Robust control design

A flexible transmission system was considered as a benchmark example at the European Control Conference 1995. The system is characterized by two highly resonant modes at frequencies that significantly change with load. The controller must be able to work in three different configurations: no load, half load and full load. Models for the three load cases are identified with the structure $\deg A = 4$, $\deg B = 4$. The following specifications are given:

(a) Rise time t_{rise} of less than 1s for a reference step.

(b) Overshoot $o.s.$ of less than 10% for a reference step.

(c) Rejection time t_{dist}, the time necessary to reject to 10% of measured peak value a step output disturbance filtered by $1/A$. Here $t_{\text{dist}} < 1.2$s

(d) Asymptotic rejection of constant disturbances (using integral action).

(e) Disturbance attenuation band from 0 to $f_{\text{att}} > 0.2$Hz.

(f) Output sensitivity function less than 6dB, i.e. $||\mathcal{S}_y||_\infty < 2$ (modulus margin greater than 0.5).

(g) Delay margin t_{d} of a least 40ms (80% of the sampling period 50ms).

(h) Input sensitivity function in the frequency range $8 - 10$Hz less than 10dB, i.e. $\mathcal{S}_{\text{noise}} = \max_{\omega \in [0.8\pi, \pi]} |\mathcal{S}_u(\text{e}^{-\text{i}\omega})| < 3.16$

All specifications should be satisfied for the three load cases. The `Sysquake` file `ECC.sq` includes the three models. The specifications are somewhat reformulated such that design can be done more easily by interactive pole placement. For example, specification (c) is changed to a settling time constraint, which is the same for all models. The specification on delay margin (g) is related to the output sensitivity constraint (f) and is therefore not necessary to directly take into account. Also, the disturbance attenuation band (e) is related to the speed requirement (a), and does not need special attention. Moreover, the noise feedback constraint can be tighten without sacrifying the other specifications. The tighter constraint is set to $||\mathcal{S}_u|| < 2$. Try to fulfill all these specification for all three load cases simultaneously.