ECE-320, Practice Quiz #9

1) Consider the following state variable model

$$\dot{q}(t) = \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix} q(t) + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 3 & 0 \end{bmatrix} q(t)$$

Assume state variable feedback of the form $u(t) = G_{pf} r(t) - Kq(t)$ The closed loop transfer function for this system is which of the following?

a) $G(s) = \frac{-6G_{pf}}{s(s-1+2k_2)+2k_1-1}$ b) $G(s) = \frac{6G_{pf}}{s(s-1+2k_2)+2k_1-1}$

c) $G(s) = \frac{6G_{pf}}{s(s-1+2k_2)-2k_1+1}$ d) $G(s) = \frac{-6G_{pf}}{s(s-1+2k_2)-2k_1+1}$

2) Consider the following state variable model

$$\dot{q}(t) = \begin{bmatrix} -1 & 2 \\ 0 & 1 \end{bmatrix} q(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} q(t)$$

Assume state variable feedback of the form $u(t) = G_{pf} r(t) - Kq(t)$ Is the closed loop transfer function for this system equal to

$$G(s) = \frac{G_{pf}}{s+1+k_1}$$

a) yes b) no

Problems 3-6 refer to a system with state variable feedback with the transfer function

$$G(s) = \frac{8G_{pf}}{s^2 + (k_1 + 12)s + (k_1 + k_2 + 20)}$$

3) Is this system ***controllable***?

a) Yes b) No c) impossible to determine

4) What is the approximate bandwidth of the open loop system?

a) 2 Hz b) 2 rad/sec c) 2π rad/sec d) 10 Hz

5) In order for the open loop system to have a zero steady state error for a unit step input, the value of the prefilter should be

a) $G_{pf} = 1$ b) $G_{pf} = \frac{2}{5}$ c) $G_{pf} = \frac{5}{2}$ d) none of these

6) If we want to choose the feedback gains so the bandwidth of the system is 5 rad/sec and the second pole is 4 time further from the imaginary axis than the first pole (both are assumed to be real poles), then we should choose the gains to be

a) $k_1 = 5, k_2 = 20$ b) $k_1 = 25, k_2 = 100$ c) $k_1 = 13, k_2 = 87$ d) $k_1 = 13, k_2 = 67$ e) none of these

Problems 7-10 refer to a system with state variable feedback that has the following transfer function

$$G(s) = \frac{G_{pf}}{s^2 + (k_1 - 1)s + (k_2 + 2)}$$

7) Is the system controllable?

a) Yes b) No c) impossible to determine

8) In order for the open loop system to have a zero steady state error for a unit step input, the value of the prefilter should be

a) $G_{pf} = 1$ b) $G_{pf} = 2$ c) $G_{pf} = -1$ d) none of these

9) Assume we use our state variable feedback to place both poles at -5. Then we should choose the gains to be

a) $k_1 = 5, k_2 = 5$ b) $k_1 = 10, k_2 = 25$ c) $k_1 = 11, k_2 = 23$ d) $k_1 = 9, k_2 = 27$ e) none of these

10) Assume we use our state variable feedback to place both poles at -5. If we want a zero steady state error for a unit step input, then the prefilter gain should be

a) $G_{pf} = 1$ b) $G_{pf} = 2$ c) $G_{pf} = 5$ d) $G_{pf} = 25$ e) none of these

11) A system with state variable feedback has the following transfer function

$$G(s) = \frac{G_{pf}}{(s - k_1 k_2)^2}$$

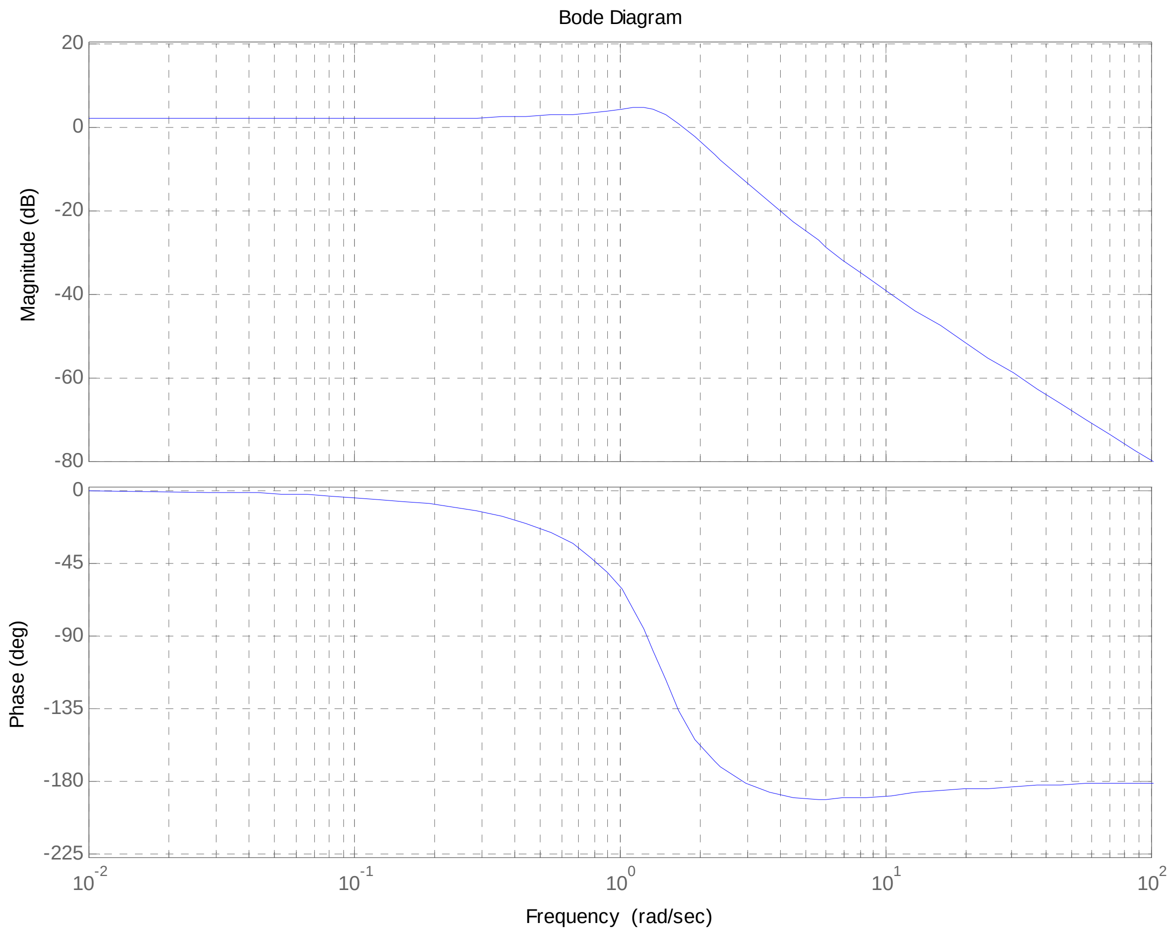
Is the system controllable?

a) Yes b) No c) impossible to determine

12) Consider a plant that is unstable but is a controllable system. Is it possible to use state variable feedback to make this system stable?

a) Yes b) No

Problems 13-7 refer to the following open loop Bode plot of $G(s)H(s)$



13) The *gain crossover frequency used to determine the phase margin* for this system is best estimated as

a) 0 rad/sec   b) 1 rad/sec   c) 1.8 rad/sec   d) 12 rad/sec   e) 100 rad/sec

14) The *phase crossover frequency* for this system is best estimated as

a) 0 rad/sec   b) 1.8 rad/sec   c) 3 rad/sec   d) 30 rad/sec   e) 100 rad/sec

15) The phase margin for this system is best estimated as

a) $+45^o$ b) -45^o c) $+135^o$ d) -135^o

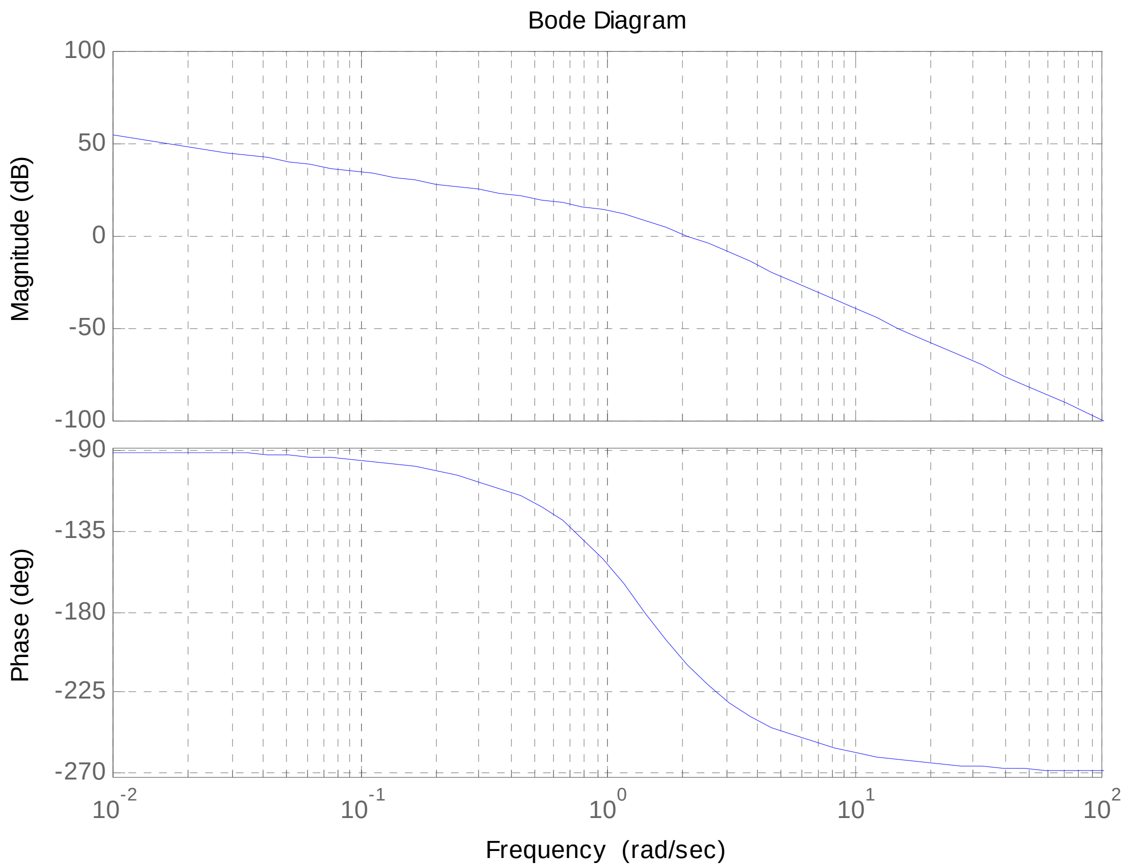
16) The gain margin for this system is best estimated as

a) +12 dB   b) - 12 dB   c) ∞ dB   d) -2 dB

17) Assuming $G(s)H(s)$ is minimum phase, is the closed loop system **stable**?

a) Yes   b) No   c) impossible to determine

Problems 18-22 refer to the following open loop Bode plot of $G(s)H(s)$



18) The *gain crossover frequency used to determine the phase margin* for this system is best estimated as

a) 0 rad/sec b) 1 rad/sec c) 1.5 rad/sec d) 2 rad/sec e) 100 rad/sec

19) The *phase crossover frequency* for this system is best estimated as

a) 0 rad/sec b) 1 rad/sec c) 1.5 rad/sec d) 2 rad/sec e) 100 rad/sec

20) The phase margin for this system is best estimated as

a) $+30^o$ b) -30^o c) $+60^o$ d) -60^o

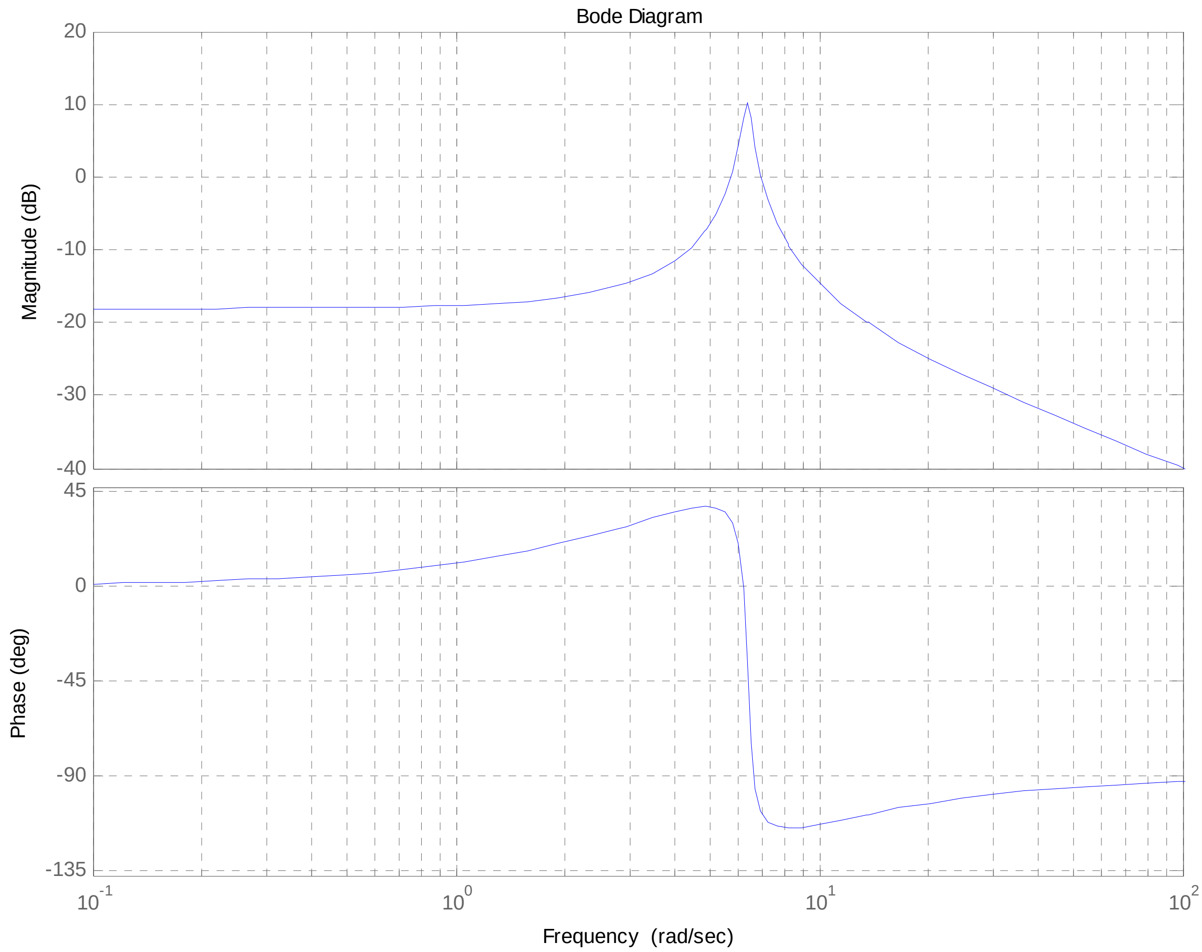
21) The gain margin for this system is best estimated as

a) +5 dB b) - 5 dB c) ∞ dB d) 0 dB

22) Assuming $G(s)H(s)$ is minimum phase, is the closed loop system **stable**?

a) Yes b) No c) impossible to determine

Problems 23-27 refer to the following open loop Bode plot of $G(s)H(s)$



23) The *gain crossover frequency used to determine the phase margin* for this system is best estimated as

a) 0 rad/sec b) 5.5 rad/sec c) 7 rad/sec d) 15 rad/sec

24) The *phase crossover frequency* for this system is best estimated as

a) 0 rad/sec b) 1 rad/sec c) 1.5 rad/sec d) 2 rad/sec e) none of these

25) The phase margin for this system is best estimated as

a) $+70^o$ b) -70^o c) $+135^o$ d) -135^o

26) The gain margin for this system is best estimated as

a) +5 dB b) - 5 dB c) ∞ dB d) 0 dB

27) Assuming $G(s)H(s)$ is minimum phase, is the closed loop system **stable**?

a) Yes b) No c) impossible to determine

Answers: 1-b, 2-a,
3-a, 4-b, 5-c, 6-d, 7-a, 8-b, 9-c, 10-d,
11-b, 12-a,
13-c, 14-c, 15-a, 16-a, 17-a
18-d, 19-c, 20-b, 21-b, 22-b,
23-c, 24-e, 25-a, 26-c, 27-a