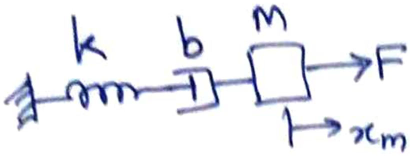
Tutorial Sheet 4, EE302 S2, Control Systems, 22nd Feb 2024

Q-1:



(a) Find relation between F & x_m using 2 approaches to convert to RLC circuit.

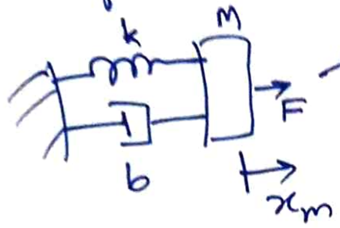
— $\binom{F}{x} \rightarrow \binom{V}{I}$

— $\binom{F}{x} \rightarrow \binom{I}{V}$

Fix k = 5, M = 3 (SI units)

(b) Find range of b > 0 for underdamped.

Q-2:



Same as Q-1 a & b,

Q-3: They say "positive feedback leads to instability"

(a) Give an example when the saying is true.

(b) — " — is false.

Q-4: They say "negative feedback leads to stability". Same as Q-3 a & b.

Q-5: They say "higher gain k leads to smaller steady state error" (for step response, for type 0 system, for std. negative unity feedback configuration).

Same as Q-3 a & b.

Q-6: They say "higher gain causes faster transients" (i.e. smaller time constants).

Same as Q-3 a & b.

Q-7: Plot steady state error vs k for $k \in (0, \infty)$ (for standard negative unity feedback configuration) for (a) $G(s) = \frac{s-2}{s+4}$

(b) $G(s) = \frac{2-s}{s+4}$ (c) $\frac{s+2}{s+4}$

Q-8: For $G(s) = \frac{1}{s^2+5s+6}$, – plot steady state error vs k.

– what is settling time when %OS is 10%.

contd: (in next page).

Q-9 (a) Find breakaway / break in points for $G(s) = \frac{(s+2)(s+4)}{s^2+4s+8}$

and angle of arrival/departure.

(b) Let $k<0$ & do Q-9a.

Q-10: Same as Q9 for $\frac{s}{s^2+9}$. (for $k>0$ & $k<0$).

Q-11: $\frac{(s+1)(s+3)(s+5)(s+7)}{(s+2)(s+4)(s+6)(s+8)}$: for ~~that~~ both $k>0$ & $k<0$.

Q-12: Exploit symmetry after shifting to left/right for

$G(s) = \frac{1}{(s+1)(s+2)(s+3)(s+4)}$: Find asymptotes angles, intersection point.

Also find breakaway / break in pts.

for $k>0$ & $k<0$.

Q-13 (a) For $G(s) = \frac{1}{(s+1)(s+2)}$ can we get 2% OS & < 2 ~~OST~~ seconds settling time?

(b) what about $\frac{(s+5)}{(s+1)(s+2)}$? —||—.

Q-14: Can ~~pow~~ proportional/gain controller stabilize $G(s) = \frac{1}{s^2-1}$ or $\frac{1}{s^2+1}$?

(stabilize ≡ closed loop poles in Open LHP.) $k>0$

(under standard negative feedback configuration)

Q-15: Same as Q-14 but for $\frac{s+2}{s^2-1}$ and $\frac{s+2}{s^2+1}$

Q-16: Give an example each for below such that closed loop is unstable for large k

(a) G(s) with 2 poles and a zero & G(s) is stable.

(b) G(s) with no zeros but G(s) is stable.

Q-17: Consider 8 possibilities : G(s) has leading coefficient +ve/−ve in numerator.

∴ $k>0$, $k<0$. $(2\times2\times2 = 8$ cases$)$.

∴ +ve feedback & −ve feedback

. Explain why only 2 cases are enough instead of 8 cases.

("all get captured")