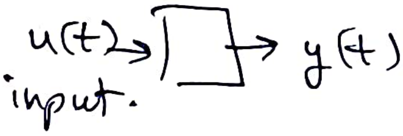
Tutorial Sheet 5, EE 302-S1, 11th March 2025.

Q-1: Consider $G(s) = \dfrac{ds+b}{s+a}$, $d \neq 0$. $\rightarrow \dfrac{ds+b}{s+a}$.



(a) Find the underlying differential equation between u & y.

(b) Rewrite $y(t) = y_1(t) + y_2(t)$ such that the input $u(t)$ would not need to be differentiated. (Hint: Get $G(s) = d + G_1(s)$)
constant — strictly proper.

(c) Conclude that (more generally) one <u>never</u> needs to differentiate input, for proper, transfer function, real distinct roots of $d(s)$ (Solve for with $G(s) = \dfrac{n(s)}{d(s)}$.).

Q-2: Consider $G(s) = \dfrac{1}{s+3}$ with standard negative unity feedback configuration but with k increasing from $-\infty$ to 0. Draw root locus.

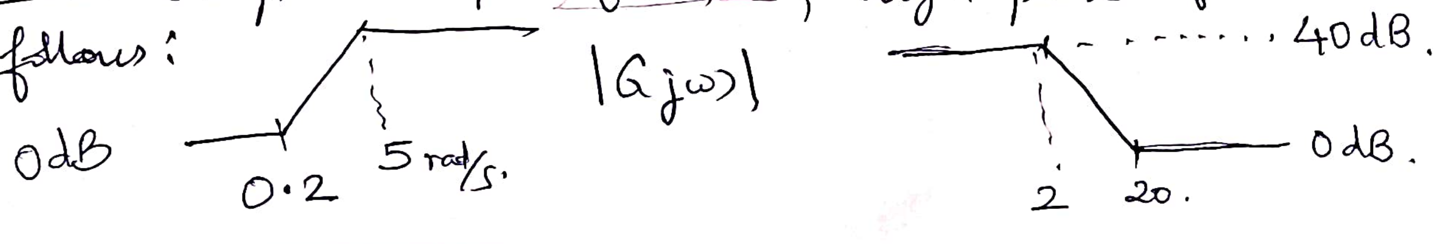
(b) Draw: complete root locus $-\infty \rightarrow 0 \rightarrow +\infty$.

(c) Guess/get rules for $k<0$ (for strictly proper G & biproper G.).

(d) Consider cases: $k<0$, $k>0$, and −ve feedback & +ve feedback, and $G(s) = \dfrac{n(s)}{d(s)}$: leading coefficients of n, d: same sign/opposite sign. Explain why we have <u>not</u> 2^3 but just 2 cases to study <u>for closed loop pole locus</u>.

Q-3: Draw <u>asymptotic</u> Bode plot for $\dfrac{1}{s+1}$, $\dfrac{1}{(s+1)(s+2)}$: Both phase & magnitude.

Q-4: Design low pass filter & high pass filter as follows:



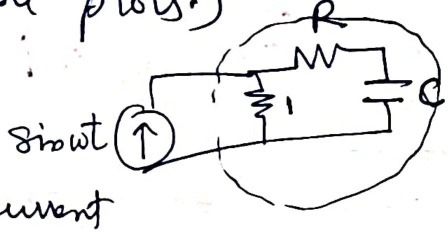
Q-5: (a) Verify that $\sin \omega t$ input gives output $|G(j\omega)| \sin(\omega t + ?)$
(verify using linearity & consider complex valued signals $e^{j\omega t}$.
(b) What about $\cos \omega t$ input?

Q-6: If relative degree of a $G(s) = 0$, can G be low-pass? high pass?

(Q-7) If $G(s)$ is high pass, can $G(s)$ be relative degree $= 1$ or $2, \ldots$? What should relative degree be?

Q-8: If magnitude plot is given, (like in Q-4), how much non-uniqueness is possible in $G(s)$? (Answer for both magnitude plots.)

Q-9: Consider



Current source.

(a) Find impedance $Z(s)$ of this circuit.

(b) For one period, find active power absorbed by the circuit. (get $\int_0^T v(\tau)\, i(\tau)\, d\tau$ for $T = \frac{2\pi}{\omega}$.)

(c) Relate active power w.r.t. $\mathrm{Re}(Z(j\omega))$

Q-10: Plot complete root locus ($K: -\infty \to +\infty$)
for $G(s) = \dfrac{1}{(s+1)(s+2)(s+3)}$, $\dfrac{1}{(s+1)(s+2)}$, $\dfrac{s}{s^2+\omega^2}$