ESE 406 - FALL 2009 – *Practice* FINAL EXAM – Open Book & Open Notes

- Choose one best answer (A through D) for each question by *circling the letter*.
- A correct answer is worth 2 points.
- No answer is worth 0 points.
- An incorrect answer is worth -1 point. Random guessing will lower your grade (on average).

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1. For the following differential equation:

$$\frac{dy}{dt} + \sin(3y) = 2(u-1)$$

the transfer function, $\frac{\Delta Y(s)}{\Delta U(s)}$, for small changes from a trim condition at $y_o = 0$ is

A. $\frac{2}{s+3}$

B. $\frac{2}{s+1}$

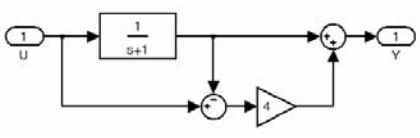
C. $\frac{1}{s+1}$

D. $\frac{2s-1}{s+\cos(\pi/6)}$

2. Which of the following is NOT a true statement about the transfer function

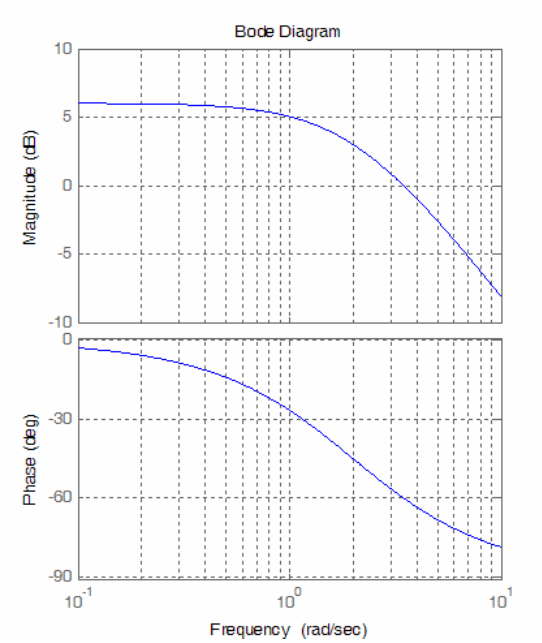
$$G(s) = \frac{2s+36}{\left(s^2+18s+324\right)}$$

A. The system is stable.
B. The poles are complex with natural frequency $\omega_n = 18$ and damping ratio $\varsigma = 0.5$
C. The zero is on the negative real axis at $z = -36$
D. The steady-state ("DC") gain of the system is $\frac{1}{9}$.



3. The filter shown in the block diagram above is:

A. a lag filter
B. a lead filter
C. a notch filter
D. none of the above



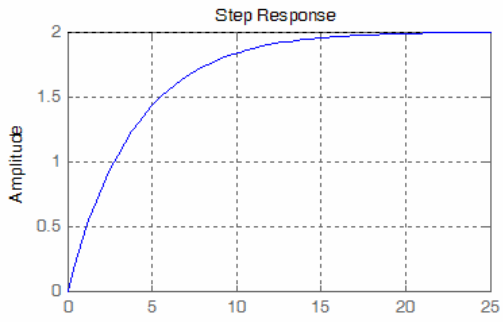
4. Which of the following is the transfer function corresponding to the frequency response (bode) diagram show above?

A. $G(s) = \frac{(s+2)}{(s+1)}$

B. $G(s) = \frac{8}{(s+2)^2}$

C. $G(s) = \frac{6}{s+1}$

D. $G(s) = \frac{4}{s+2}$

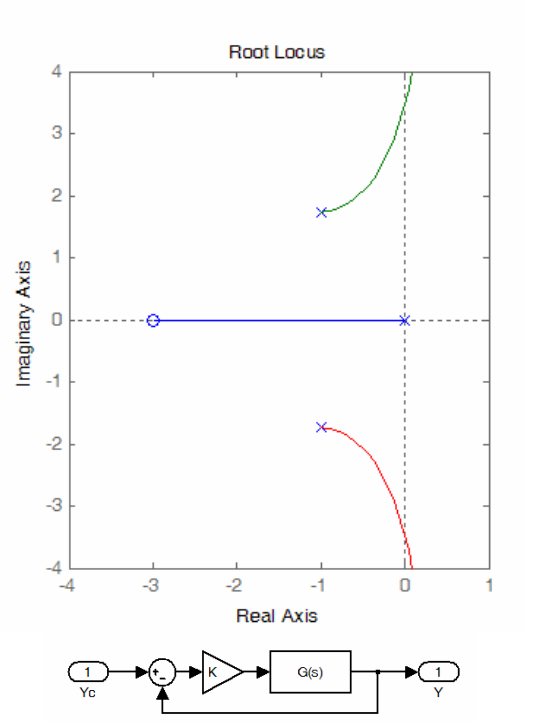


5. The time constant for the first-order step response shown above is:

   A. 2 seconds
   B. 4 seconds
   C. 8 seconds
   D. None of the above

6. Which of the following statements is NOT correct concerning derivative feedback?

   A. It is usually used to improve damping.
   B. It has infinite gain at high frequency, which can result in noise rejection issues.
   C. It can only be used in conjunction with proportional and integral feedback (PID control).
   D. None of the above is NOT correct. (That is, all of the above are correct.)



7. Which of the following statements is NOT correct concerning the block diagram and root locus (on K) shown above?

   A. The root locus shows the variation of the closed-loop pole locations as the gain K is increased from zero.
   B. The system will be unstable for some finite positive value of the gain, K.
   C. The system will necessarily be stable for K less than 1.0.
   D. For any positive value of K, there will be exactly one closed-loop pole on the negative real axis.

8. The transfer function corresponding to the root locus shown in the previous problem could be:

   A. $G(s) = \dfrac{3s}{(s+3)(s^2+4s+4)}$

   B. $G(s) = \dfrac{3}{(s+3)(s^2+4s+4)}$

   C. $G(s) = \dfrac{(s+4)}{(s^2+3s+9)}$

   D. $G(s) = \dfrac{s+3}{s(s^2+2s+4)}$

9. For the following differential equations:

$$\frac{dh}{dt} + 2q\sqrt{h} = 2u$$

$$\frac{dq}{dt} + q^2 = u$$

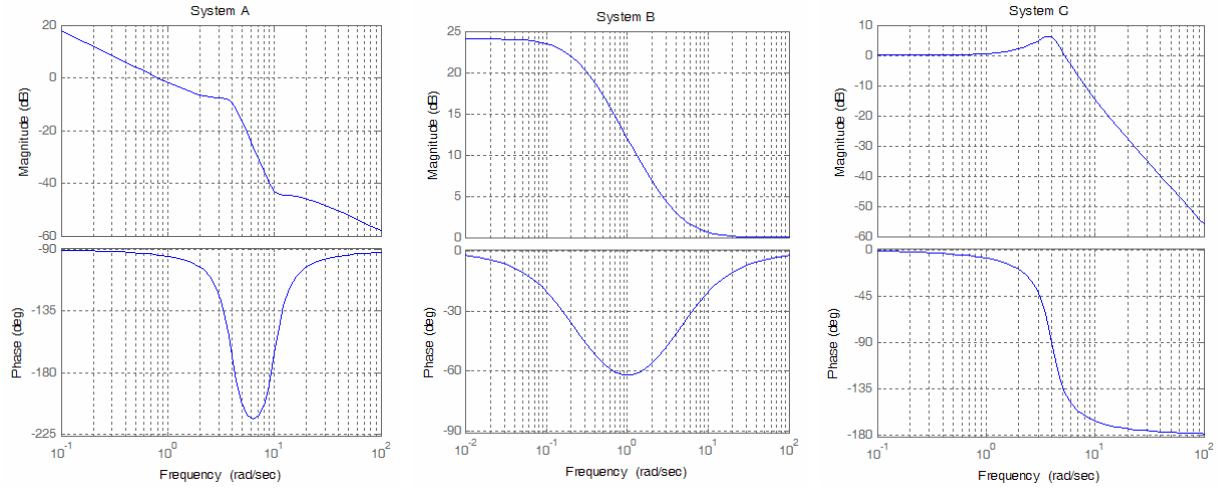
the trim condition is determined by which of the following?

   A. $2q_o\sqrt{h_o} = 2u_o$
      $q_o^2 = u_o$
   B. $h_o = 0$
      $q_o = 1$
      (trim control, u_o, is always arbitrary)
   C. $2\sqrt{h_o} + \dfrac{q_o}{\sqrt{h_o}} = 2u_o$
      $2q_o = u_o$
   D. None of the above

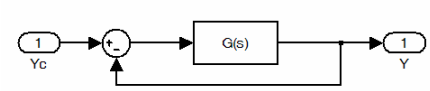
10. For the equations in the previous problem, a trim condition of $u_o = 4$ results in what $\dfrac{\Delta H(s)}{\Delta U(s)}$?

   A. $\dfrac{1}{s+4}$
   B. $\dfrac{2s+4}{s^2+5s+4}$
   C. $\dfrac{2s+4}{s^2+6s+8}$
   D. None of the above

Each of the following figures below shows the frequency response for some transfer function, G(s)



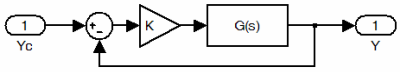
11. Using feedback of the following form:



which of the systems shown above has a phase margin of approximately 41 degrees?

A. System A
B. System B
C. System C
D. All of the systems shown above are unstable with this form of feedback.

12. Using feedback of the following form:



which of the systems shown above will reach neutral stability with K approximately equal to 3.5?

A. System A
B. System B
C. System C
D. None of the above

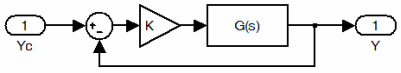
13. The frequency response for

$$G(s) = \frac{s^2 + 5s + 100}{\left(s^2 + 2s + 16\right)}$$

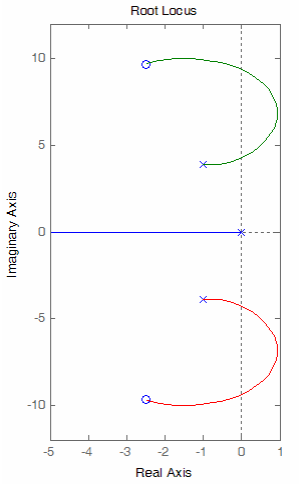
is shown in which figure above?

A. System A
B. System B
C. System C
D. None of the above

14. Using feedback of the following form:



results in the following root locus (K>0)



for which of the systems shown above?

A. System A
B. System B
C. System C
D. None of the above

15. Which figure above represents an instance of a first-order lag compensator?

A. System A
B. System B
C. System C
D. None of the above