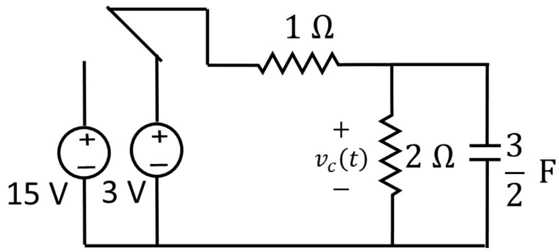
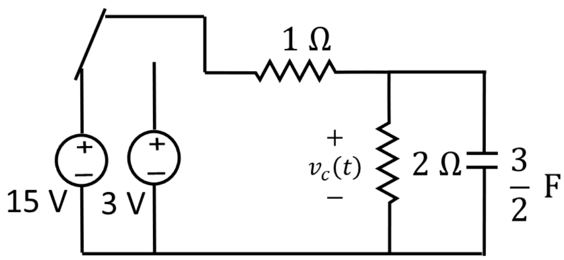
Question 1. (11 points)

The switch in the circuit below switches from a 3 V source to a 15 V source at t = 0. Find $v_c(t)$ for $t \geq 0$

$t < 0$



$t \geq 0$



(a) $v_c(t) = 12 - 8e^{-t}$

(b) $v_c(t) = 12 - 10e^{-t}$

(c) $v_c(t) = 10 - 8e^{-t}$

(d) $v_c(t) = 10 - 10e^{-t}$

(e) $v_c(t) = -6 + 8e^{-t}$

(f) $v_c(t) = -6 + 10e^{-t}$

(g) $v_c(t) = -8 + 8e^{-t}$

(h) $v_c(t) = -8 + 10e^{-t}$

Question 2. (11 points)

Given: $f(t) = tu(t-1)$ and $g(t) = \delta(t-1)$. Compute $f(t) * g(t)$ at t=2.5. Hint: $f(t) * g(t) = \int_{-\infty}^{\infty} f(\tau)g(t-\tau)d\tau$

(a) 0

(b) 0.5

(c) 1

(d) 1.5

(e) 2.0

(f) 2.5

(g) 3.0

(h) 3.5

Question 3. (11 points)

Given f[n]={5,3,2,1} and g[n]={1 2 3}, compute f[n]*g[n] for n=4.

Hint: $f[n] * g[n] = \sum_{m=-\infty}^{\infty} f[m]g[n-m]$, furthermore, function definitions start at zero (i.e. f[0]=5 and g[0]=1).

(a) 3

(b) 5

(c) 7

(d) 8

(e) 14

(f) 15

(g) 21

(h) 23

Question 4. (11 points)

The unit step response of an LTI system (i.e. response to a unit step input) is $y_u(t) = e^{-4t}u(t)$. Find the response $y(t)$ of the system to an input of $x(t) = 3e^{-t}u(t)$. Hint: use $y(t) = x(t) * h(t)$.

(a) $4e^{-4t}u(t) - 4e^{-t}u(t)$

(b) $-4e^{-4t}u(t) + 4e^{-t}u(t)$

(c) $4e^{-4t}u(t) - 7e^{-t}u(t)$

(d) $-4e^{-4t}u(t) + 7e^{-t}u(t)$

(e) $e^{-4t}u(t) - 4e^{-t}u(t)$

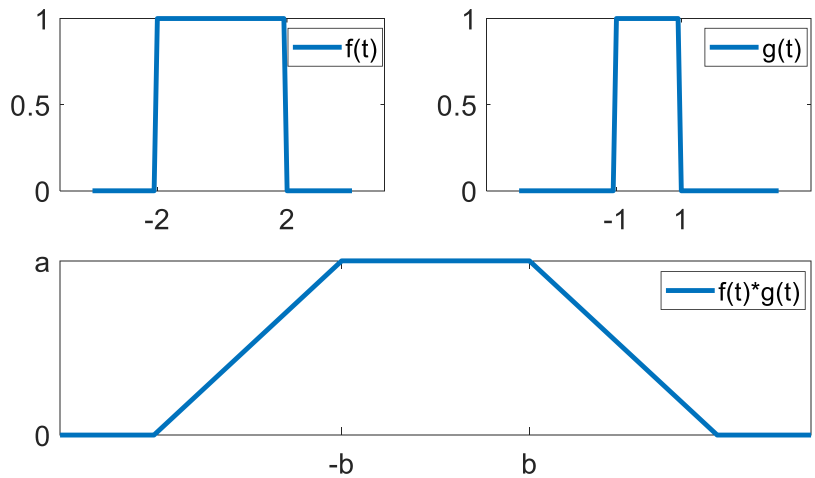
(f) $-e^{-4t}u(t) + 4e^{-t}u(t)$

(g) $4e^{-4t}u(t) - e^{-t}u(t)$

(h) $-4e^{-4t}u(t) + e^{-t}u(t)$

Question 5. (11 points)

The convolution of two pulses f(t) = u(t+2) − u(t-2) and g(t) = u(t+1) − u(t-1) is shown in the bottom plot of the figure below. What is the value of a and b in the x and y axis tick marks?



(a) a=1 b=1/2

(b) a=2 b=1/2

(c) a=4 b=1/2

(d) a=1 b=1

(e) a=2 b=1

(f) a=4 b=1

(g) a=1 b=2

(h) a=2 b=2

Question 6. (11 points)

Find the Laplace transform of $(t-4)e^{-4t}u(t)$ at s = 1.

$\boldsymbol{f(t)}$	$\boldsymbol{F(s)}$	**ROC**
$\delta(t)$	1	$all\ s$
$u(t)$	$\frac{1}{s}$	$Re\{s\} > 0$
$tu(t)$	$\frac{1}{s^2}$	$Re\{s\} > 0$
$e^{-at}u(t)$	$\frac{1}{s+a}$	$Re\{s\} > Re\{a\}$
$te^{-at}u(t)$	$\frac{1}{(s+a)^2}$	$Re\{s\} > Re\{a\}$
$\cos(\omega_0 t)u(t)$	$\frac{s}{s^2+\omega_0^2}$	$Re\{s\} > 0$
$sin(\omega_0 t)u(t)$	$\frac{\omega_0}{s^2+\omega_0^2}$	$Re\{s\} > 0$

Operation	$g(t) =$	$G(s) =$
Differentiation	$\frac{d}{dt}f(t)$	$sF(s) - f(0^-)$
Integration	$\int_{-\infty}^{t} f(\tau)\, d\tau$	$\frac{F(s)}{s} + \frac{\int_{-\infty}^{0^-} f(\tau)\, d\tau}{s}$
Time-shift	$f(t-t_0)$	$e^{-st_0}F(s)$
Frequency-shift	$e^{-at}f(t)$	$F(s+a)$

(a) −0.04

(b) 0.04

(c) −0.75

(d) 0.75

(e) −0.76

(f) 0.76

(g) −0.80

(h) 0.80

Question 7. (11 points)

Find the inverse Laplace transform of $\frac{9}{s^3+3s^2}$.

$f(t)$	$F(s)$	ROC
$\delta(t)$	1	$all\ s$
$u(t)$	$\frac{1}{s}$	$Re\{s\} > 0$
$tu(t)$	$\frac{1}{s^2}$	$Re\{s\} > 0$
$e^{-at}u(t)$	$\frac{1}{s+a}$	$Re\{s\} > Re\{a\}$
$te^{-at}u(t)$	$\frac{1}{(s+a)^2}$	$Re\{s\} > Re\{a\}$
$\cos(\omega_0 t)u(t)$	$\frac{s}{s^2+\omega_0^2}$	$Re\{s\} > 0$
$sin(\omega_0 t)u(t)$	$\frac{\omega_0}{s^2+\omega_0^2}$	$Re\{s\} > 0$

Operation	$g(t) =$	$G(s) =$
Differentiation	$\frac{d}{dt}f(t)$	$sF(s) - f(0^-)$
Integration	$\int_{-\infty}^{t} f(\tau)\, d\tau$	$\frac{F(s)}{s} + \frac{\int_{-\infty}^{0^-} f(\tau)\, d\tau}{s}$
Time-shift	$f(t - t_0)$	$e^{-st_0}F(s)$
Frequency-shift	$e^{-at}f(t)$	$F(s + a)$

(a) $(3 + e^{-3t})u(t)$

(b) $(-1 + e^{-3t})u(t)$

(c) $(3t + e^{-3t})u(t)$

(d) $(-t + e^{-3t})u(t)$

(e) $(3 - t + e^{-3t})u(t)$

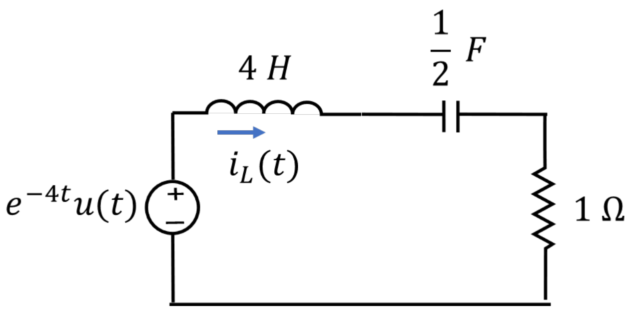
(f) $(-1 + 3t + e^{-3t})u(t)$

(g) $(3 + t - e^{-3t})u(t)$

(h) $(1 + 3t + e^{-3t})u(t)$

Question 8. (11 points)

Find the Laplace transform of the inductor current for the RLC circuit below. (assume: $i_L(0) = 0\,A$ and $v_c(0) = 0\,V$)



$f(t)$	$F(s)$	ROC
$\delta(t)$	1	$all\ s$
$u(t)$	$\frac{1}{s}$	$Re\{s\} > 0$
$tu(t)$	$\frac{1}{s^2}$	$Re\{s\} > 0$
$e^{-at}u(t)$	$\frac{1}{s+a}$	$Re\{s\} > Re\{a\}$
$te^{-at}u(t)$	$\frac{1}{(s+a)^2}$	$Re\{s\} > Re\{a\}$
$\cos(\omega_0 t)u(t)$	$\frac{s}{s^2+\omega_0^2}$	$Re\{s\} > 0$
$sin(\omega_0 t)u(t)$	$\frac{\omega_0}{s^2+\omega_0^2}$	$Re\{s\} > 0$

(a) $\frac{1}{\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

(b) $\frac{1}{(s+4)\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

(c) $\frac{4s}{\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

(d) $\frac{4s}{(s+4)\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

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

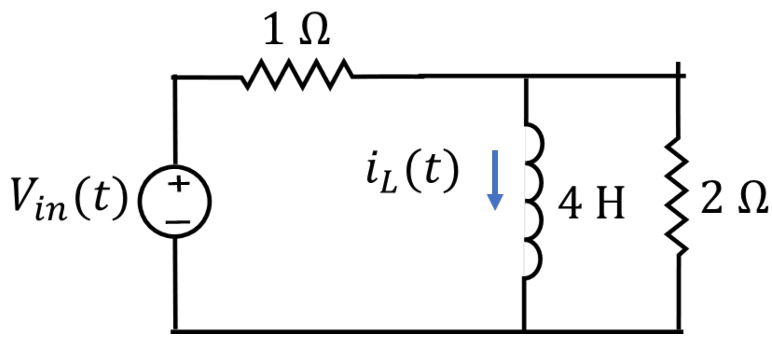
(f) $\frac{s/4}{(s+4)\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

(g) $\frac{s}{\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

(h) $\frac{s}{(s+4)\left(s^2+\frac{s}{4}+\frac{1}{2}\right)}$

Question 9. (11 points)

Find the transfer function of $i_L(t)$ for the circuit below.



(a) $\frac{1/6}{s+\frac{1}{6}}$

(b) $\frac{1}{s+\frac{1}{6}}$

(c) $\frac{6}{s+\frac{1}{6}}$

(d) $\frac{4s}{s+\frac{1}{6}}$

(e) $\frac{1/6}{(s+6)}$

(f) $\frac{1}{(s+6)}$

(g) $\frac{6}{(s+6)}$

(h) $\frac{4s}{(s+6)}$