Exercise 1

Solving a quadratic optimization problem in Simulink using *qpOASES solver*

Aim:

To be familiar with the use of qpOASES solver in Simulink for solving a quadratic optimization problem.

1. Preliminary requirements

You should have understood the contents of lecture 2. If not, make sure that you have read and looked into **all** the videos connected to lecture 2. To solve this exercise, you should have installed both the *qpOASES* solver and the C++ compiler. Please look at the videos for lecture 2 in the homepage (https://home.usn.no/roshans/mpc) if you have not done so.

Finally, you should also have looked into the example of oil refinery that is taught in lecture 2. You should look into how to formulate the problem into a standard QP problem and then how to solve the QP problem in Simulink using *qpOASES.* All of these information are the contents of lecture 2 and are available in the homepage of the course.

2. Solve the following quadratic optimization problem in Simulink using *qpOASES* solver.

Quadratic Objective:

$$\min_{(x_1,x_2,x_3)} \quad J = f(x) = -5x_3^2 + 3x_1^2 + 2.5x_1 + 7x_2$$

Linear Constraints:

$$2x_1 + 3x_2 + 4x_3 = 5$$
$$-3x_1 - 8x_3 = -6$$
$$-4x_1 - 3.2x_2 + 1.8x_3 = 2$$

Tasks:

a) First express the given optimization problem into a standard QP form as,

$$J = f(x) = \frac{1}{2} x^T Hx + c^T x$$
$$A_\epsilon x = b_\epsilon$$

b) Now use the standard QP formulation for finding the solution of the optimization problem using *qpOASES* solver in Simulink.
Please Note: This is a static optimization problem, i.e. you need to solve the optimization only once. To do so, please choose the "simulation stop time" in Simulink equal to the sampling time (fixed step size, fundamental sampling time). For example: If you choose 0.1 second as the sampling time, then please choose 0.1 second for the simulation stop time. This way you will get straight lines as your optimal values.

Individual submission: Submit a lab journal with screenshots of your implementation and the solution. You should submit your lab journal in Canvas. Make sure to show all the details of your implementation (i.e. show what is inside your subsystem blocks).

Use the oil refinery example as a motivation.

Good luck!