Quiz 3

1) For the second order equation $\ddot{y}(t) + 7\dot{y}(t) + 12y(t) = 6x(t)$ with an input x(t) = 2u(t), we should look for a solution of the form

a)
$$y(t) = c_1 e^{-3t} + c_2 e^{-4t} + 6$$

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$$y(t) = c_1 e^{-3t} + c_2 e^{-4t} + 6$$
 b) $y(t) = c_1 e^{-3t} + c_2 e^{-4t} + 12$ c) $y(t) = c_1 e^{-3t} + c_2 e^{-4t} + 1$

c)
$$y(t) = c_1 e^{-3t} + c_2 e^{-4t} + 1$$

d)
$$y(t) = c_1 e^{3t} + c_2 e^{4t} + 1$$
 e) $y(t) = c_1 e^{3t} + c_2 e^{4t} + 6$ f) none of these

e)
$$y(t) = c_1 e^{3t} + c_2 e^{4t} + 6$$

2) For the second order equation $\ddot{y}(t) + 6\dot{y}(t) + 9y(t) = 3x(t)$ with an input x(t) = 3u(t), we should look for a solution of the form

a)
$$y(t) = c_1 e^{-3t} + c_2 t e^{-3t} + 1$$

b)
$$y(t) = c_1 e^{-3t} + c_2 e^{-3t} + 9$$

a)
$$y(t) = c_1 e^{-3t} + c_2 t e^{-3t} + 1$$
 b) $y(t) = c_1 e^{-3t} + c_2 e^{-3t} + 9$ c) $y(t) = c_1 e^{-3t} + c_2 t e^{-3t} + 3$

d)
$$y(t) = c_1 e^{3t} + c_2 t e^{3t} + c_3 t e^{3t}$$

d)
$$y(t) = c_1 e^{3t} + c_2 t e^{3t} + 1$$
 e) $y(t) = c_1 e^{3t} + c_2 t e^{3t} + 3$ f) none of these

3) For the second order equation $\ddot{y}(t) + 4\dot{y}(t) + 13y(t) = 26x(t)$ with an input x(t) = u(t), we should look for a solution of the form

a)
$$y(t) = ce^{-2t} \sin(3t + \theta) + 1$$

a)
$$y(t) = ce^{-2t} \sin(3t + \theta) + 1$$
 b) $y(t) = ce^{-2t} \sin(3t + \theta) + 13$ c) $y(t) = ce^{-3t} \sin(2t + \theta) + 2$

c)
$$y(t) = ce^{-3t} \sin(2t + \theta) + 2$$

d)
$$y(t) = ce^{-2t} \sin(3t + \theta) + 0.5$$
 e) $y(t) = ce^{2t} \sin(3t + \theta) + 13$ f) none of these

e)
$$y(t) = ce^{2t} \sin(3t + \theta) + 13$$

4) Assume we have a solution of the form $y(t) = c_1 + c_2 e^{-3t} + 4$ and the initial conditions $y(0) = \dot{y}(0) = 0$. The equations we need to solve are:

a)
$$c_1 + c_2 = 4$$
, $2c_2 = 0$

b)
$$c_1 + c_2 = -4, -3c_2 = 0$$

a)
$$c_1 + c_2 = 4$$
, $2c_2 = 0$ b) $c_1 + c_2 = -4$, $-3c_2 = 0$ c) $c_1 + c_2 = -4$, $c_1 - 2c_2 = 0$

d)
$$c_1 + c_2 = -4$$
, $c_1 + 3c_2 = -4$ e) $c_1 + c_2 = 0$, $c_1 + 3c_2 = -4$ f) none of these

e)
$$c_1 + c_2 = 0$$
, $c_1 + 3c_2 = -4$

5) Assume we have a solution of the form $y(t) = c_1 e^{-2t} + c_2 t e^{-2t} + 2$ and the initial conditions $y(0) = \dot{y}(0) = 0$. The equations we need to solve are:

a)
$$c_1 + 2 = 0$$
, $-2c_1 + c_2 = 0$

a)
$$c_1 + 2 = 0$$
, $-2c_1 + c_2 = 0$ b) $c_1 + 2 = 0$, $2c_1 + 2c_2 = 0$ c) $c_1 + c_2 = -2$, $-2c_1 + -2c_2 = 0$

d)
$$c_1 + c_2 = -2$$
, $-2c_1 + 2$, $c_2 = 0$ e) $c_1 = 2$, $2c_1 + 2$, $c_2 = 0$ f) none of these

e)
$$c_1 = 2$$
, $2c_1 + 2$ $c_2 = 0$

6) Assume we have a solution of the form $y(t) = ce^{-t} \sin(2t + \theta) - 4$ and the initial conditions $y(0) = \dot{y}(0) = 0$. The equations we need to solve are:

a)
$$c\sin(\theta) = -4$$
, $\tan(\theta) = \frac{3}{2}$

a)
$$c\sin(\theta) = -4$$
, $\tan(\theta) = \frac{3}{2}$ b) $c\sin(\theta) = -4$, $\tan(\theta) = \frac{1}{2}$ c) $c\sin(\theta) = 4$, $\tan(\theta) = \frac{1}{-2}$

d)
$$c \sin(\theta) = 4$$
, $\tan(\theta) = 2$

d)
$$c \sin(\theta) = 4$$
, $\tan(\theta) = 2$ e) $c \sin(\theta) = 4$, $\tan(\theta) = \frac{1}{2}$ f) none of these

Problems 7-10 assume we have a system described by a standard for of a second order system, $\ddot{y}(t) + 2\zeta\omega_n\dot{y}(t) + \omega_n^2y(t) = K\omega_n^2x(t)$, and the input to the system is a unit step. Assume the system is under damped.

7) The **percent overshoot** for the system is a function of

a)
$$\zeta$$
 only b) ω_n only c) K only d) ζ and ω_n e) ζ , ω_n , and K

8) The settling time for the system is a function of

a)
$$\zeta$$
 only b) ω_n only c) K only d) ζ and ω_n e) ζ , ω_n , and K

9) The static gain for the system is a function of

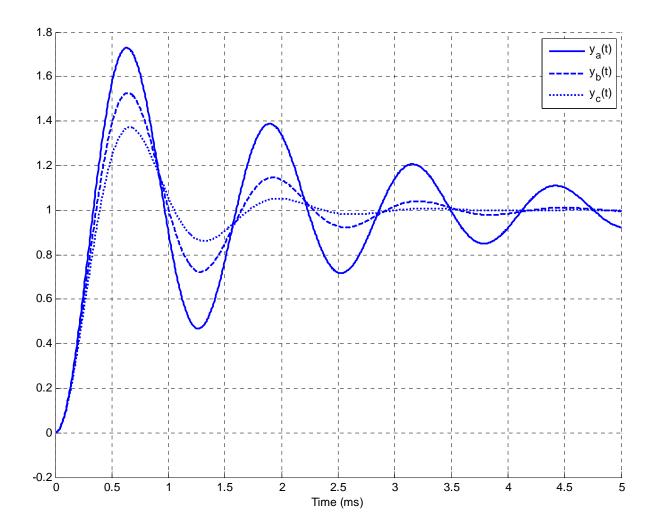
a)
$$\zeta$$
 only b) ω_n only c) K only d) ζ and ω_n e) ζ , ω_n , and K

10) The **damped frequency** for the system is a function of

a)
$$\zeta$$
 only b) ω_n only c) K only d) ζ and ω_n e) ζ , ω_n , and K

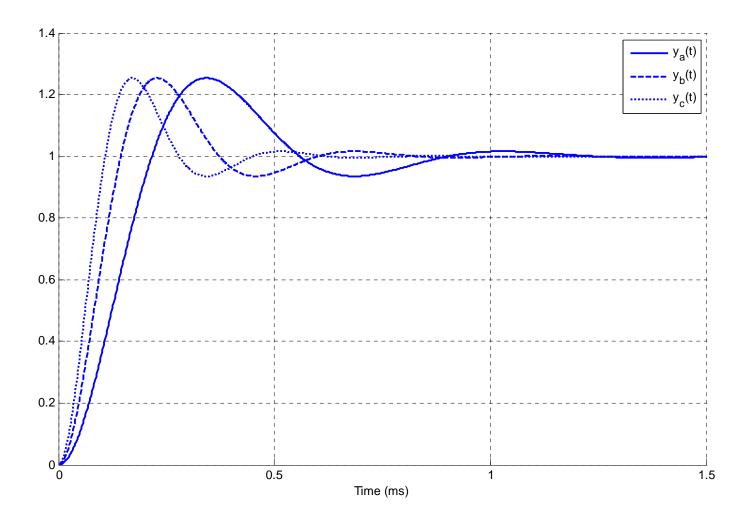
11) The following figure shows the step response of three systems. The only difference between the systems is the damping ratio, ζ .

For which system is the damping ratio the smallest? a) $y_a(t)$ b) $y_b(t)$ c) $y_c(t)$

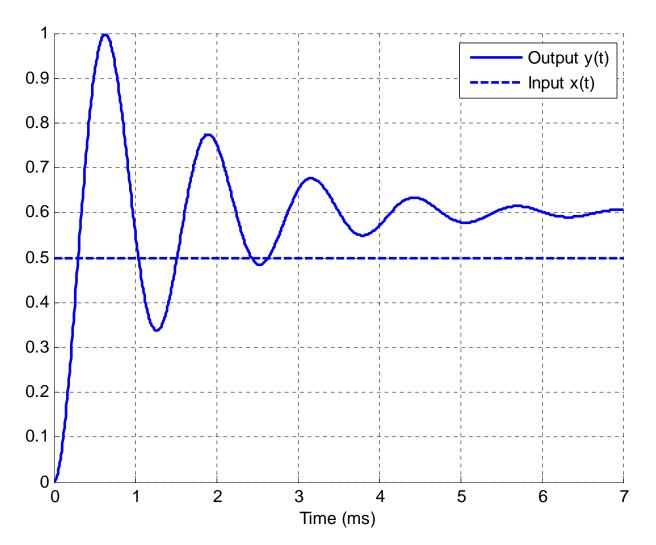


12) The following figure shows the step response of three systems. The only difference between the systems is the natural frequency, ω_n .

For which system is the natural frequency the largest? a) $y_a(t)$ b) $y_b(t)$ c) $y_c(t)$

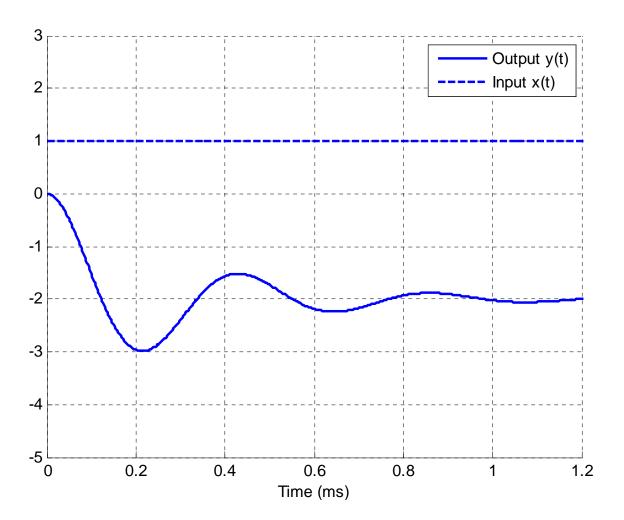


Problems 13 and 14 refer the following graph showing the response of a second order system to a step input.



- 13) The percent overshoot for this system is best estimated as
- a) 200 % b) 150 %
- c) 100%
- d) 67 %
- e) 50 % f) 33%
- 14) The static gain for this system is best estimated as
- a) 0.1
- b) 0.5 c) 1.0
- d) 1.2
- e) 1.5 f) 2.0

Problems 15 and 16 refer the following graph showing the response of a second order system to a step input.



- **15)** The percent overshoot for this system is best estimated as
- a) 200% b) -200 %
- c) 100%
- d) -100 %
- e) 50 %
- f) -50%
- **16)** The static gain for this system is best estimated as
- a) 3
- b) -3
- c) 2
- d) -2