ECE 463/663 - Homework #5

Full State Feedback. Due Wednesday, February 22nd
Please submit as a hard copy, email to jacob.glower@ndsu.edu, or submit on BlackBoard

1) Write a Matlab m-file which is passed

- The system dynamics (A, B),
- The desired pole locations (P)

and then returns the feedback gains, Kx, so that roots(A - B Kx) = P

```
function [Kx] = ppl(A, B, P)
```

Problems 2-4) Assume the following dynamic system:

$$sX = \begin{bmatrix} -10.2 & 5 & 0 & 0 & 0 \\ 5 & -10.2 & 5 & 0 & 0 \\ 0 & 5 & -10.2 & 5 & 0 \\ 0 & 0 & 5 & -10.2 & 5 \\ 0 & 0 & 0 & 5 & -5.2 \end{bmatrix} X + \begin{bmatrix} 5 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} U$$

$$Y = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 \end{bmatrix} X$$

2) (20 points) Find the feedback control law of the form

$$U = K_r R - K_x X$$

so that

- The DC gain is 1.000 and
- The closed-loop poles are at {-2, -8, -9, -10, -11}

Plot

- The resulting closed-loop step reponse, and
- The resulting input, U

Note: In Matlab, to plot the output (blue) and input (red), use the following commands:

```
G2 = ss(A-B*Kx, B*Kr, [C ; -Kx], [D ; Kr]);
t = [0:0.01:5]';
y2 = step(G2,t);
plot(t,y2(:,1),'b',t,y2(:,2),'r')
xlabel('Time (seconds)');
```

3) (20 points) Repeat problem #2 but find Kx and Kr so that

- The DC gain is 1.000 and
- The closed-loop dominant pole is at s = -2 and the other four poles don't move (the are the same as the fast four poles of the open-loop system (eigenvalues of A)

Plot

- The resulting closed-loop step reponse, and
- The resulting input, U

4) (20 points) Repeat problem #2 but find Kx and Kr so that

- The DC gain is 1.000
- The 2% settling time is 2 seconds, and
- There is 10% overshoot for a step input.

Plot

- The resulting closed-loop step reponse, and
- The resulting input, U