EECS C128/ ME C134
Midterm
Tues Oct. 19, 2010
1110 - 1230 pm

Name:____________________________
SID:_____________

- Closed book. One page formula sheet. No calculators.

- There are 4 problems worth 100 points total.

Problem	Points	Score
1	30	
2	30	
3	20	
4	20	

In the real world, unethical actions by engineers can cost money, careers, and lives. The penalty for unethical actions on this exam will be a grade of zero and a letter will be written for your file and to the Office of Student Conduct.

$\tan^{-1}\frac{1}{2} = 26.6°$	$\tan^{-1} 1 = 45°$
$\tan^{-1}\frac{1}{3} = 18.4°$	$\tan^{-1}\frac{1}{4} = 14°$
$\tan^{-1}\sqrt{3} = 60°$	$\tan^{-1}\frac{1}{\sqrt{3}} = 30°$
$\sin 30° = \frac{1}{2}$	$\cos 60° = \frac{\sqrt{3}}{2}$

$20\log_{10} 1 = 0dB$	$20\log_{10} 2 = 6dB$
$20\log_{10}\sqrt{2} = 3dB$	$20\log_{10}\frac{1}{2} = -6dB$
$20\log_{10} 5 = 20db - 6dB = 14dB$	$20\log_{10}\sqrt{10} = 10$ dB
$1/e \approx 0.37$	$1/e^2 \approx 0.14$
$1/e^3 \approx 0.05$	$\sqrt{10} \approx 3.16$

Problem 1 (30 pts)
For the system below, let $H_y(s) = 1, G(s) = \frac{8}{(s+6)}$, and $D(s) = \frac{1}{s}$.

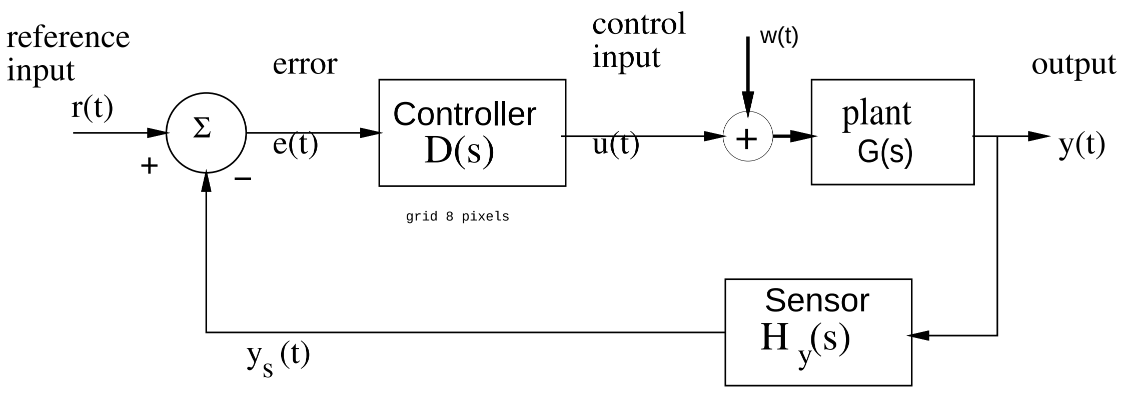
[4 pts] a) For $w(t) = 0$, determine $\frac{E(s)}{R(s)} =$ ______

[4 pts] b) for $r(t) = 0$, determine $\frac{Y(s)}{W(s)} =$ ______

[4 pts] c) If $r(t) = 0$ and $w(t)$ is a unit step, find $y(t) =$ ______

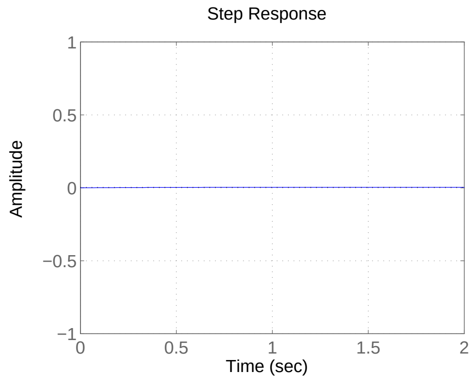
[4 pts] d) If $r(t) = 0$ and $w(t)$ is a unit step, find $\lim_{t\to\infty} e(t) =$ ______

[4 pts] e) If $r(t) = tu(t)$ and $w(t) = 0$, find $\lim_{t\to\infty} e(t) =$ ______



Problem 1, cont.

[4 pts] f) given $H(s) = \frac{s-1}{s+3}$, sketch the step response $y(t) = h(t) * u(t)$.



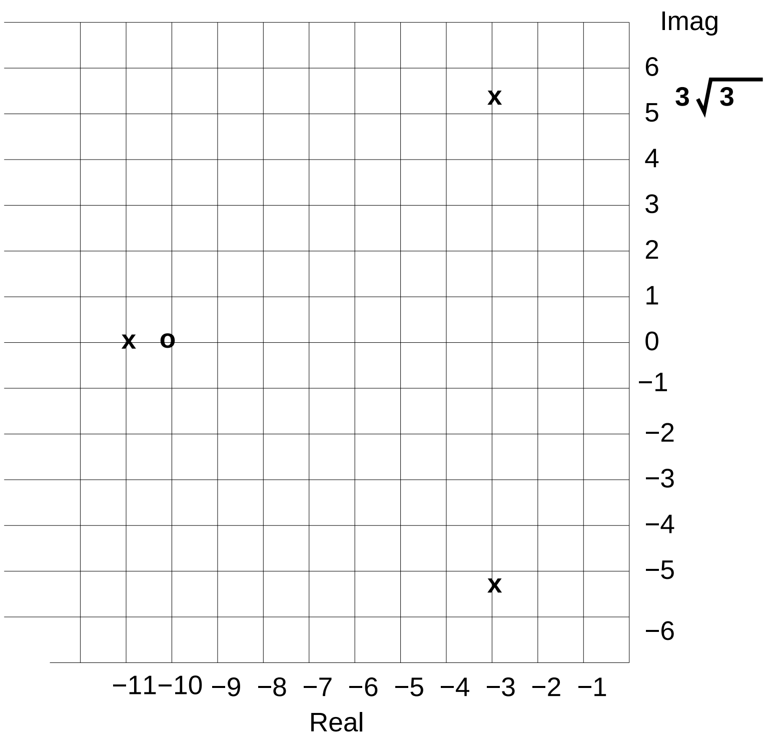
[6 pts] g) For the system with closed loop poles and zeros as shown, estimate

damping ratio $\zeta =$ ______,

natural frequency $\omega_n =$ ______,

damped frequency $\omega_d =$ ______,

and percent overshoot $M_p =$ ______ (ok to leave as expression).



Problem 2. (30 pts)

Given open loop transfer function $G(s)$:

$$G(s) = \frac{500(s+21)}{(s+1)(s+11)(s^2+2s+101)}$$

For the root locus:

[2 pts] a) Determine the number of branches of the root locus = ___

[4 pts] b) Determine the locus of poles on the real axis ____________

[3 pts] c) Determine the angles for each asymptote:_____________________

[4 pts] d) The approximation for the asymptote intersection point is $s =$_____

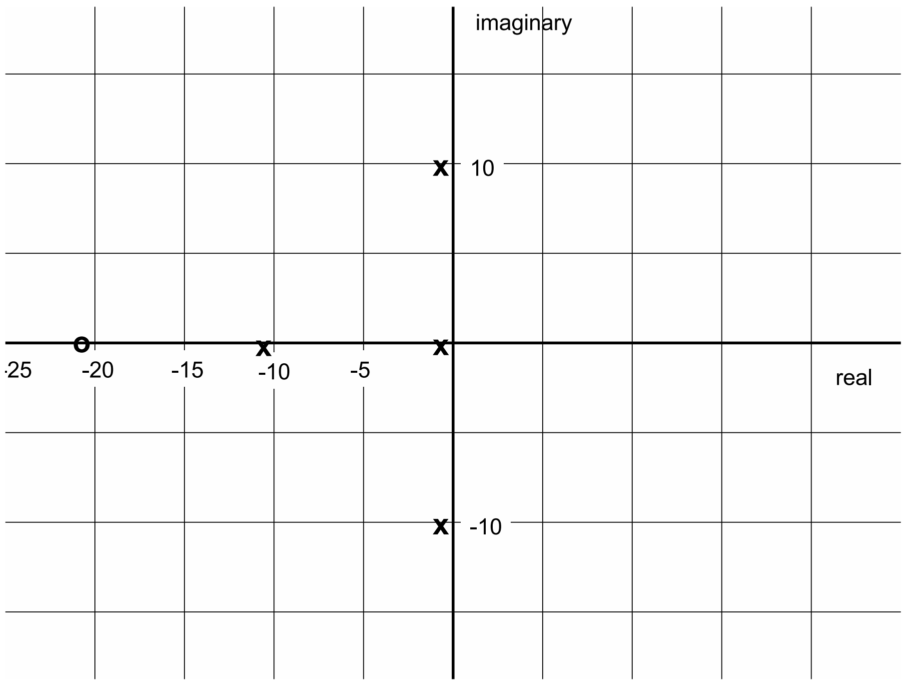
[9 pts] e) The angle of departure for the poles are:

$s = -1$: ______

$s = -11$:______

$s = -1 + 10j$:______ $s = -1 - 10j$:______

[8 pts] f) Sketch the root locus below using rules 1-4 discussed in class.



Problem 3. Bode Plot (20 points)

[10 pts] a) Sketch, labeling slopes, the magnitude and phase of $G(s)$ on the graph below for

$$G(s) = \frac{800}{(s+20)(s^2+2s+4)}$$

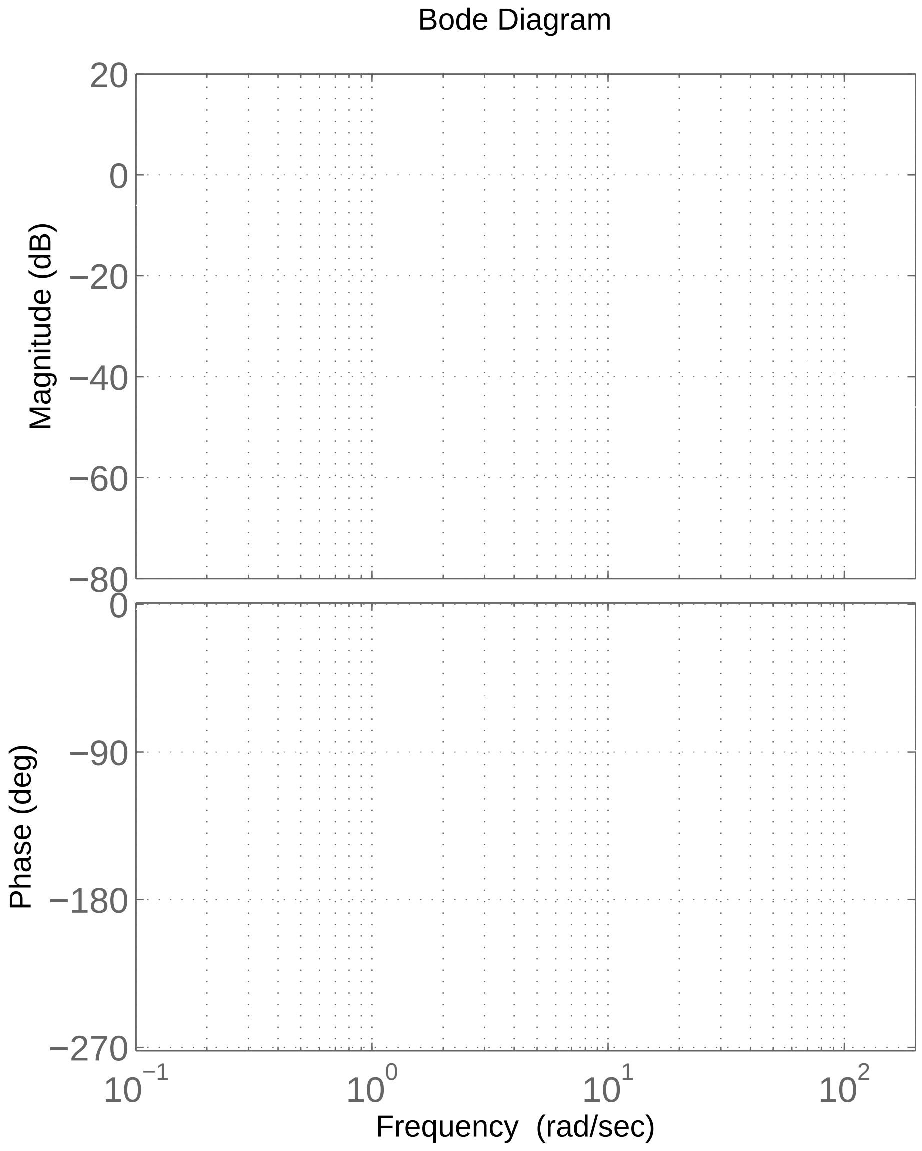
[4 pts] b) label gain and phase margin in Bode plot

[6 pts] c) based on the Bode plot, estimate the following:

phase margin = __________ degrees,

cross over frequency ω_c =_______ rad/sec

gain margin = __________ dB



Problem 4. (20 pts)

Given open loop transfer function $G(s)$:

$$G(s) = \frac{500(s+21)}{(s+1)(s+11)(s^2+2s+101)}$$

[6 pts] a) Estimate $|G(s = 10j)|$ from transfer function = ___________ (Hint: consider breakpoints).

[4 pts] b) sketch Nyquist plot for $G(s)$ below, showing clearly any encirclements.

[4 pts] c) number of closed loop right half plane poles = ? ____

[6 pts] d) Use the Nyquist plot to determine range of gain k for stability for the closed loop system $\frac{kG}{1+kG}$: $0 < k <$ ________