW. We assume that the demand during a certain period is constant and known at the beginning of the period. If needed, additional power can be purchased to a cost of 10 kkr/MWh from other suppliers. Modify your model to take this stochastics into account. Determine once again an optimal cyclic production plan. The production level may vary with the demand, but the periods in which the units are running must be equal each 24 hour period. Comment on differences in the producation plan compared to the answer of Exercise 1.

3. Discuss potential improvements of the model.

Good luck!