ECE 141 Homework 4

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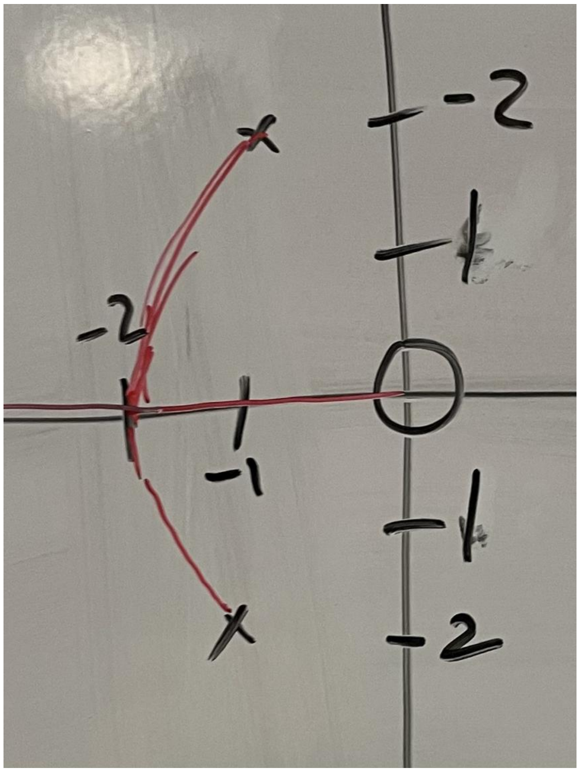
Problem 5.9

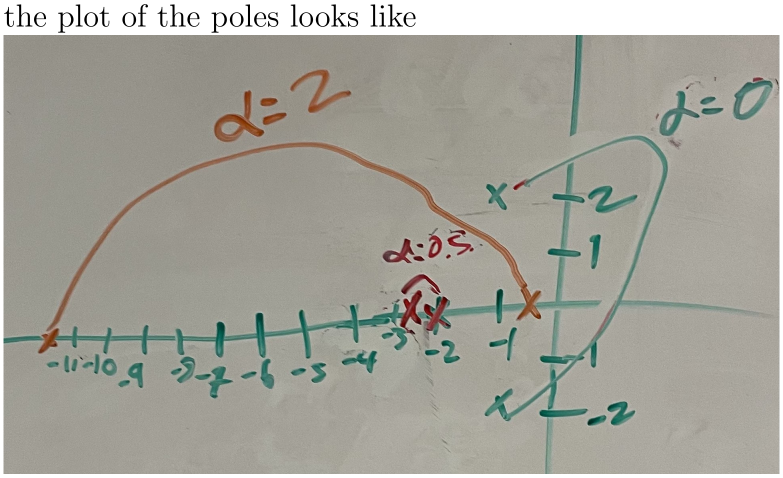
The transfer function is

$$\frac{Y}{R} = \frac{5}{(s(s+2)+5+5\alpha s)}$$

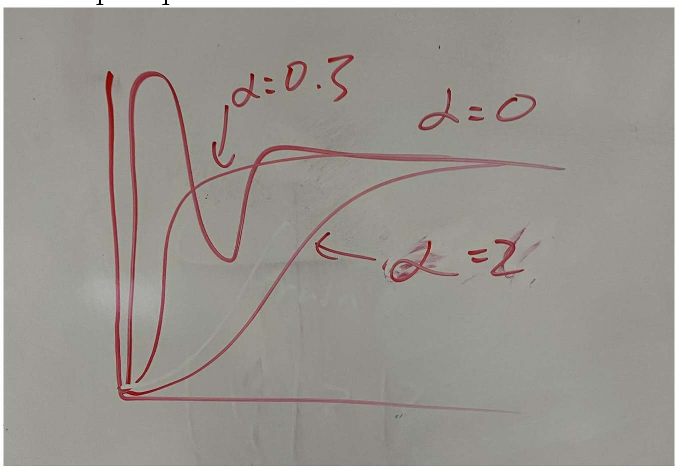
, therefore the characteristic equation is $s(s+2)+5+5\alpha s = 0$, therefore we have $b(s) = 5s$ and $a(s) = s^2+2s+1$ Therefore we have that $L(s) = \frac{5s}{s^2+2s+1}$, therefore 1 line will approach asymptotes centered at -2 and leaving at angles $180°$. Furthermore, the departure angle from the poles $-1 \pm 2j$ is $\mp 153.4°$ and the arival angle to the zero at 0 is $180°$, therefore the root locuses are at



When $\alpha = 0$, there are poles at $-1 \pm 2j$, when $\alpha = 0.5$, there are poles at -2 and -2.5, and when $\alpha = 2$, there are poles at -0.432 and -11.568, therefore the plot of the poles looks like



Therefore since $alpha = 0$ the step response will be underdamped since it has poles with imaginary components, and for $\alpha = 0.5$ the damping factor $\zeta = \frac{4.5}{2\sqrt{5}}$ and when $\alpha = 2$ the damping factor $\zeta = \frac{6}{\sqrt{5}}$, therefore the plot of the step responses would look like



With the following matlab code we can verify it

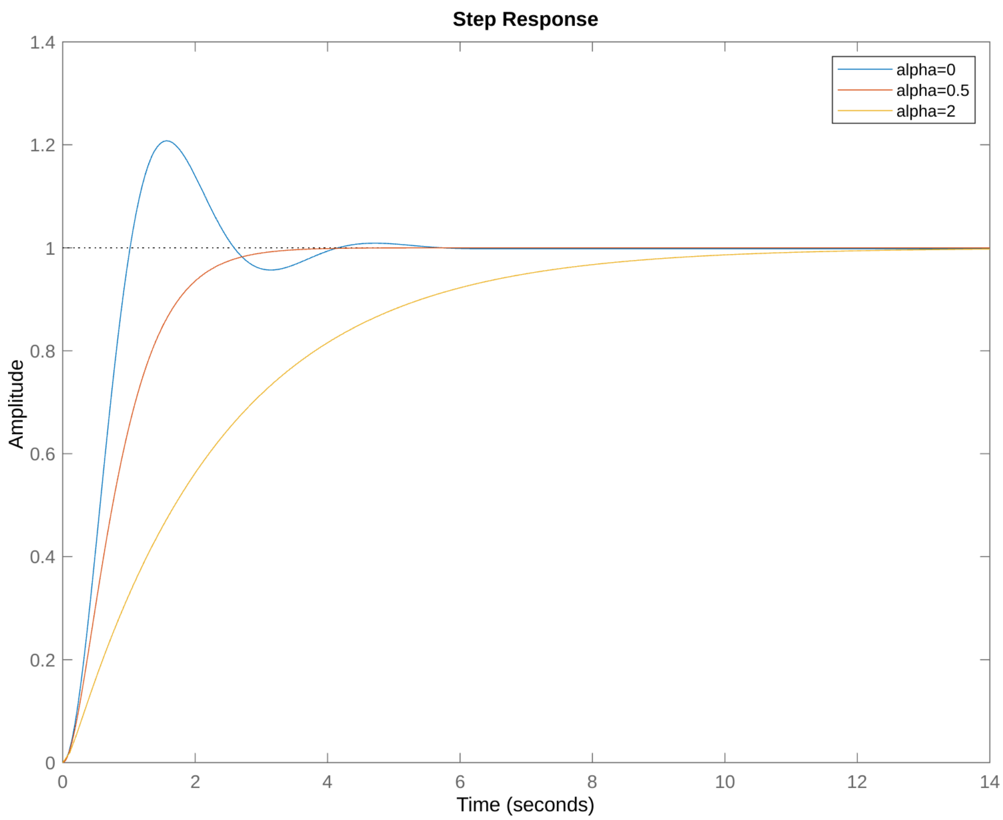
```
sys = tf([5],[1 2 5]);
step(sys)
stepinfo(sys)
hold on;

sys = tf([5],[1 2+2.5 5]);
step(sys)
stepinfo(sys)

sys = tf([5],[1 12 5]);
step(sys)
stepinfo(sys)

hold off;
legend('alpha=0','alpha=0.5','alpha=2')
```

Which produces the following plot.



Problem 5.13

(a)