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Quiz #1

Problems 1 and 2 refer to the impulse responses of six different systems given below:

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

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

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

3) 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

Problems 4 and 5 refer to the following transfer function

$$H(s) = \frac{2s+1}{(s+2)^2+1}$$

4) For this transfer function, the corresponding impulse response $h(t)$ is composed of which terms?

a) $e^{-t}\cos(2t), e^{-t}\sin(2t)$ b) $e^{-2t}\cos(t), e^{-2t}\sin(t)$
c) $e^{-t}\cos(4t), e^{-t}\sin(4t)$ d) $e^{-4t}\cos(t), e^{-4t}\sin(t)$

5) The **poles** of the transfer function are

a) $2 \pm j$ b) $-2 \pm j$
c) $-1 \pm 2j$ d) $-1 \pm 4j$

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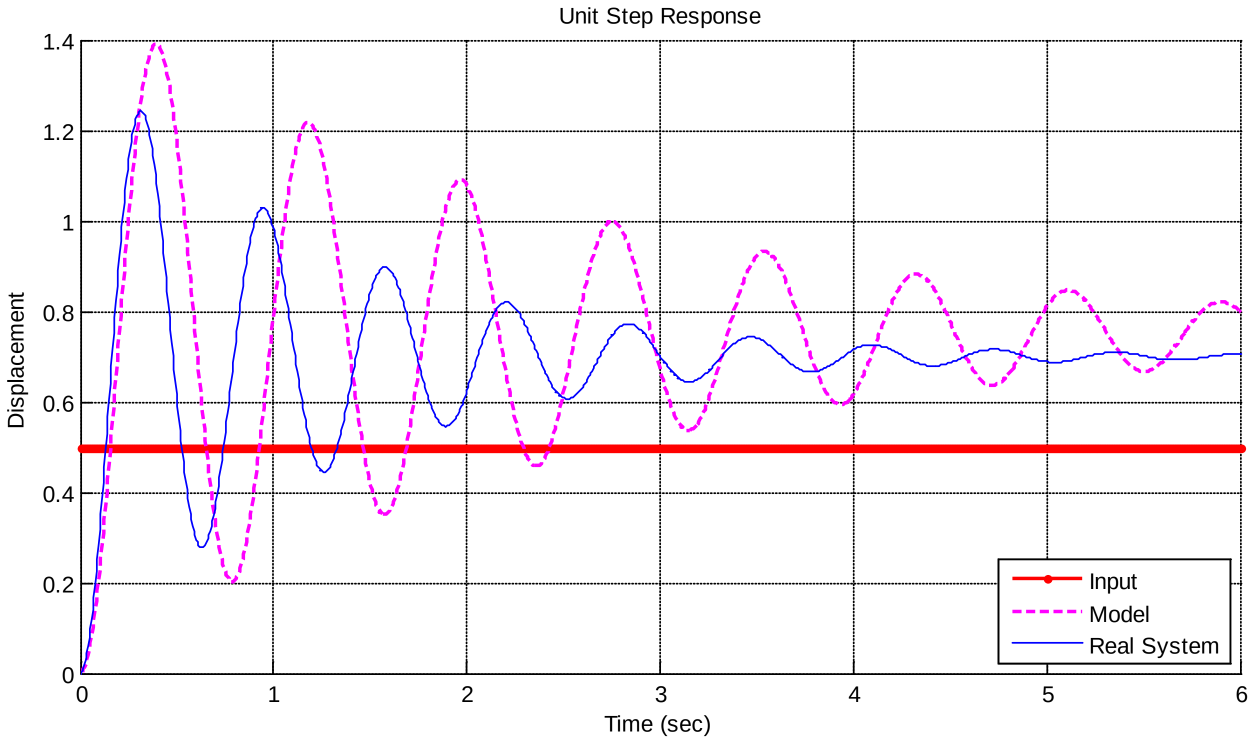
Problems 6-8 refer to the figure below, which shows the unit step response of a real 2nd order system and the unit step response of a second order model we are trying to match to the real system.



6) 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

7) 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

8) 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

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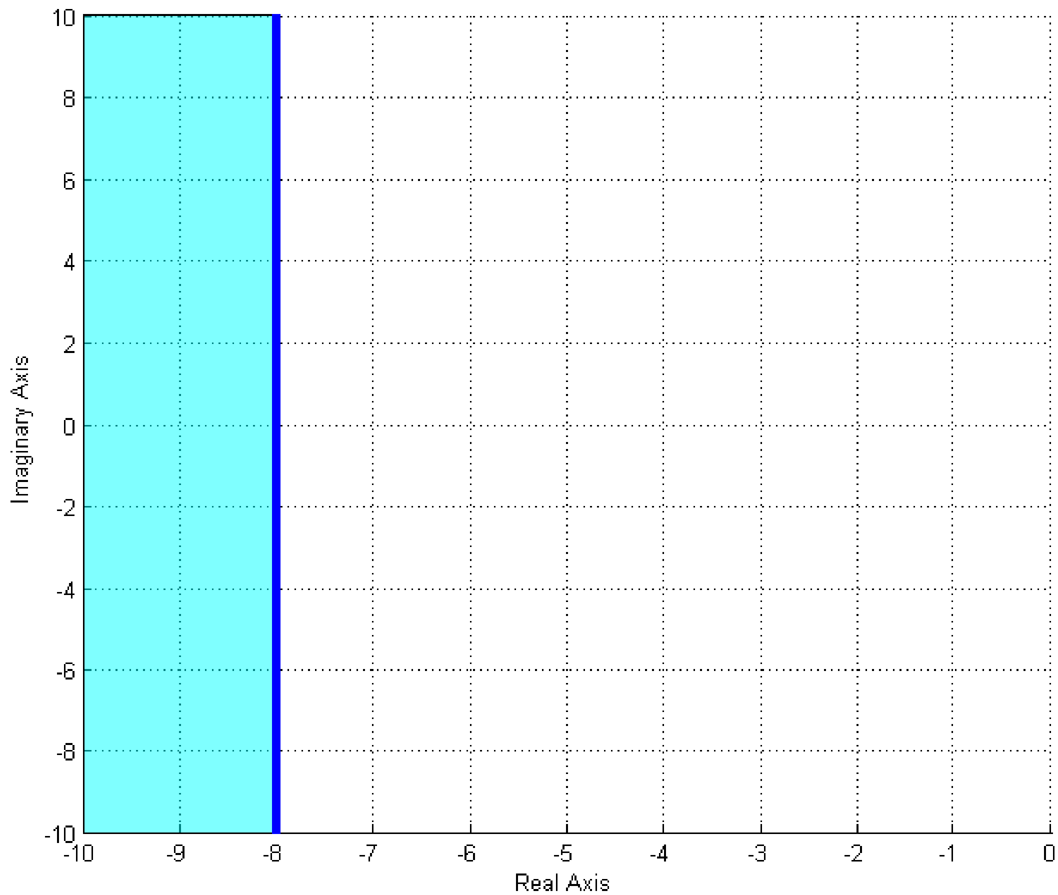
9) The (dark) shaded area in the s-plane figure below shows the possible pole location for an ideal second order system that meets which of the following constraints?

a) $T_s \le 0.5$ b) $T_s \ge 0.5$ c) $T_s \ge 8$ d) $T_s \le 8$ e) none of these



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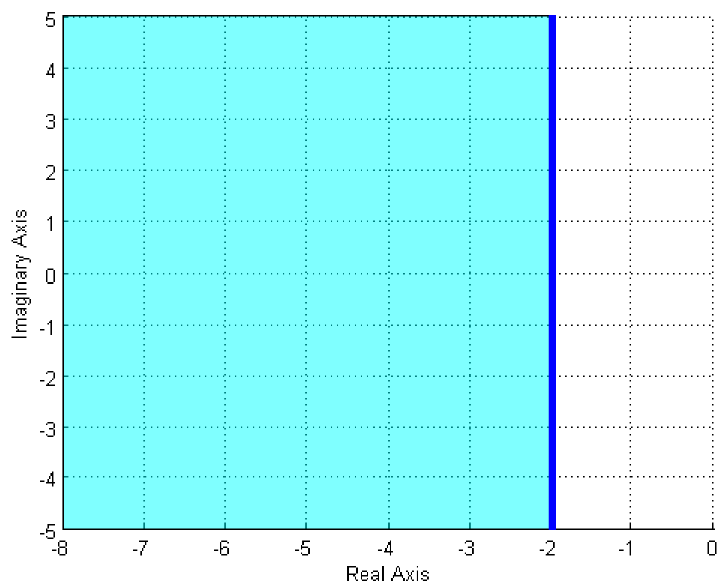
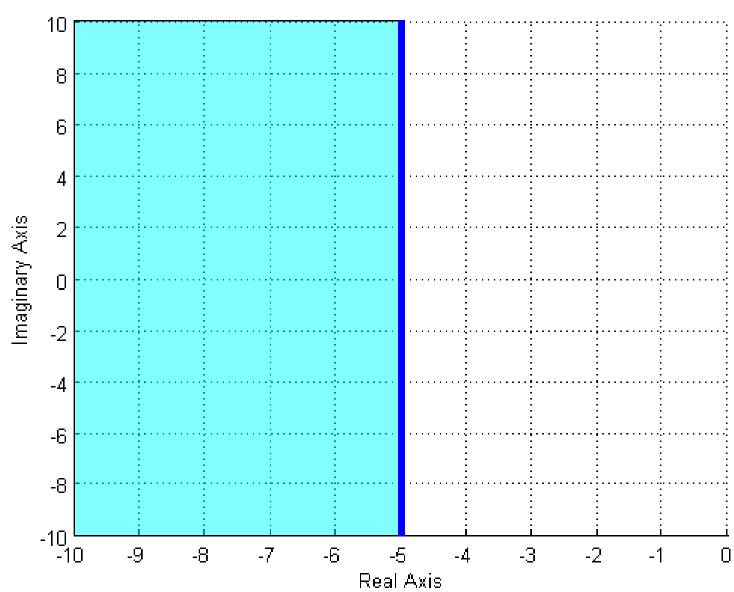
10) Assuming we are allowed to place our poles only in the (dark) shaded areas, which of the following two shaded regions will in general result in a **smaller settling time** for our system?

a) the region in the top figure b) the region in the bottom figure





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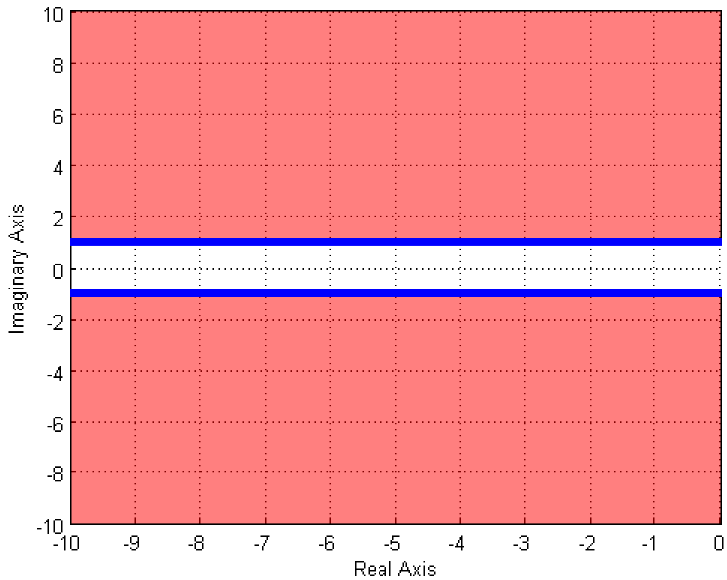
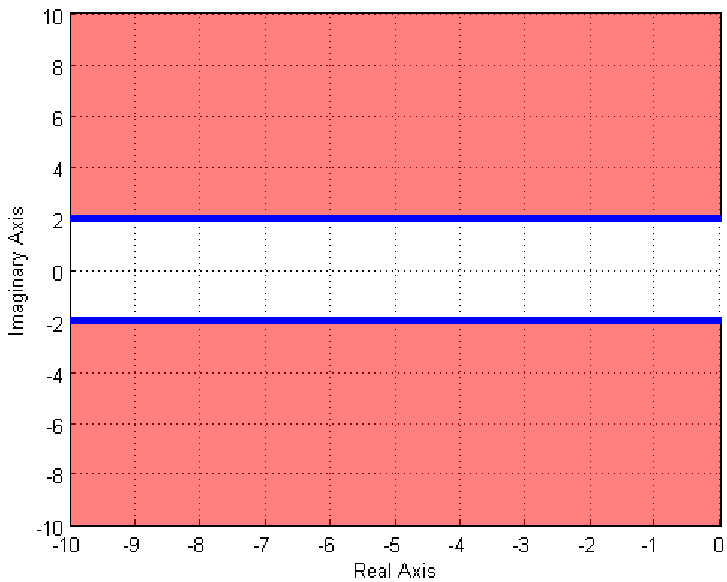
11) Assuming we are allowed to place our poles only in the (dark) shaded areas, which of the following two shaded regions will in general result in a **smaller time to peak** for our system?

a) the region in the top figure b) the region in the bottom figure





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12) One of the shaded regions below shows the possible pole locations for a percent overshoot less than 10%, and the other shows the possible pole locations for a percent overshoot less than 20%. Which of the two graphs shows the possible pole locations for a percent overshoot less than 20%?

a) the region in the top figure b) the region in the bottom figure