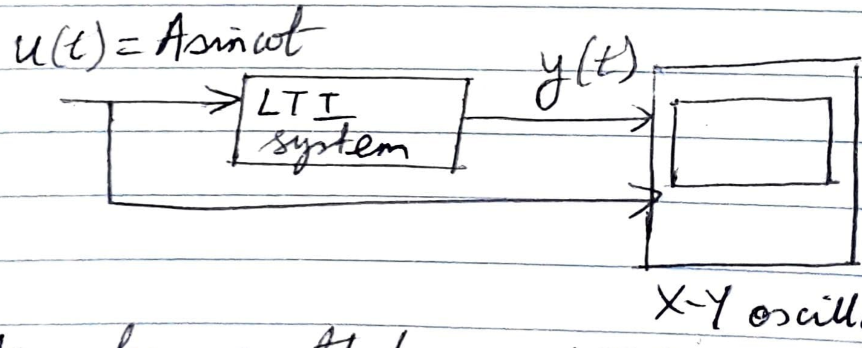
Assignment 3, EE302, Subm: 29/3/2021

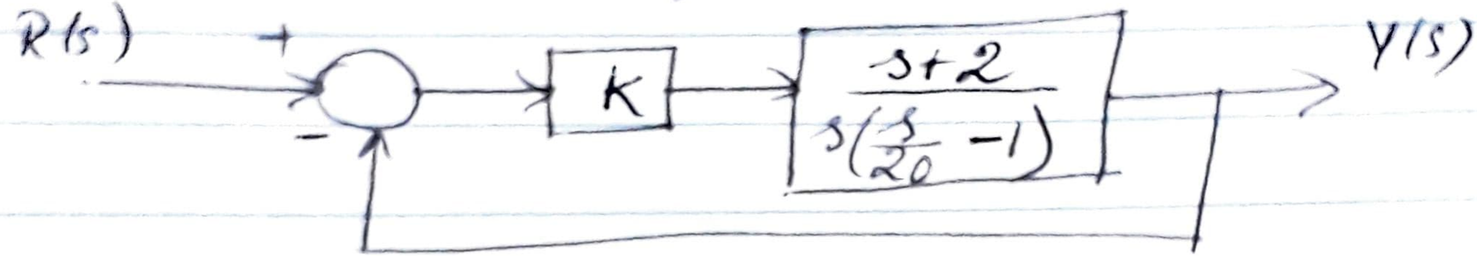
1. Consider an open loop transfer function $G(s)$, which is connected in a unity feedback configuration. On the $G(j\omega)$ plane, show that the locus of all points corresponding to constant closed loop ~~gain~~ magnitude is a circle. What is the radius and centre of this circle as a function of the given closed loop magnitude?
   Now, consider the closed loop phase. Show that for a given value of phase for CL system, the locus of all points on the $G(j\omega)$ plane is a circle. What are the centre and radius of this circle in terms of the given phase?

2. Consider the set-up below.



We know that an LTI system's steady state behaviour can be characterized by its magnitude and phase functions ($M(\omega)$ and $\phi(\omega)$). What ~~...~~ kind of curve do you expect to see on the X-Y scope when the LTI system is excited by $u(t) = A\sin\omega t$? For a given ω, ~~$M(\omega)$ and $\phi(\omega)$~~ can you read off $M(\omega)$, $\phi(\omega)$ from the curve displayed on the X-Y scope? Describe your strategy.

3. Consider the system below:



Using both Bode plot and Nyquist criteria, obtain the condition on K for stability. You may use MATLAB if you find it convenient.

(4) Consider $G(s) = \frac{s-1}{s^2+9}$. Draw Nyquist plot in following two ways and get range of k for closed loop stability

(a) $\pm 3j$ within the D-contour (bypass appropriately)

(b) $\pm 3j$ outside the D-contour. (bypass appropriately)

In both cases, ~~plot~~ sketch Nyquist plot and use Nyquist criteria to get same range k (for closed loop stability). $(k>0)$

(5) Get range of k for closed loop stability (w.r.t. std. negative unity feedback conf.) for $G(s) = \frac{s-2}{s^2-2s+10}$. $(k>0)$

(6) Consider $G(s) = \frac{1}{(s+1)(s+10)(s+100)}$.

(a) Use Routh Hurwitz/Root locus to find range of $k>0$ to have closed loop stability

(b) Get range of k (as for a) using Bode magnitude/phase asymptotic plot.

(c) Sketch Nyquist plot & Nyquist criteria to get range of k for closed loop stability.

Q-7: (a) Consider $G(s) = \frac{1}{(s+1)(s+2)(s+3)}$.

Use Root locus method to design a PD controller that gives 5% OS and ~~2T~~ 2 seconds settling time (2%) for closed loop system's step response.

(b) Find steady state error and decrease the error to 10% of the value in (7a) by a lag compensator.

(Show intermediate steps very briefly.)