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

\[
>> \text{rlocus}(10,[1 12 20])
\]

and pointing and clicking indicates that \( K = 5.25 \) as is illustrated in Figure 1.
Figure 1. Root locus plot for problem 2.