ECE 202 Linear Circuit Analysis
Exam 1
September 25, 2012

Professor Clark	Professor Furgason
8:30 AM MWF	9:30 AM MWF
Section 0001	Section 0002

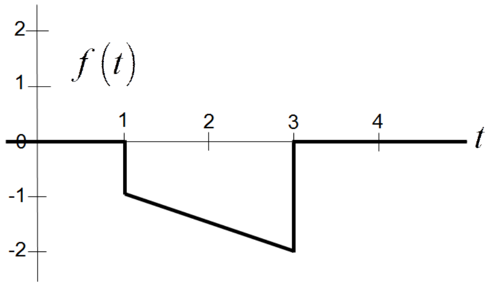
Name: ____
(Please print clearly)

PUID: _________________ Seat Number: ____

INSTRUCTIONS

- This is a closed book, closed notes exam. No scrap paper, calculators, PDAs, or cell phones are permitted. Two transform tables are attached with the test booklet.
- You are not allowed to place any items on the seat beside you.
- The test consists of 12 multiple choice (MC) problems, of 8.33 points each for a total of 100 points.
- Carefully mark your MC answers on the scantron form BEFORE THE END OF THE EXAM PERIOD. Any work in the test booklet related to the MC problems will **not** be graded.
- When the exam ends, **all** writing is to stop. **Any** writing on the exam booklet or the scantron form after the end of the exam is announced will result in a grade of zero (0) on the exam.
- You will turn in **both** the scantron form and the test booklet.
- All students are expected to abide by the customary ethical standards of the university, i.e., your answers must reflect only your own knowledge and reasoning ability. As a reminder, at the very minimum, cheating will result in a zero on the exam and possibly an **F** in the course.
- Communicating with any of your classmates, in any language, by any means, for any reason, at any time between the official start of the exam and the official end of the exam is grounds for immediate ejection from the exam site and loss of all credit for this test.

1. A plot of $f(t)$ is shown immediately below. Which choice best represents $-f(3-t)$?



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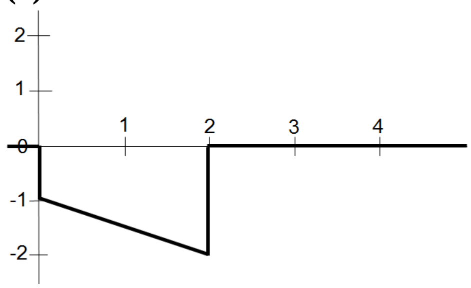

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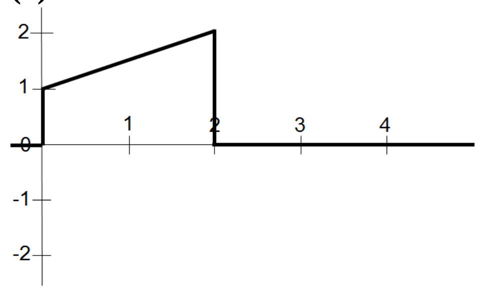

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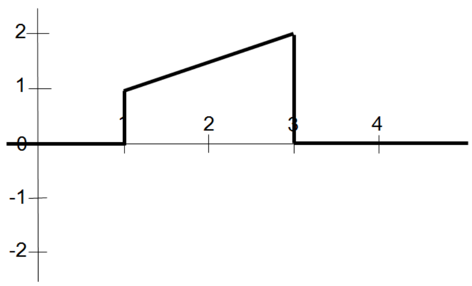

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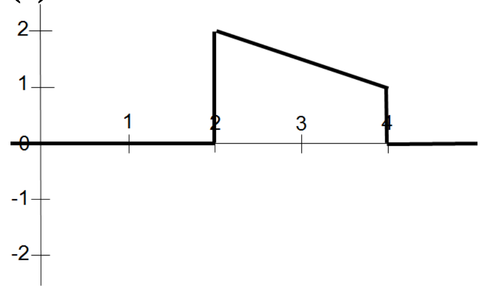

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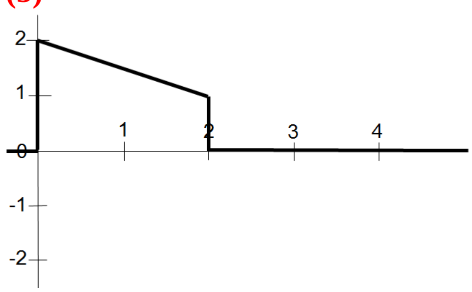

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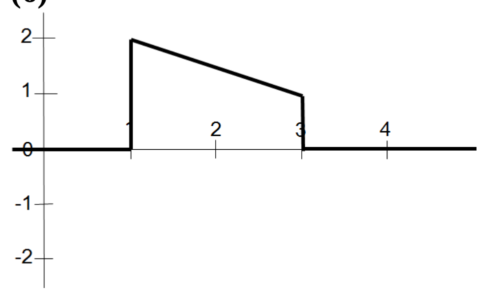
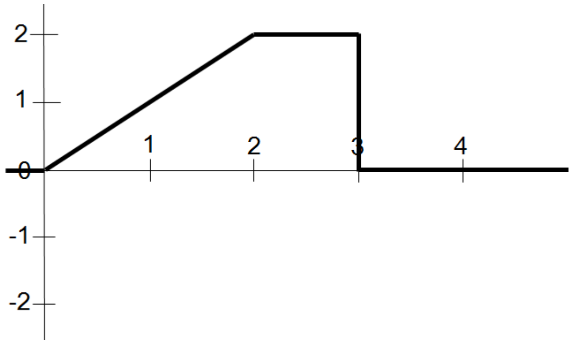


(7) None of these.

2. If $f(t)$ is given by the following plot, then find $F(s)$?



(1) $\frac{1}{s^2}\left(1-e^{-2s}\right)-\frac{2}{s}e^{-3s}$

(2) $e^{-2s}\left(\frac{2}{s^2}+\frac{1}{s}\right)+\frac{2}{s^2}e^{-3s}$

(3) $\frac{2}{s^2}-\frac{4}{s}$

(4) $\frac{2}{s^2}-e^{-2s}\left(\frac{1}{s}+\frac{2}{s^2}\right)-\frac{1}{s}e^{-3s}$

(5) $\frac{1}{s^2}-\frac{2}{s}e^{-2s}-\frac{2}{s}e^{-3s}$

(6) $\frac{2}{s^2}-\frac{2}{s}e^{-3s}+\frac{1}{s^2}e^{-1s}-\frac{2}{s}e^{-2s}$

(7) $\frac{2}{s^2}+\frac{2}{s}e^{-3s}+\frac{1}{s^2}e^{-1s}+\frac{2}{s}e^{-2s}$

(8) None of these.

3. What is the form of the partial fraction expansion of $\frac{4s^5-3s^3+2s-6}{s^2(s+3)(s^2-4)}$?

Note that this question has more than one correct answers. Both option 5 and option 7 are correct.

(1) $\frac{A}{s}+\frac{B}{s^2}+\frac{C}{(s+3)}+\frac{D}{(s^2-4)}+K$

(2) $\frac{A}{s}+\frac{B}{(s+3)}+\frac{Cs+D}{(s^2-4)}$

(3) $\frac{A}{s}+\frac{B}{(s+3)}+\frac{Cs+D}{(s^2-4)}+K$

(4) $\frac{A}{s}+\frac{B}{s^2}+\frac{C}{(s+3)}+\frac{Ds+E}{(s^2-4)}$

(5) $\frac{A}{s}+\frac{B}{s^2}+\frac{C}{(s+3)}+\frac{Ds+E}{(s^2-4)}+K$

(6) $\frac{A}{s}+\frac{B}{s^2}+\frac{C}{(s+3)}+\frac{D}{(s+2)}+\frac{E}{(s-2)}$

(7) $\frac{A}{s}+\frac{B}{s^2}+\frac{C}{(s+3)}+\frac{D}{(s+2)}+\frac{E}{(s-2)}+K$

(8) None of these.

4. What is the inverse Laplace transform of $\frac{4s^3}{s^2(s+3)}$?

(1) $\frac{1}{12}e^{3t}u(t)+\frac{1}{3}tu(t)+\frac{1}{4}\delta(t)$

(2) $4\delta(t)-12t\,u(t)-9e^{-3t}u(t)$

(3) $3\delta(t)+4e^{-2t}u(t)$

(4) $4\delta(t)-12e^{-3t}u(t)$

(5) $4\delta(t)+4tu(t)-u(t)-12e^{-3t}u(t)$

(6) $12e^{3t}u(t)+4\delta(t)$

(7) $4e^{-3t}u(t)+\frac{4}{3}tu(t)$

(8) None of these.

5. If $x(t) = L^{-1}\{X(s)\}$ is the solution to the following integro-differential equation,

$$4\frac{d}{dt}x(t) - \int_{0^-}^{t} 8\, x(t)\, dt - 4x(t) = -20\delta(t); \quad x(0^-) = 10,\ t > 0,$$

then what is $X(s)$?

(1) $\dfrac{5s}{(s+1)(s-2)}$

(2) $\dfrac{-20s}{(s+1)(s+2)}$

(3) $\dfrac{4s}{(s-1)(s-2)}$

(4) $\dfrac{40s-20}{(s+1)(s-2)}$

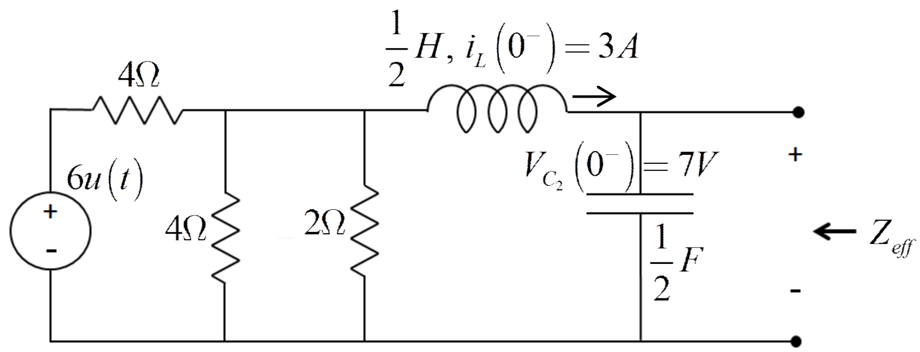
(5) $\dfrac{5s+2}{(s+2)(s-1)}$

(6) $\dfrac{4s-5}{(s+2)(s-2)}$

(7) $\dfrac{10s^2-40}{(s+4)(s-8)}$

(8) None of these.

6. What is the effective impedance of this circuit?



(1) $\dfrac{2s+4}{s^2+2s+4}$

(2) $\dfrac{2s+7}{s^2+3s+6}$

(3) $\dfrac{2s-7}{s^2+3s-6}$

(4) $\dfrac{2s-1}{s^2+6s+1}$

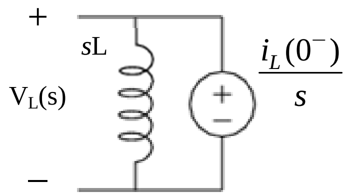
(5) $\dfrac{s-3}{2s^2-2s+6}$

(6) $\dfrac{0.5s+3}{s^2+4s+7}$

(7) $\dfrac{3s+0.5}{s^2+4s+7}$

(8) None of these.

7. The correct equivalent s-domain circuit for an inductor carrying an initial current of $i_L(0^-)$ is:



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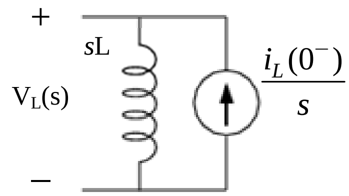

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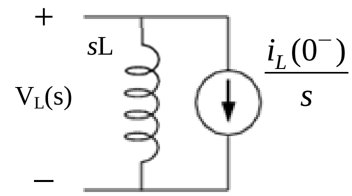

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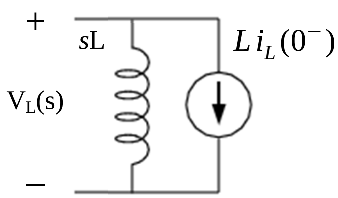

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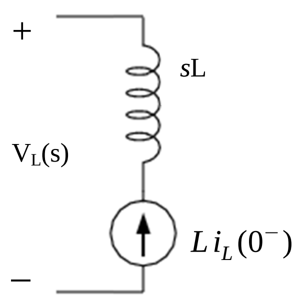

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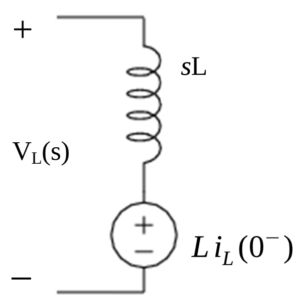

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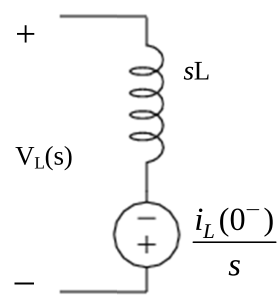
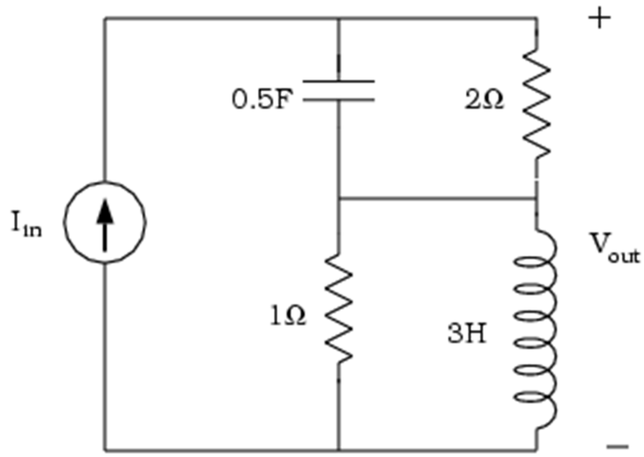


(7)

(8) None of these

8. The Transfer Function, $H(s) = \dfrac{V_{out}(s)}{I_{in}(s)}$, of the circuit shown below is:



(1) $\dfrac{3s^2+2s+2}{s^2}$ **(2)** $\dfrac{6s^2+5s+2}{3s^2+3s+1}$ **(3)** $\dfrac{3s^2+4s+4}{3s^2+3s+2}$

(4) $\dfrac{3s^2+6s+2}{3s^2+3s+2}$ **(5)** $\dfrac{3s^2+9s+2}{3s^2+4s+1}$ **(6)** $\dfrac{6s^2+3s+2}{3s^2+3s+2}$

(7) $\dfrac{6s^2+5s+2}{3s^2+3s+1}$ **(8)** None of these

9. A circuit similar to the one in Problem 8 has a Transfer Function,

$$H(s) = \frac{\mathrm{V}_{\text{out}}(s)}{\mathrm{I}_{\text{in}}(s)} = \frac{3s^2+s+2}{(3s+1)(s+2)}.$$

The Impulse Response, h(t), in ohms is :

(1) $\delta(t)+\frac{1}{5}\left[2e^{-t/3}-12e^{-2t}\right]u(t)$

(2) $\frac{1}{5}\delta(t)+\frac{1}{5}\left[2e^{-t/3}-12e^{-2t}\right]u(t)$

(3) $\frac{1}{5}\left[2e^{-t/3}-12e^{-2t}\right]u(t)$

(4) $\delta(t)+\frac{1}{5}\left[2e^{-3t}-12e^{-2t}\right]u(t)$

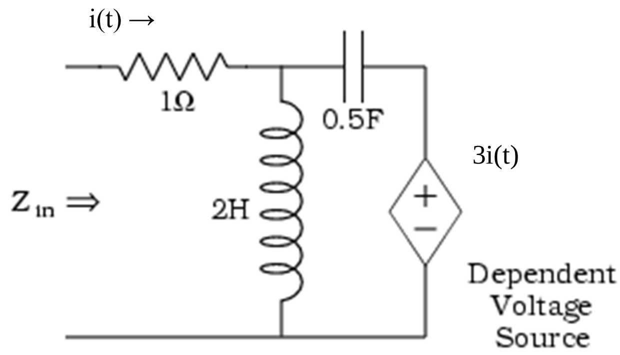
(5) $3\delta(t)+\frac{1}{3}\left[4e^{-t/3}-7e^{-2t}\right]u(t)$

(6) $\delta(t)+\frac{1}{3}\left[4e^{-t/3}-7e^{-2t}\right]u(t)$

(7) $\delta(t)+\frac{1}{3}\left[4e^{-3t}-7e^{-2t}\right]u(t)$

(8) None of these

10. The input impedance of the elements shown below is

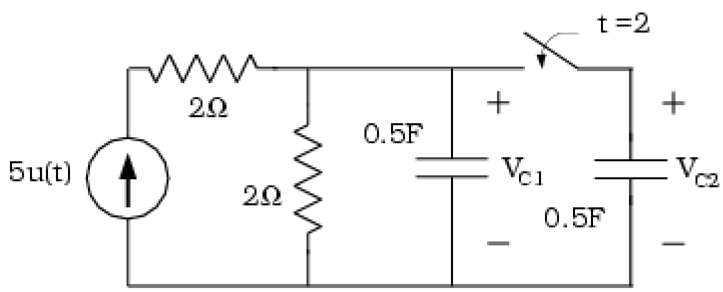


(1) $1+2s$ **(2)** $\dfrac{3s^2}{s^2+1}$ **(3)** $\dfrac{3s^2}{(s+1)^2}$

(4) $\dfrac{s^2+2s+1}{s^2+1}$ **(5)** $\dfrac{2s^2+3s+1}{s^2+1}$ **(6)** $\dfrac{4s^2+2s+1}{s^2+1}$

(7) $\dfrac{s^2+2s+1}{s^2+3s+1}$ **(8)** None of these

11. Solve the circuit shown below to obtain the s-domain capacitor voltage, $V_{C1}(s)$, which is valid for the time interval $0 \le t < 2$. The initial conditions are: **switch is initially open at t = 0**, $\mathbf{V_{C1}(0^-) = 2V}$, and $\mathbf{V_{C2}(0^-) = 4V}$, **and the switch closes at t = 2**.

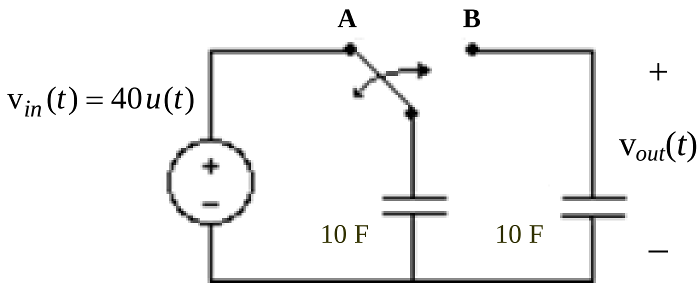


(1) $\frac{10}{s(s+2)}$ **(2)** $\frac{2s+10}{s(s+1)}$ **(3)** $\frac{2s+10}{s(s+2)}$ **(4)** $\frac{4s+10}{s(s+1)}$

(5) $\frac{4s+10}{s(s+2)}$ **(6)** $\frac{8s+10}{s(s+1)}$ **(7)** $\frac{8s+10}{s(s+2)}$

(8) None of these

12. For the circuit shown below, $v_{out}(0^{-}) = 0$. The switch moves from position A to position B at t = 1 sec, back to position A at 2 sec, and then back to position B at t = 3 sec, where it remains forever.
Then $v_{out}(4) =$ (in V):



(1) 10 **(2)** 20 **(3)** 30 **(4)** 40

(5) 15 **(6)** 25 **(7)** 35

(8) None of these

Laplace Transforms and Properties (*This page and next page*)

Item Number	$f(t)$	$\mathcal{L}[f(t)] = F(s)$
1	$K\delta(t)$	K
2	Ku(t) *or* K	$\frac{K}{s}$
3	$r(t)$	$\frac{1}{s^2}$
4	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5	$e^{-at}u(t)$	$\frac{1}{s+a}$
6	$te^{-at}u(t)$	$\frac{1}{(s+a)^2}$
7	$t^n e^{-at}u(t)$	$\frac{n!}{(s+a)^{n+1}}$
8	$\sin(\omega t)u(t)$	$\frac{\omega}{s^2+\omega^2}$
9	$\cos(\omega t)u(t)$	$\frac{s}{s^2+\omega^2}$
10	$e^{-at}\sin(\omega t)u(t)$	$\frac{\omega}{(s+a)^2+\omega^2}$
11	$e^{-at}\cos(\omega t)u(t)$	$\frac{(s+a)}{(s+a)^2+\omega^2}$
12	$t\sin(\omega t)u(t)$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
13	$t\cos(\omega t)u(t)$	$\frac{s^2-\omega^2}{(s^2+\omega^2)^2}$
14	$\sin(\omega t+\phi)u(t)$	$\frac{s\sin(\phi)+\omega\cos(\phi)}{s^2+\omega^2}$
15	$\cos(\omega t+\phi)u(t)$	$\frac{s\cos(\phi)-\omega\sin(\phi)}{s^2+\omega^2}$

16	$e^{-at}[\sin(\omega t) - \omega t\cos(\omega t)]u(t)$	$\dfrac{2\omega^3}{[(s+a)^2+\omega^2]^2}$
17	$te^{-at}\sin(\omega t)u(t)$	$2\omega\dfrac{s+a}{[(s+a)^2+\omega^2]^2}$
18	$e^{-at}\left[C_1\cos(\omega t)+\left(\dfrac{C_2-C_1a}{\omega}\right)\sin(\omega t)\right]u(t)$	$\dfrac{C_1 s+C_2}{(s+a)^2+\omega^2}$

Property	Transform Pair
Linearity	$L\,[a_1f_1(t) + a_2f_2(t)] = a_1F_1(s) + a_2F_2(s)$
Time Shift	$L\,[f(t-T)u(t-T)] = e^{-sT}F(s),\ T > 0$
Multiplication by t	$L\,[tf(t)u(t)] = -\dfrac{d}{ds}F(s)$
Multiplication by t^n	$\mathrm{L}[t^n f(t)] = (-1)^n \dfrac{d^nF(s)}{ds^n}$
Frequency Shift	$L\,[e^{-at}f(t)] = F(s+a)$
Time Differentiation	$L\left[\dfrac{d}{dt}f(t)\right] = sF(s) - f(0^-)$
Second-Order Differentiation	$\mathrm{L}\left[\dfrac{d^2 f(t)}{dt^2}\right] = s^2F(s) - sf(0^-) - f^{(1)}(0^-)$
nth-Order Differentiation	$\mathrm{L}\left[\dfrac{d^n f(t)}{dt^n}\right] = s^nF(s) - s^{n-1}f(0^-) - s^{n-2}f^{(1)}(0^-) - \ldots - f^{(n-1)}(0^-)$
Time Integration	(i) $\mathrm{L}\left[\int_{-\infty}^{t} f(q)dq\right] = \dfrac{F(s)}{s} + \dfrac{\int_{-\infty}^{0^-} f(q)dq}{s}$ (ii) $\mathrm{L}\left[\int_{0^-}^{t} f(q)dq\right] = \dfrac{F(s)}{s}$
Time/Frequency Scaling	$L\,[f(at)] = \dfrac{1}{a}F\left(\dfrac{s}{a}\right)$