控制系統 (Feedback control system) Final Exam

* Upload 5 Matlab scripts: Final_1.m, Final_2.m, Final_3.m, Final_4.m, and Final_5.m to iLMS by 12 pm (中午12點), June 23, 2020. Late submission would result in discounted scores. Your final scores will be evaluated on the basis of these 5 files, so no other files are required to be submitted.

* Throughout this exam, we assume a unity feedback system with plant $G(s)$ and controller $G_c(s) = K\frac{s+z}{s+p}$ in the feedforward loop, where $K, z,$ and p are parameters to be determined. To get the full grade of each problem, use the minimum number of parameters. For example, if a gain K is sufficient to meet the specs, we set $z = p = 0$.

* What you can do: Use Internet to search for relevant information, such as the functionality of Matlab commands.

* What you CANNOT do: Ask for answers in any form, e.g., posting the question online and waiting for the answer, using social media to ask for or send answers to your classmates. If you were to provide answers to your classmates, you would fail your final.

* Abbreviations and symbols: P. M.=phase margin; P. O.=percent overshoot; position constant K_p; velocity constant K_v; settling time $\mathrm{T_s}$.

1. (30%)

$$G(s) = \frac{3.6}{s(1+0.9s)(1+0.04s)}$$

(a) Use a phase-lag compensator $G_c(s)$ to meet the specs: $77^\circ \geq \mathrm{P.M.} \geq 75^\circ$ and $K_v = 18$.
(b) Use a two-stage phase-lead compensator $G_{c1}(s)G_{c2}(s)$ to meet the specs in (a).

2. (20%)

$$G(s) = \frac{s+5}{s^3+2s^2+20s+3}$$

Design a one-stage phase-lead or phase-lag compensator $G_c(s)$ to meet the specs: $K_p = 30$, $50^\circ \geq \mathrm{P.M.} \geq 48^\circ$, $\mathrm{P.O.} \leq 14.5\%$.

3. (20%)

$$G(s) = \frac{3.6}{(s+0.14)(0.1s+1)}$$

Specs: $\mathrm{P.O.} \leq 11\%$, $\mathrm{T_s} \leq 1.5$ seconds.

4. (20%)

$$G(s) = \frac{1}{(s-3)(s-2)}$$

(a) Design a one-stage phase-lead or phase-lag compensator $G_c(s)$ to meet the specs: $T_s \leq 1$ seconds.

(b) From (a), add a prefilter $G_p(s)$ to meet the specs: $T_s \leq 1$ seconds, $P.O. \leq 5\%$.

5. (10%)

$$G(s) = \frac{1}{(s+0.1)(s+4)}$$

(a) meet the specs: steady-state error for a step input=0, $P.O. \leq 21\%$.

(b) From (a), add a prefilter $G_p(s)$ to meet the specs: steady-state error for a step input=0, $P.O. \leq 5\%$.