- Only part of the problems may be graded. But, you have to submit all the problems.
- **Submit one file per question, unless otherwise specified.**

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1. 9 marks (a) Consider the linear optimisation problem "A small airline, Ivy Air, flies between three ..." from HW1 [Vanderbei. Exercise 1.2]. Find out what is the solution using a Python routine in the Jupyter notebook as it was shown in Thursday's lecture. Attach the .pdf *and* .pynb files as separate files.

   (b) The Vancouver Police Department has the following daily minimum requirements for police officers on duty.

0:00-4:00	4:00-8:00	8:00-12:00	12:00-16:00	16:00-20:00	20:00-0:00
15	35	65	80	40	25

   Considering that each officer can start his or her shift at 0:00, 4:00, 8:00, 12:00, 16:00 or 20:00, and he or she can stay on duty for 8 consecutive hours, find the schedule that minimises the number of officers needed. (Formulate the problem as a linear optimisation problem, and find the solution using a Python routine. Attach the .pdf *and* .pynb files as separate files.)

2. 9 marks Solve the following optimization problem using the method exposed during Tuesday's class.

$$\begin{aligned} \text{maximize} \quad & \zeta = 6x_1 + 8x_2 + 5x_3 + 9x_4 \\ \text{subject to} \quad & 2x_1 + x_2 + x_3 + 3x_4 \leq 5 \\ & x_1 + 3x_2 + x_3 + 2x_4 \leq 3 \\ & x_1, x_2, x_3, x_4 \geq 0 \end{aligned} \quad .$$

3. 8 marks Consider the following optimization problem:

$$\begin{aligned} \text{maximize} \quad & \zeta = 2 - 3x_1 + 3x_2 + 3x_3 \\ \text{subject to} \quad & 3x_1 + 3x_2 + x_3 \leq 13 \\ & -x_1 + x_2 + x_3 \leq 1 \\ & 3x_2 + x_3 \leq 5 \\ & x_1, x_2, x_3 \geq 0 \end{aligned} \quad .$$

$w_2 = 1 + x_1 - x_2 - x_3 = 0$

$x_3 = 1 + x_1 - x_2$

   (a) Find the maximum value of ζ.

   (b) Describe explicitly the set of all vectors $\mathbf{x} = (x_1, x_2, x_3)$ that lead to the maximum value. Give a graphical interpretation of your answer.