Exercise 2

A two-input, two-output, six-state model of a turbo-alternator is defined by the following state-space matrices:

$$A = \begin{bmatrix} -18.4456 & 4.2263 & -2.2830 & 0.2260 & 0.4220 & -0.0951 \\ -4.0977 & -6.0706 & 5.6825 & -0.6966 & -1.2246 & 0.2873 \\ 1.4449 & 1.4336 & -2.6477 & 0.6092 & 0.8979 & -0.2300 \\ -0.0093 & 0.2302 & -0.5002 & -0.1764 & -6.3152 & 0.1350 \\ -0.0464 & -0.3489 & 0.7238 & 6.3117 & -0.6886 & 0.3645 \\ -0.0602 & -0.2361 & 0.2300 & 0.0915 & -0.3214 & -0.2087 \end{bmatrix}$$

$$B = \begin{bmatrix} -0.2748 & 3.1463 \\ -0.0501 & -9.3737 \\ -0.1550 & 7.4296 \\ 0.0716 & -4.9176 \\ -0.0814 & -10.2648 \\ 0.0244 & 13.7943 \end{bmatrix}$$

$$C = \begin{bmatrix} 0.5971 & -0.7697 & 4.8850 & 4.8608 & -9.8177 & -8.8610 \\ 3.1013 & 9.3422 & -5.6000 & -0.7490 & 2.9974 & 10.5719 \end{bmatrix}$$

$$D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

An .m-file defining these matrices are available at
`https://people.isy.liu.se/rt/andersh/teaching/tal6abcd.m`.

The poles of the system are -15.8730, -10.3872, $-0.3493 \pm 6.3444j$, -1.0444, -0.2346.

The inputs are

- $u1$: throttle-valve position
- $u2$: excitation control

The outputs are

- $y1$: generator terminal voltage
- $y2$: generator load angle

Try do design a controller to the plant such that

(a) The closed loop bandwidth is about 0.5 rad/s.

(b) The sensitivity should not exceed 0.1 for $\omega < 0.05$ (for any singal direction).

(c) The output-sensor noise amplification should not exceed 0.002 for $\omega > 50$ (for any signal direction).