ECE-205 Practice Quiz 2

(No Calculators, except problems 28 and 29)

1) A **standard form** for a first order system, with input $x(t)$ and output $y(t)$, is

a) $\frac{1}{\tau}\frac{dy(t)}{dt}+y(t)=Kx(t)$ b) $\tau\frac{dy(t)}{dt}+y(t)=Kx(t)$ c) $\frac{dy(t)}{dt}+\tau\, y(t)=Kx(t)$

d) $\frac{dy(t)}{dt}+\tau\, y(t)=\frac{1}{K}x(t)$ e) $\tau\frac{dy(t)}{dt}+y(t)=\frac{1}{K}x(t)$ f) $\frac{dy(t)}{dt}+\tau y(t)=Kx(t)$

2) The units of the time constant, τ, are a) 1/[time unit] b) [time unit] c) neither of these

Problems 3 -5 refer to a system described by the differential equation $5\dot{y}(t)+2y(t)=4x(t)$.

3) If the input is a step of amplitude 2, $x(t)=2u(t)$, then the **steady state value** of the output will be

a) $y(t)=8$ b) $y(t)=4$ c) $y(t)=2$ d) none of these

4) The **time constant** of this system is

a) $\tau=5$ b) $\tau=2.5$ c) $\tau=1.0$ d) none of these

5) The **static gain** of this system is

a) $K=4$ b) $K=2$ c) $K=5$ d) none of these

Problems 6 -8 refer to a system described by the differential equation $2\dot{y}(t)+3y(t)=5x(t)$.

6) If the input is a step of amplitude 2, $x(t)=2u(t)$, then the **steady state value** of the output will be

a) $y(t)=10$ b) $y(t)=5$ c) $y(t)=3.33$ d) none of these

7) The **time constant** of this system is

a) $\tau=2$ b) $\tau=0.4$ c) $\tau=0.667$ d) none of these

8) The **static gain** of this system is

a) $K=3$ b) $K=1.667$ c) $K=5$ d) none of these

9) A **standard form** for a second order system, with input $x(t)$ and output $y(t)$, is

a) $\ddot{y}(t)+\zeta\omega_n\dot{y}(t)+\omega_n^2 y(t)=K\omega_n^2 x(t)$ b) $\ddot{y}(t)+2\zeta\omega_n\dot{y}(t)+\omega_n^2 y(t)=Kx(t)$

c $\ddot{y}(t)+2\zeta\omega_n\dot{y}(t)+\omega_n^2 y(t)=K\omega_n^2 x(t)$ d) $\ddot{y}(t)+2\zeta\omega_n\dot{y}(t)+y(t)=Kx(t)$

Problems 10-13 refer to a system described by the differential equation $\ddot{y}(t)+0.4\dot{y}(t)+4y(t)=6x(t)$

10) If the input is a step of amplitude 2, $x(t)=2u(t)$, then the **steady state value** of the output will be

a) $y(t)=2$ b) $y(t)=6$ c) $y(t)=12$ d) none of these

11) The **natural frequency** of this system is

a) $\omega_n=1$ b) $\omega_n=2$ c) $\omega_n=4$ d) none of these

12) The **damping ratio** of this system is

a) $\zeta=0.1$ b) $\zeta=0.2$ c) $\zeta=0.4$ d) none of these

13) The **static gain** of the system is

a) $K=6$ b) $K=4$ c) $K=1.5$ d) none of these

Problems 14-17 refer to a system described by the differential equation $4\ddot{y}(t)+\dot{y}(t)+y(t)=3x(t)$

14) If the input is a step of amplitude 2, $x(t)=2u(t)$, then the **steady state value** of the output will be

a) $y(t)=2$ b) $y(t)=6$ c) $y(t)=12$ d) none of these

15) The **natural frequency** of this system is

a) $\omega_n = 0.25$ b) $\omega_n = 0.5$ c) $\omega_n = 4$ d) none of these

16) The **damping ratio** of this system is

a) $\zeta = 0.25$ b) $\zeta = 1$ c) $\zeta = 0.5$ d) none of these

17) The **static gain** of the system is

a) $K = 6$ b) $K = 4$ c) $K = 1.5$ d) none of these

18) For the differential equation $\dot{y}(t) + 2y(t) = x(t)$ with intial time $t_0 = 0$ and initial value $y(0) = 0$, the output of the system at time t for an arbitrary input $x(t)$ can be written as

a) $y(t) = \int_0^t e^{2(t-\lambda)} x(\lambda) d\lambda$ b) $y(t) = \int_0^t e^{-2(t-\lambda)} x(\lambda) d\lambda$ c) $y(t) = \int_0^t e^{-\frac{1}{2}(t-\lambda)} x(\lambda) d\lambda$ d) $y(t) = \int_0^t e^{\frac{1}{2}(t-\lambda)} x(\lambda) d\lambda$

19) For the differential equation $2\dot{y}(t) + y(t) = x(t)$ with intial time $t_0 = 0$ and initial value $y(0) = 0$, the output of the system at time t for an arbitrary input $x(t)$ can be written as

a) $y(t) = \int_0^t e^{\frac{1}{2}(t-\lambda)} x(\lambda) \mathrm{d}\lambda$ b) $y(t) = \frac{1}{2}\int_0^t e^{\frac{1}{2}(t-\lambda)} x(\lambda) \mathrm{d}\lambda$ c) $y(t) = 2\int_0^t e^{\frac{1}{2}(t-\lambda)} x(\lambda) \mathrm{d}\lambda$

d) $y(t) = \int_0^t e^{-\frac{1}{2}(t-\lambda)} x(\lambda) \mathrm{d}\lambda$ e) $y(t) = \frac{1}{2}\int_0^t e^{-\frac{1}{2}(t-\lambda)} x(\lambda) \mathrm{d}\lambda$ f) $y(t) = 2\int_0^t e^{-\frac{1}{2}(t-\lambda)} x(\lambda) \mathrm{d}\lambda$

20) For the differential equation $\dot{y}(t) + 2y(t) = 2x(t)$ with intial time $t_0 = 0$ and initial value $y(0) = 1$, the output of the system at time t for an arbitrary input $x(t)$ can be written as

a) $y(t) = e^{+2t} + \int_0^t e^{-2(t-\lambda)} x(\lambda) d\lambda$ b) $y(t) = e^{-2t} + \int_0^t e^{-2(t-\lambda)} x(\lambda) d\lambda$ c) $y(t) = e^{+2t} + \int_0^t e^{2(t-\lambda)} x(\lambda) d\lambda$

d) $y(t) = e^{-2t} + \int_0^t e^{2(t-\lambda)} x(\lambda) d\lambda$ e) $y(t) = e^{-2t} + 2\int_0^t e^{2(t-\lambda)} x(\lambda) d\lambda$ f) none of these

21) For the differential equation $\dot{y}(t) - 3y(t) = e^{3t}x(t-1)$ with intial time $t_0 = 1$ and initial value $y(1) = 2$, the output of the system at time t for an arbitrary input $x(t)$ can be written as

a) $y(t) = 2e^{3(t-1)} + \int_1^t e^{3t}x(\lambda - 1)d\lambda$ b) $y(t) = 2e^{-3(t-1)} + \int_1^t e^{3t}x(\lambda - 1)d\lambda$ c) $y(t) = 2e^{-3(t-1)} + \int_1^t e^{-3t}x(\lambda - 1)d\lambda$

d) $y(t) = 2e^{-3(t-1)} + \int_1^t e^{-3(t-\lambda)}x(\lambda - 1)d\lambda$ e) $y(t) = 2e^{3(t-1)} + \int_1^t e^{3(t-\lambda)}x(\lambda - 1)d\lambda$ f) none of these

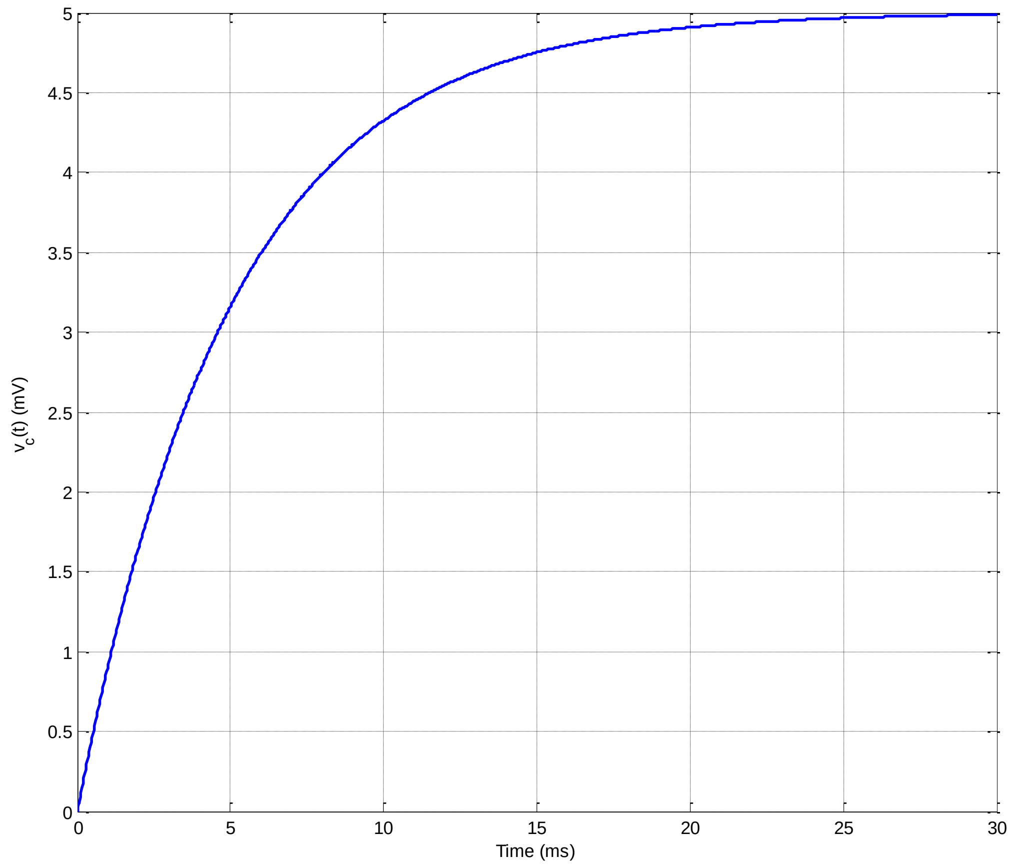
22) A first order system has a time constant $\tau = 0.1$ seconds. The system will be within 2% of its final value in (choose the smallest possible time)

a) 0.1 seconds b) 0.2 seconds c) 0.3 seconds d) 0.4 seconds e) 0.5 seconds f) 1 second

23) A first order system has a time constant $\tau = 0.05$ seconds. The system will be within 2% of its final value in (choose the smallest possible time)

a) 0.1 seconds b) 0.2 seconds c) 0.3 seconds d) 0.4 seconds e) 0.5 seconds f) 1 second

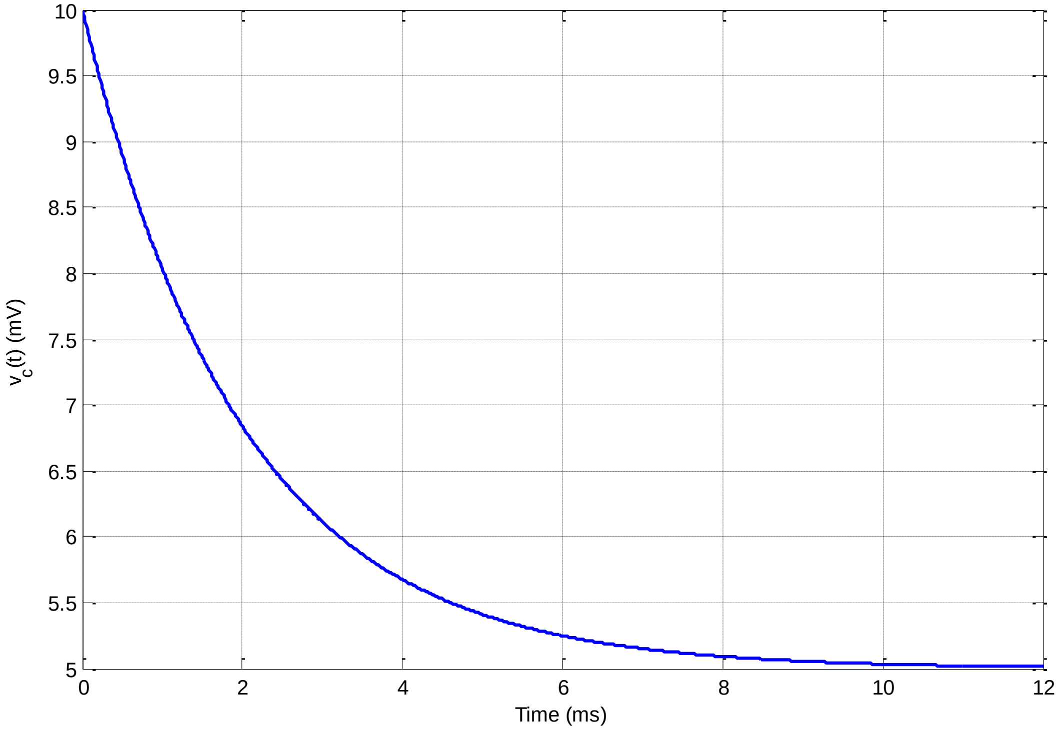
24) The following figure shows a capacitor charging.



Based on this figure, the best estimate of the **time constant** for this system is

a) 1 ms b) 2.5 ms c) 5 ms d) 7.5 ms e) 10 me f) 15 ms g) 30 ms

25) The following figure shows a capacitor discharging.



Based on this figure, the best estimate of the **time constant** for this system is

a) 1 ms   b) 2 ms   c) 3 ms   d) 4 ms   e) 6 me   f) 10 ms   g) 12 ms

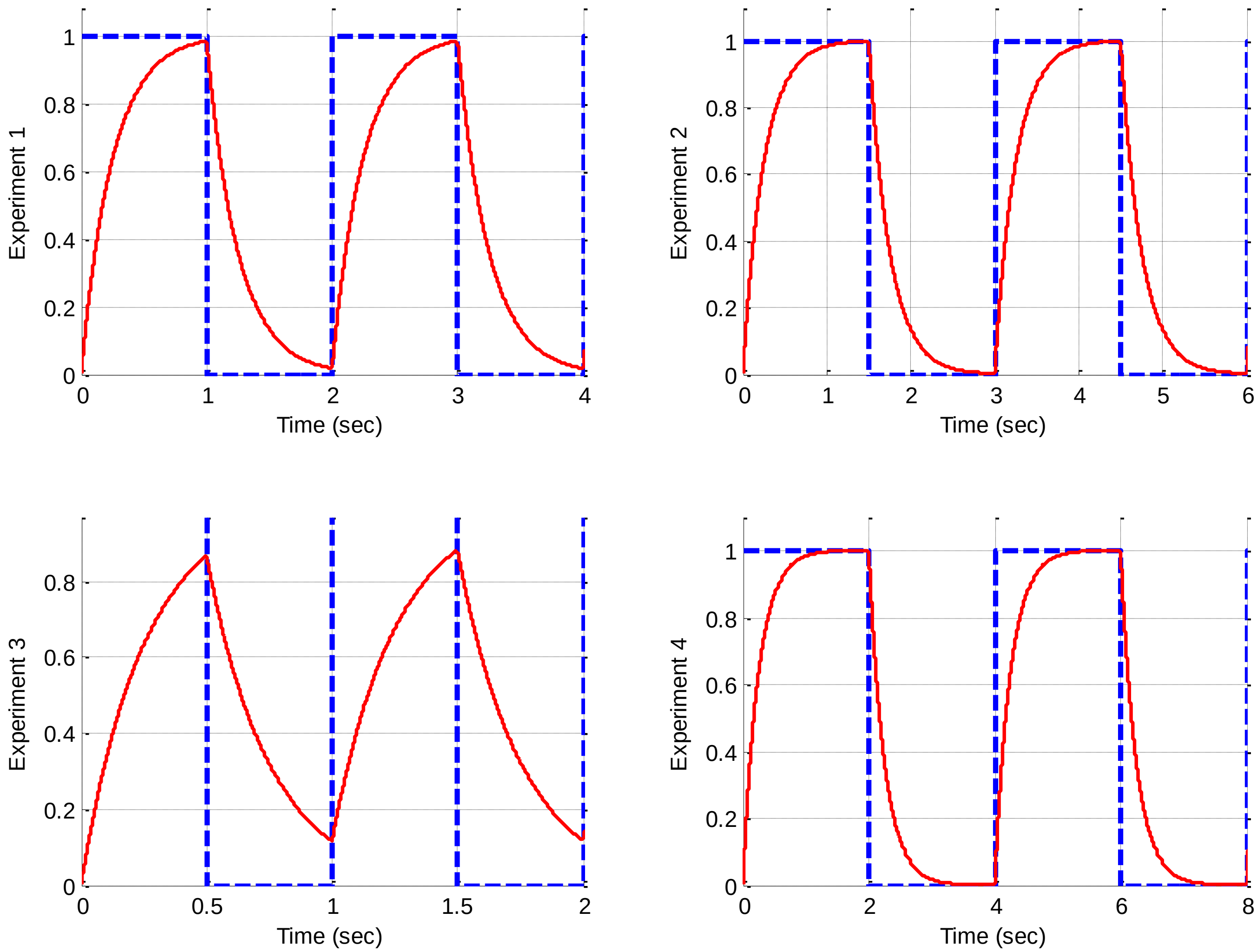
26) Assume we have a first order system in standard form, and the input is a step. The usual form used to compute the response of the system is

a) $y(t) = [y(0) - y(\infty)]e^{-t/\tau} + y(0)$ b) $y(t) = [y(\infty) - y(0)]e^{-t/\tau} + y(0)$

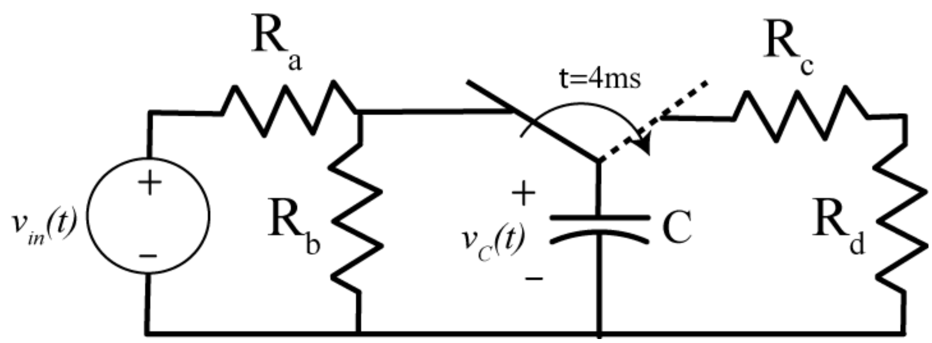
c) $y(t) = [y(\infty) - y(0)]e^{-t/\tau} + y(\infty)$ d) $y(t) = [y(0) - y(\infty)]e^{-t/\tau} + y(\infty)$

27) Assume we are trying to use measure the time constant of a first order system experimentally using the fall time of the system (the fall time corresponds to the rise time, but we use this when the signal is decaying). The input to the system is the rectangular pulse shown in the dotted line. Which of the experiments can we use? (Circle all that can be used)

a) Experiment 1 b) Experiment 2 c) Experiment 3 d) Experiment 4



Consider the following circuit. Assume the time constant for charging the capacitor (t < 4 ms) is 4 ms, and the time constant during the capacitor discharge (t > 4 ms) is 1 ms. Assume also that the static gain is 2.74 and the input is a step of amplitude 3V that starts at time t=0. You should use the table below for simple calculations. (You can use a calculator for the following two problems)



Time (t)	t/τ	$y(t)$
0	0	$0\,y_{ss}$
τ	1	$0.632\,y_{ss}$
2τ	2	$0.865\,y_{ss}$
3τ	3	$0.950\,y_{ss}$
4τ	4	$0.982\,y_{ss}$
5τ	5	$0.993\,y_{ss}$

28) Which of the following is the best estimate for the voltage on the capacitor at t = 4 ms?

a) 1.75V b) 2 V c) 2.6 V d) 3 V e) 5.2 V f) 6 V

29) Which of the following is the best estimate of the voltage on the capacitor at time t = 7 ms?

a) 0.0 V b) 0.10 V c) 0.26 V d) 0.30V e) 0.42V

Answers: 1-b, 2-b, 3-b, 4-b, 5-b, 6-c, 7-c, 8-b, 9-c, 10-d, 11-b, 12-a, 13-c, 14-b, 15-b, 16-a, 17-d, 18-b, 19-e, 20-f, 21-a, 22-d, 23-b, 24-c, 25-b, 26-d, 27-b and d, 28-e, 29-c