1. Derive the output (after a long time) from a system with transfer function \( G(s) \) when the input signal \( A \cos(\omega t) + B \sin(\omega t) \) is applied. (10 points)

2. Draw an approximate Bode plot (for magnitude (in dB) and frequency) of the following transfer function. (10 points)
\[
G(s) = \frac{(s + 10)}{s(s + 1)(s + 100)}
\]

3. Consider the following system.

i. Draw the root locus if the plant has three open loop poles, all on the negative real axis. The three poles are all distinct (no repeats). (2 points)

ii. Draw the root locus of the same plant with the following compensator. What is the name of this compensator? (3 points)

iii. Draw the root locus of the same plant with the following compensator where \( a \) is a very small positive number. What is the name of this compensator? (3 points)

iv. Take the same plant and use a PD controller as the compensator. Draw four root locus diagrams when the zero of the compensator is in four different positions (left of all the system poles, between two poles, right of all poles etc.) (4 points)

v. What is the advantage of using a lag compensator instead of a PI compensator, and what is the advantage of using a lead compensator instead of a PD compensator? (2 points)

vi. What performance measure does a lead compensator improve and which one does a lag compensator improve? (1 point)

4. (Take home problem due Monday after break) Do problem 7 (page 573) (5 points)