Name_____________________________ UCID____________________________

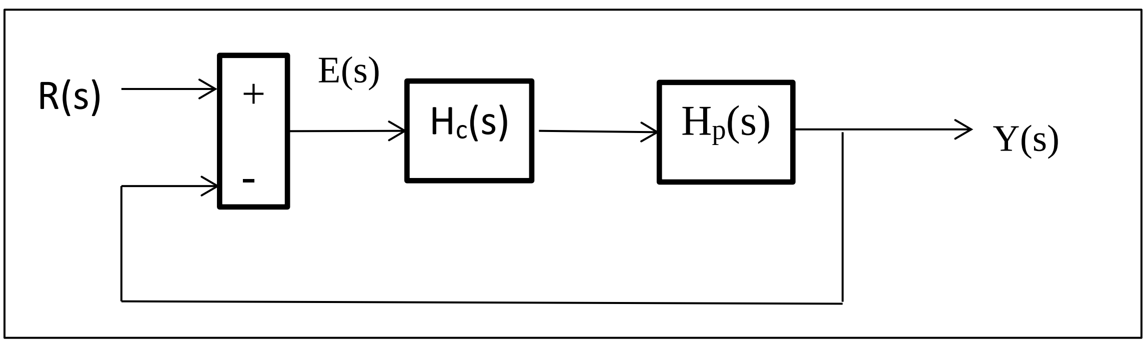
ENEL441 QUIZ 5 March 25, 2020

Please consider and insert your name as indicated

This quiz is to be completed by you only. Your submitted filled out quiz is to be your work only and not a product of groupthink. So how can the university monitor this and ensure that these take-home exams are honestly completed and that your grade thereby becomes a fair assessment of your comprehension of the course material? We can't and there is no point in even trying except to ask you to insert your name here as a promise that your submitted quiz is entirely your work.

I, (_____your name here_____) certify that the solutions provided to this quiz have been produced by myself only without collaboration with others.

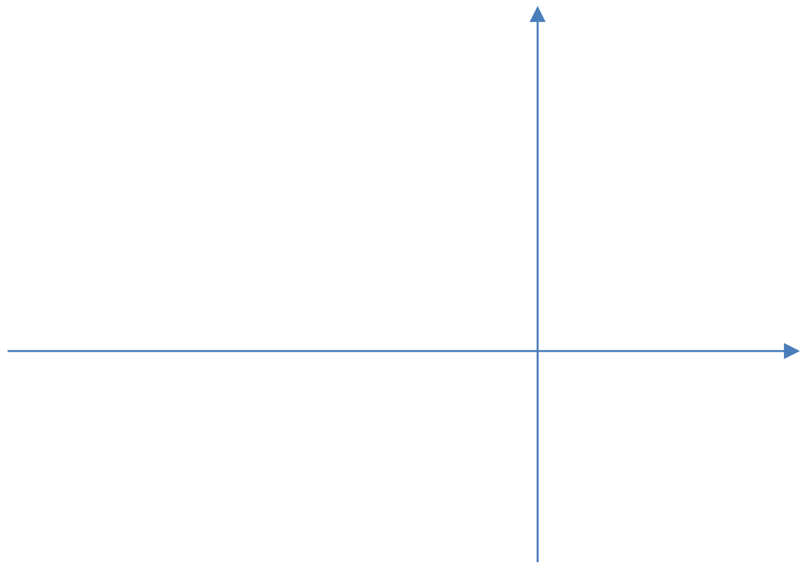
Consider the feedback system given below with the plant as $H_p(s) = \frac{1}{s^2-2s+2}$



Q1(5) Assume the compensator is

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

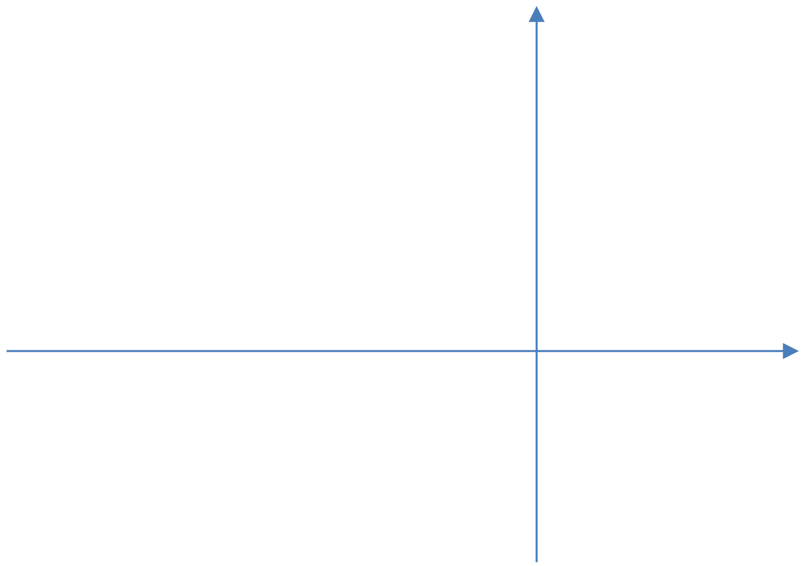
Generate a root locus plot of the closed loop trajectories for $0 < G < \infty$ using the axis below. Label all of the open loop poles and zeros. Can G be selected for this compensator that makes the loop stable?



Q2(5) Now assume that the compensator is

$$H_c(s) = G\frac{(s+1)^2}{s(s+8)}$$

Generate a root locus plot of the closed loop trajectories for $0 < G < \infty$ using the axis below. Label all of the open loop poles and zeros.



Q3(5) Assume the compensator of question **Q2** and that G is selected such that the closed loop is stable, determine what $e(\infty)$ is for the input of $r(t) = tu(t)$.

Aid Sheet

One sided Laplace Transform $F(s)=\int_0^\infty f(t)e^{-st}dt$, $f(t)=\frac{1}{2\pi j}\int F(s)e^{st}ds$

$f(t)$	$F(s)$	$f(t)$	$F(s)$
1	$\delta(s)$	$\dot{f}$	$sF(s)-f(0^-)$
$\delta(t)$	1	$\ddot{f}$	$s^2F(s)-sf(0^-)-\dot{f}(0^-)$
$u(t)$	$1/s$	$\dddot{f}$	$s^3F(s)-s^2f(0^-)-s\dot{f}(0^-)-\ddot{f}(0^-)$
$t^m u(t)$	$m!/s^{m+1}$	$\int f(t)dt$	$F(s)/s$
$e^{-at}u(t)$	$1/(s+a)$	$\lim_{t\to\infty} f(t)$	$\lim_{s\to 0} sF(s)$
$\frac{1}{(m-1)!}t^{m-1}e^{-at}u(t)$	$1/(s+a)^m$	$\sin(at)u(t)$	$\frac{a}{s^2+a^2}$
$f(t-T)$	$F(s)e^{-sT}$	$\cos(at)u(t)$	$\frac{s}{s^2+a^2}$
$tf(t)$	$-\frac{d}{ds}F(s)$	$x(t)*y(t)$	$X(s)Y(s)$

$*$ implies convolution as $x(t)*y(t)=\int_{-\infty}^{\infty}x(\tau)y(t-\tau)d\tau$

Poles of second order system $s^2+2D\omega_n s+\omega_n{}^2=0$,

$s=-\sigma\pm j\omega_d \quad \sigma=D\omega_n \quad \omega_d=\omega_n\sqrt{1-D^2}$ rise time $\tau_r=\frac{2.2}{pole}$

State Space $\dot{x}=Ax+Br \quad y=Cx+Dr \quad H(s)=C(sI-A)^{-1}B+D$

Electric motor with parameters $\{R,K_T,K_b\}$, R internal resistance, current I flowing through motor gives torque $T=K_T I$, ω is rotation rate then induced back EMF voltage is $V_b=K_b\omega$

roots of quadratic $ax^2+bx+c=0 \quad x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$