AUTOMATIC CONTROL

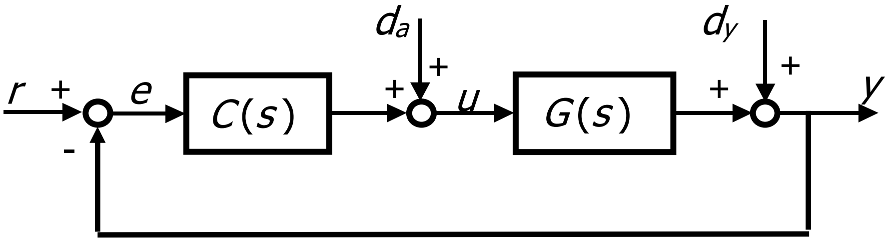
Computer Engineering and Electronic and Communications Engineering

Laboratory practice n. 6

Objectives: Steady state analysis and design, loop shaping design.

Problem 1 : loop shaping design of feedback control systems

Consider the feedback control system below



where:

$$G(s) = \frac{10}{s(s+5)(s+10)},\ d_a(t) = \delta_a \varepsilon(t), |\delta_a| \le 0.3, d_y(t) = \delta_y \sin(t), |\delta_a| \le 0.3$$

Design a cascade controller C(s) to meet the following requirements:

1. $|e_r^\infty| \le 1$ in the presence of a linear ramp reference signal with unitary slope;
2. $|y_{d_a}^\infty| \le 0.1$;
3. $\hat{S} \le 8.5\%$;
4. $t_{s,2\%} \le 0.75\ s$.

Evaluate through time domain simulation

- requirements satisfaction;
- the maximum magnitude of the input signal $u(t)$ in the presence of a step reference signal with amplitude 0.1;
- the maximum magnitude of the output signal $y(t)$ in the presence of both a step reference signal with amplitude 0.1 and the disturbance d_a

After the design evaluate

- the resonant peak T_p (in dB) of the complementary sensitivity function as well as its bandwidth ω_B;
- the resonant peak S_p (in dB) of the sensitivity function as well as its bandwidth ω_{BS}.

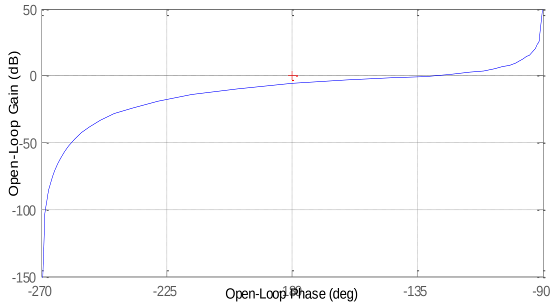
Write the expression of the final controller in the dc-gain form.

Conceptual problem

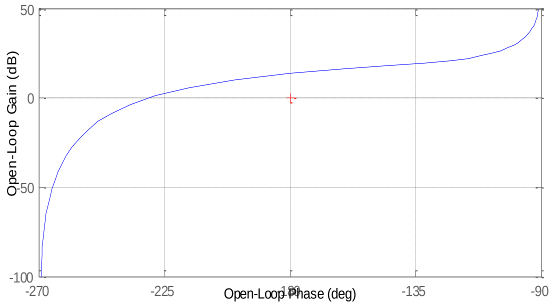
Problem 2: steady state analysis

Consider the following Nichols plots of four different loop functions L(s) of a unitary negative feedback, cascade compensation control system architecture

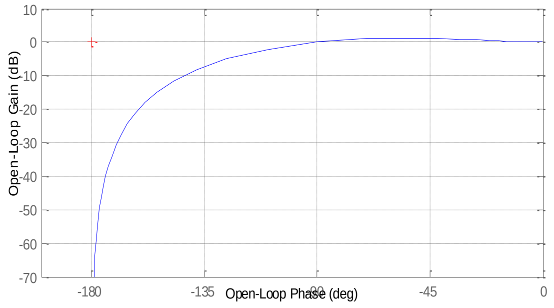
1



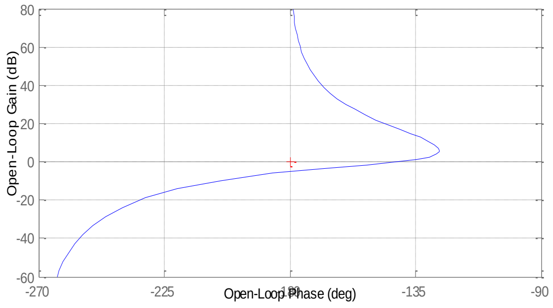
2



3



4



Suppose that, for each L(s), the generalized dc-gain is such that $K_g=\lim_{s\to 0} s^g L(s) > 0$, then, based on the Nichols plot only, determine which of the four

1. corresponds to a closed loop stable system
2. guarantees a finite value of $\left|e_r^\infty\right|$ in the presence of a constant reference signal
3. guarantees $\left|e_r^\infty\right| = 0$ in the presence of a constant reference signal
4. guarantees a finite value of $\left|e_r^\infty\right|$ in the presence of a linear ramp reference signal
5. guarantees $\left|e_r^\infty\right| = 0$ in the presence of a linear ramp reference signal
6. surely guarantees $\left|y_{d_a}^\infty\right| = 0$ in the presence of a constant actuator disturbance signal $d_a(t)$

(Answer:
1. → 1,3,4 2. → 1,3,4 3. → 1,4 4. → 1,4 5. → 4 6. → none)