UNIVERSITY OF NOTRE DAME
Aerospace and Mechanical Engineering

AME 437: Control Systems Engineering
Homework 7 Solutions

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1. First, the ordinary differential equation in the time domain corresponding to the transfer function must be determined. Let

$$\frac{Y(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + omega_n^2}$$

so that

$$Y(s)\left(s^2 + 2\zeta\omega_n s + \omega_n^2\right) = R(s)\omega_n^2.$$

Inverse Laplace transforming gives

$$\ddot{y}(t) + 2\zeta\omega_n\dot{y}(t) + \omega_n^2 y(t) = \omega_n^2.$$

Converting to two first order equations gives

$$\frac{d}{dt}\begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix} = \begin{bmatrix} y_2(t) \\ \omega_n^2 - 2\zeta\omega_n y_2(t) - \omega_n^2 y_1(t) \end{bmatrix}.$$

I'll put the code here later. It won't be on the test anyway.

2. Consider

$$G(s) = \frac{10}{(s+2)(s+10)}.$$

(a) By inspection, the answer is (ii) because it is a Type-1 system due to the fact that the lowest power of s in the denominator is 1.

(b) Using Matlab

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>> rlocus(10,[1 12 20])
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and pointing and clicking indicates that $K = 5.25$ as is illustrated in Figure 1.

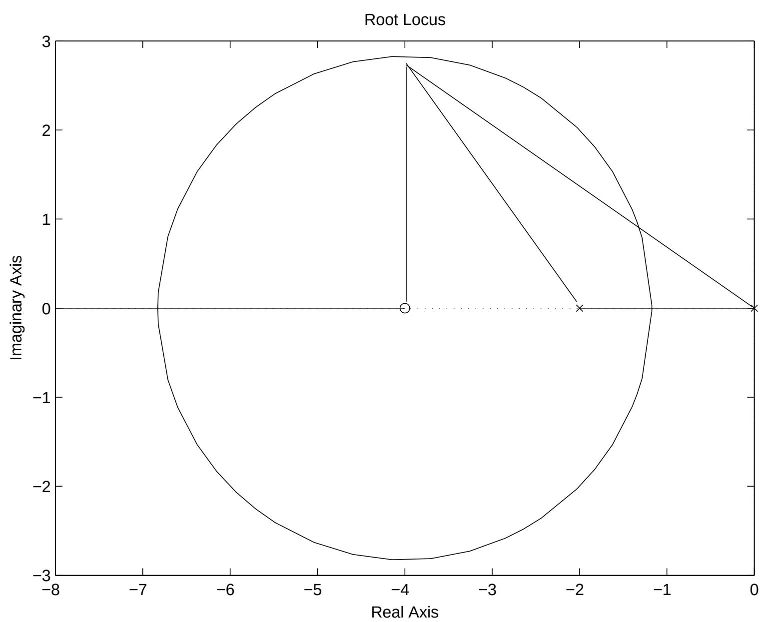

Figure 1. Root locus plot for problem 2.