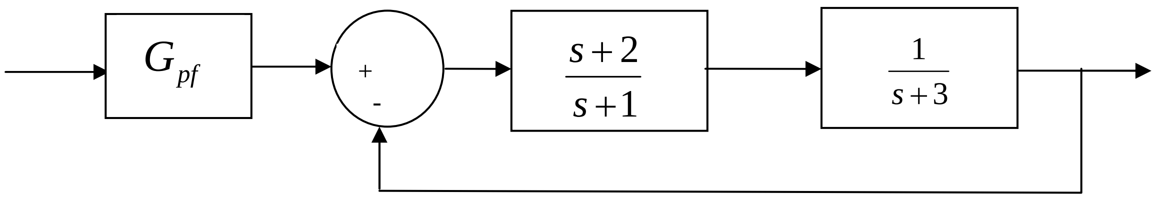
ECE-320, Practice Quiz #3

1) For the following system:



the value of the prefilter G_{pf} that produces **a steady state error** of zero for a unit step input is:

a) 1 b) 3/2 c) 5/2 d) 1/3

Problems 2 and 3 refer to the impulse responses of six different systems given below:

$$h_1(t) = [1 + e^{-t}]u(t)$$
$$h_2(t) = e^{-2t}u(t)$$
$$h_3(t) = [2 + \sin(t)]u(t)$$
$$h_4(t) = [1 - t^3 e^{-0.1t}]u(t)$$
$$h_5(t) = [1 + t + e^{-t}]u(t)$$
$$h_6(t) = [te^{-t}\cos(5t) + e^{-2t}\sin(3t)]u(t)$$

2) The number of **maginally stable systems** is a) 0 b) 1 c) 2 d) 3

3) The number of **unstable systems** is a) 0 b) 1 c) 2 d) 3

4) The **<u>unit step response</u>** of a system is given by $y(t) = 0.5u(t) - tu(t) - t^4 e^{-t}u(t) + e^{-t}u(t)$

The **<u>steady state error</u>** for a unit step input for this system is best estimated as

a) ∞ b) 0.5 c) 2.0 d) impossible to determine

5) The **<u>unit step response</u>** of a system is given by $y(t) = 0.5u(t) - t^4 e^{-t}u(t) + e^{-t}u(t)$

The **<u>steady state error</u>** for a **unit step input** for this system is best estimated as

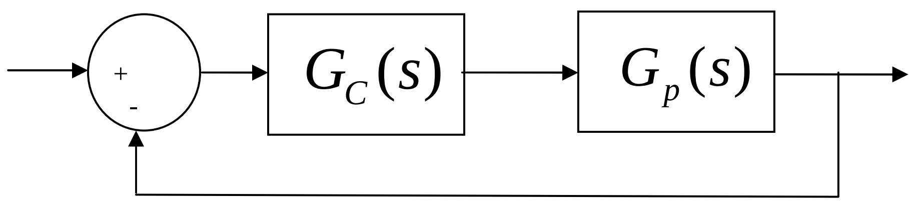
a) ∞ b) 0.5 c) 2.0 d) impossible to determine

6) The **unit ramp response** of a system is given by $y(t) = -0.5u(t) + tu(t) + e^{-t}u(t)$.

The best estimate of the **steady state error** is

a) 0.5 b) 2.0 c) 1.0 d) ∞

7) Assume we are using model matching to determine the controller in the following system.



The plant is given by $G_p(s) = \frac{(s+1)(s-1)}{s^2+2s+2}$

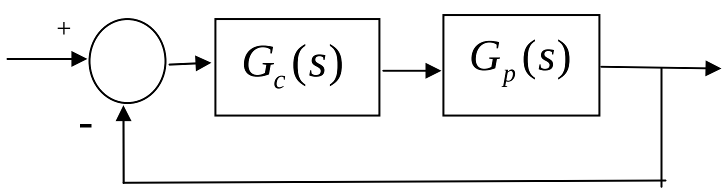
Which of the following candidate closed loop transfer functions are acceptable?

$$G_A(s) = \frac{s-1}{s+1} \qquad G_B(s) = \frac{s+1}{s^2+2s+2} \qquad G_C(s) = \frac{s-1}{s-3}$$

$$G_D(s) = \frac{s-1}{(s+2)^2} \qquad G_E(s) = \frac{1}{s^2+s+1} \qquad G_F(s) = 1$$

a) G_A, G_C, and G_D b) only G_B c) G_A and G_D d) G_E and G_F

8) For the following system



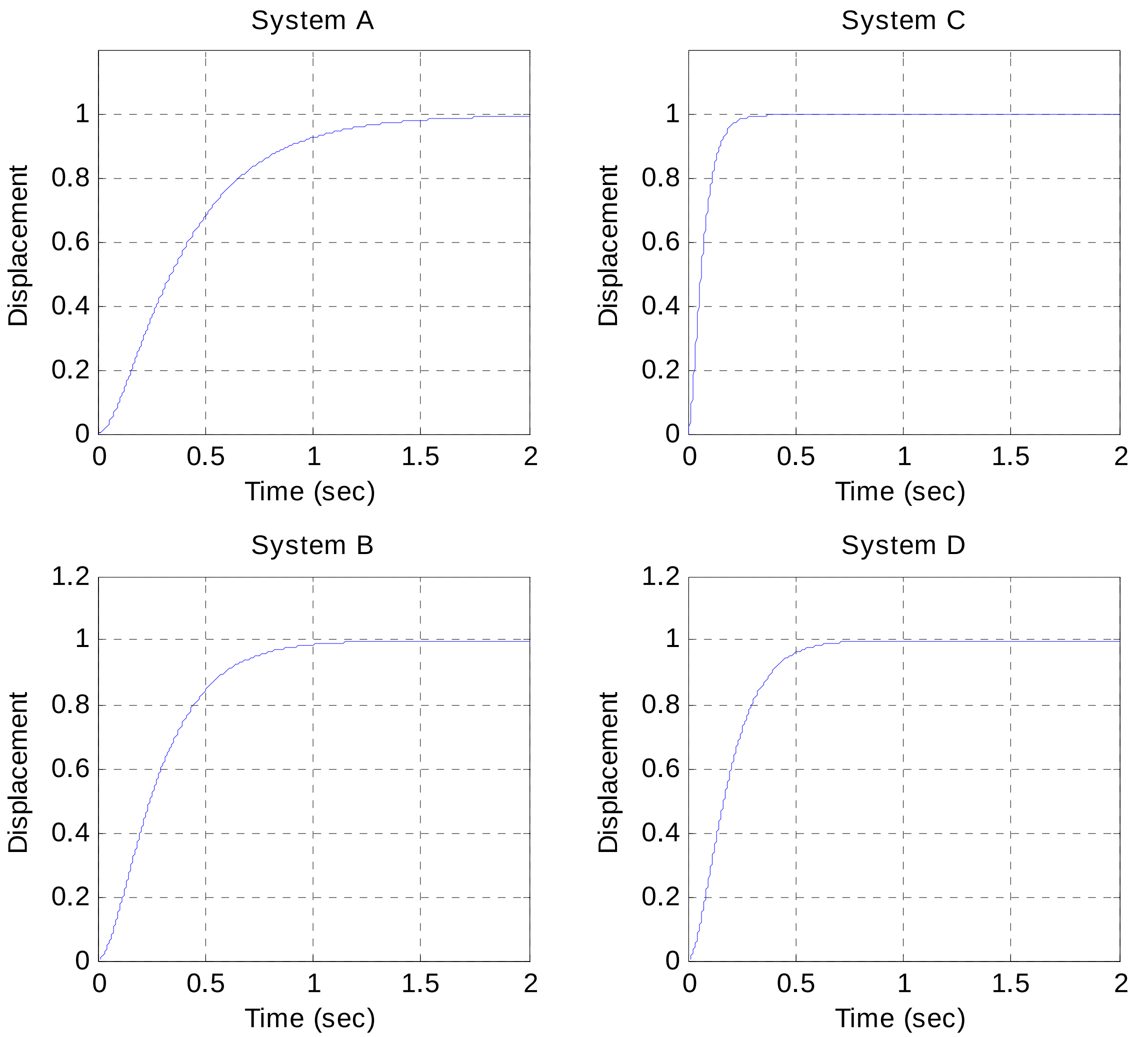
the pole of the controller $G_c(s)$ is at -15
the poles of the plant $G_p(s)$ are at -1 and -2
the poles of the closed loop system are at -7.1, -5.43 +3.98j, -5.43 -3.98j

The best estimate of the settling time of the closed loop system is

a) 4 seconds b) $\frac{4}{15}$ seconds c) $\frac{4}{7.1}$ seconds d) $\frac{4}{5.43}$ seconds

9) The unit step responses of four systems with real poles is shown below. Which system will have the **largest bandwidth**?

a) System A b) System B c) System C d) System D



10) Which of the following transfer functions represents a **stable** system?

$$G_a(s) = \frac{s-1}{s+1} \qquad G_b(s) = \frac{1}{s(s+1)} \qquad G_c(s) = \frac{s}{s^2-1}$$

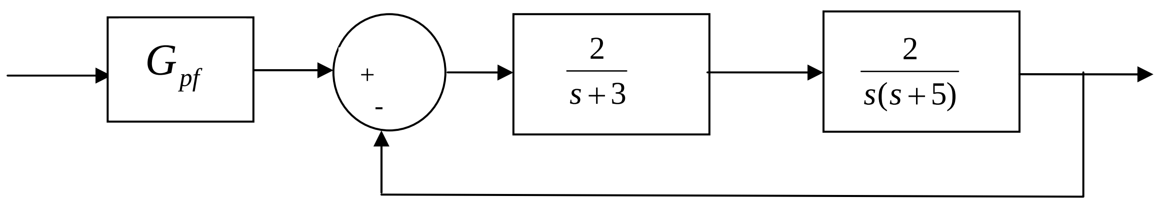
$$G_d(s) = \frac{s+1}{(s+1+j)(s+1-j)} \qquad G_e(s) = \frac{(s-1-j)(s-1+j)}{s} \qquad G_f(s) = \frac{(s-1-j)(s-1+j)}{(s+1-j)(s+1+j)}$$

a) all but G_c b) only G_a, G_b, and G_d c) only G_a, G_d, and G_f

d) only G_d and G_f e) only G_a and G_d

11) For the block diagram below, the value of the prefilter G_{pf} that produces zero **steady state error** for a unit step input is:

a) 1 b) 3/2 c) 3 d) 1/3



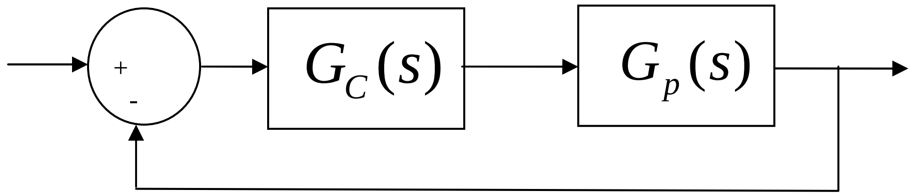
Problems 12 and 13 refer to the following impulse responses of six different systems

$$h_1(t) = [te^{-t}]u(t)$$
$$h_2(t) = e^{-2t}u(t)$$
$$h_3(t) = [2e^{-2t} + t^3 \sin(t)]u(t)$$
$$h_4(t) = [1 - t^3 e^{-0.1t}]u(t)$$
$$h_5(t) = [1 + t + e^{-t}]u(t)$$
$$h_6(t) = [te^{-t}\cos(5t) + e^{-2t}\sin(3t)]u(t)$$

12) The number of **unstable** systems is a) 1 b) 2 c) 3 d) 4

13) The number of **marginally stable** systems is a) 1 b) 2 c) 3 d) 4

14) Assume we are using model matching to determine the controller in the following system.



The plant is given by $G_p(s) = \dfrac{-1}{s^2+2s+2}$

Which of the following candidate closed loop transfer functions are acceptable?

$$G_A(s) = \frac{s-1}{s^2+1} \qquad G_B(s) = \frac{s+1}{s^2+2s+2} \qquad G_C(s) = \frac{s-1}{s-3}$$
$$G_D(s) = \frac{5}{(s+2)^2} \qquad G_E(s) = \frac{1}{s^2+s+1}$$

Circle all that apply: a) G_A b) G_B c) G_C d) G_D e) G_E

15) Which of the following transfer functions represents a **stable** system?

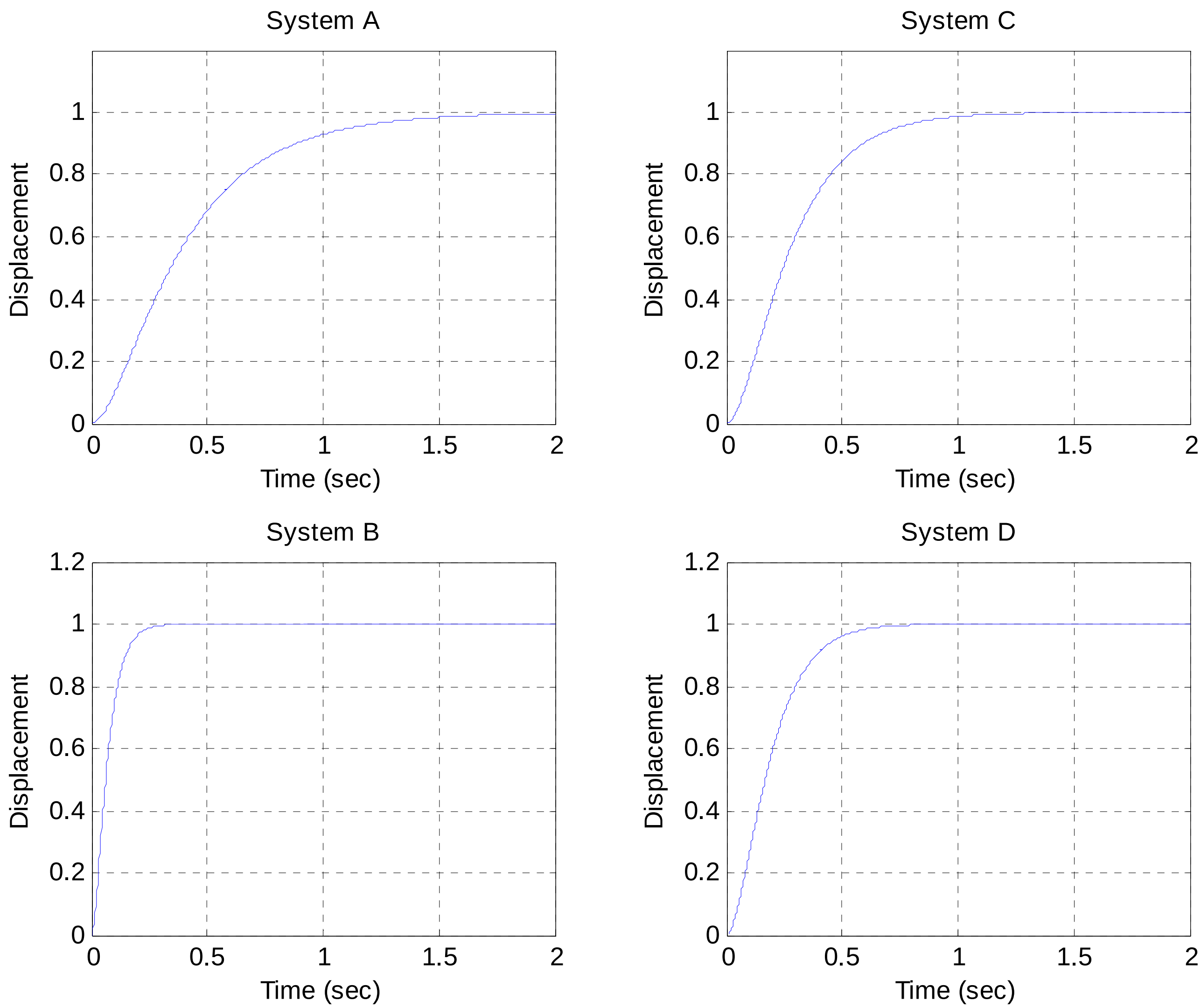
$$G_a(s) = \frac{s-1}{s+1} \qquad G_b(s) = \frac{s}{(s+1)} \qquad G_c(s) = \frac{s}{s^2-1}$$
$$G_d(s) = \frac{s+1}{(s+1+j)(s+1-j)} \qquad G_e(s) = \frac{(s-1-j)(s-1+j)}{(s+2)^2} \qquad G_f(s) = \frac{(s-1-j)(s-1+j)}{(s+1-j)(s+1+j)}$$

a) all but G_c b) only G_a, G_b, and G_d c) only G_a, G_d, and G_f d) only G_d and G_f

e) only G_a and G_d

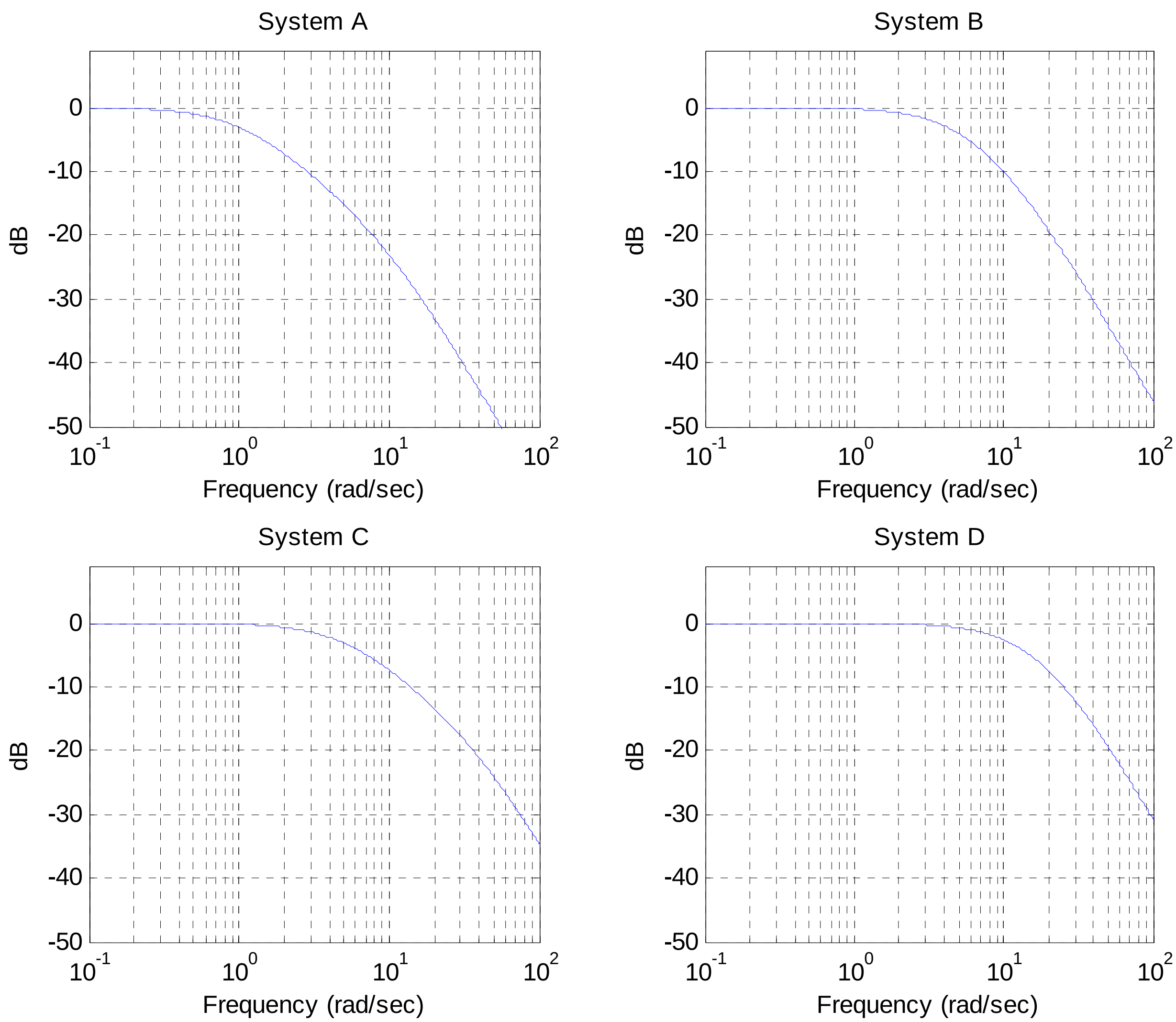
16) The **unit step responses** of four systems with real poles is shown below. Which system will have the **largest bandwidth**?

a) System A b) System B c) System C d) System D



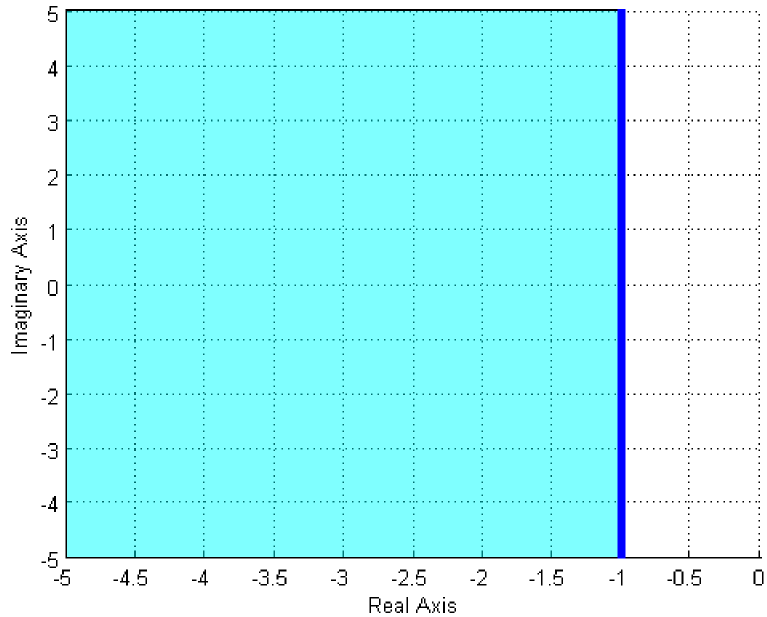
17) The magnitude of the frequency response of four systems with real poles is shown below. Which system will have the smallest **settling time**?

a) System A   b) System B   c) System C   d) System D



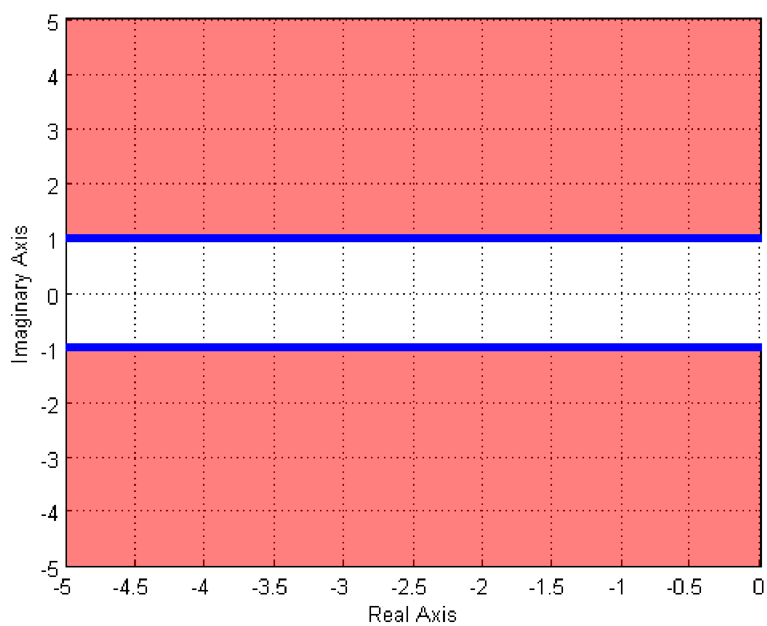
18) The (dark) shaded area in the s-plane figure below shows the possible pole location for an ideal second order system that meets which of the following constraints?

a) $T_s \leq 1$ b) $T_s \geq 1$ c) $T_s \geq 4$ d) $T_s \leq 4$ e) none of these



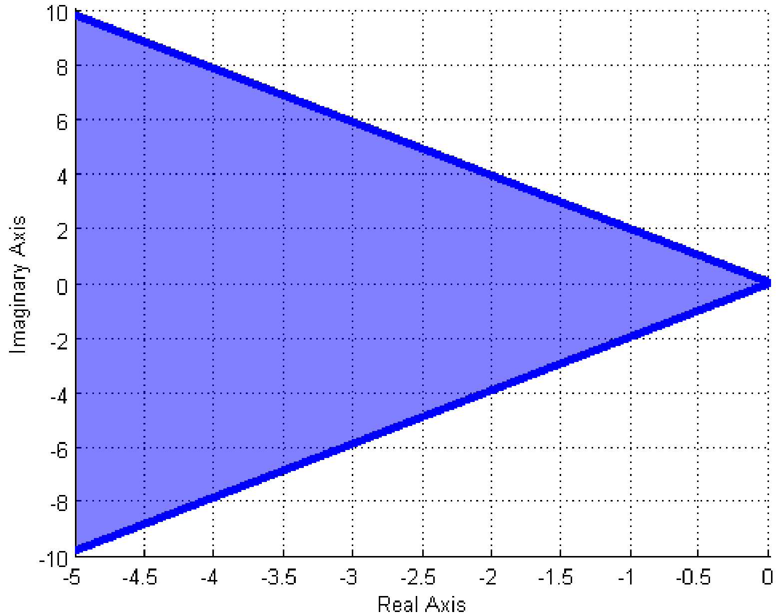
19) The (dark) shaded area in the s-plane figure below shows the possible pole location for an ideal second order system that meets which of the following constraints?

a) $T_p \leq 1$ b) $T_p \geq 1$ c) $T_p \geq \pi$ d) $T_p \leq \pi$ e) none of these

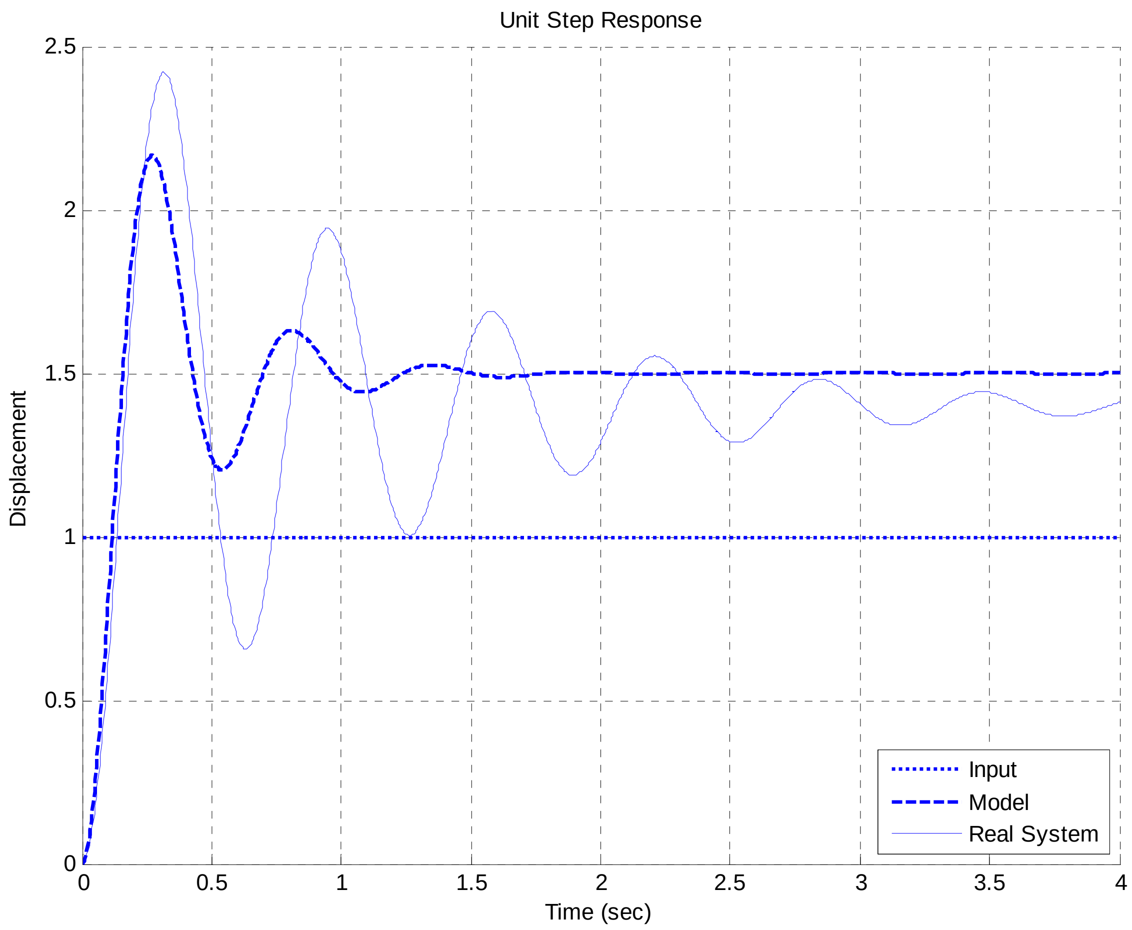


20) The (dark) shaded area in the s-plane figure below shows the possible pole location for an ideal second order system that meets which of the following constraints?

a) $PO \geq 20\%$ b) $PO \leq 20\%$



Problems 21-23 refer to the figure below, which shows the unit step response of a real 2nd order system and the unit step response of a second order model we are trying to match to the real system.



21) In order to make the model better match the real system, the ***damping ratio*** of the ***model*** should be

a) increased   b) decreased   c) left alone   d) impossible to determine

22) In order to make the model better match the real system, the ***natural frequency*** of the ***model*** should be

a) increased   b) decreased   c) left alone   d) impossible to determine

23) In order to make the model better match the real system, the ***static gain*** of the ***model*** should be

a) increased   b) decreased   c) left alone   d) impossible to determine

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