Problem 1
Consider the LR-circuit shown below driven by an input current source $i_{in}(t)$ where the output is taken as voltage $v_{out}(t)$. Assume that the circuit is at rest, i.e., $i_L(0^-)=0A$.

(a) Determine $V_{out}(s)$ as a function of $I_{in}(s)$.
(b) Determine $v_{out}(t)$ if $i_{in}(t) = I_mu(t)$, where $I_m$ is a constant.
(c) Determine the impulse response, i.e., determine $v_{out}(t)$ if $i_{in}(t) = K \delta(t)$, where $K$ is a constant and represents the weight of the impulse.

Problem 2
Consider the LRC-circuit shown below driven by an input voltage source $v_{in}(t)$ where the output variables are the capacitor voltage $v_{C}(t)$ and the inductor current $i_{L}(t)$. The component values are $R = 5\Omega$, $L = \frac{1}{2}H$ and $C = \frac{1}{8}F$. Assume that the circuit is at rest, i.e., $i_L(0^-)=0A$ and $v_C(0^-)=0V$.

(a) Determine $V_{C}(s)$ as a function of $V_{in}(s)$.
(b) Determine $I_{L}(s)$ as a function of $V_{in}(s)$.
(c) Determine $v_{C}(t)$ if $v_{in}(t) = K \delta(t)$, where $K$ is a constant.
(d) Determine $i_{L}(t)$ if $v_{in}(t) = K \delta(t)$, where $K$ is a constant.
(e) Determine $v_{C}(t)$ if $v_{in}(t) = K u(t)$, where $K$ is a constant.
(f) Determine $i_{L}(t)$ if $v_{in}(t) = K u(t)$, where $K$ is a constant.
Problem 3
Consider the opamp-based $RC$-circuit shown below driven by an input voltage source $v_{in}(t)$, which is a pulse of magnitude $V_m$ and duration $t_0$. Assume that the opamp is ideal and the circuit is at rest, i.e., $v_C(0^-)=0V$.

![RC circuit diagram]

(a) Determine $V_{out}(s)$ as a function of $V_{in}(s)$.
(b) Determine $v_{out}(t)$ if $v_{in}(t)$ is the pulse shown in the schematic.
(c) Sketch $v_{out}(t)$ vs. $t$.

Problem 4
Consider the opamp-based $RC$-circuit shown below driven by an input voltage source $v_{in}(t)$. Assume that the opamp is ideal and the circuit is at rest, i.e., $v_C(0^-)=0V$.

![RC circuit diagram]

(a) Determine $V_{out}(s)$ as a function of $V_{in}(s)$.
(b) Find the unit impulse response, i.e., find $v_{out}(t)$ if $v_{in}(t) = \delta(t)$.
(c) Find the unit step response, i.e., find $v_{out}(t)$ if $v_{in}(t) = u(t)$.
**Problem 5**
Consider the opamp-based $RC$-circuit shown below driven by an input voltage source $v_{in}(t)$. Assume that the opamp is ideal and the circuit is at rest, i.e., $v_{C}(0^-)=0V$.

(a) Determine $V_{out}(s)$ as a function of $V_{in}(s)$.
(b) Find the unit impulse response, i.e., find $v_{out}(t)$ if $v_{in}(t) = \delta(t)$.
(c) Find the unit step response, i.e., find $v_{out}(t)$ if $v_{in}(t) = u(t)$.

**Problem 6**
Consider the $LRC$-circuit shown below driven by an input voltage source $v_{in}(t)$ where the output variables are the capacitor voltage $v_{C}(t)$ and the inductor current $i_L(t)$. The component values are $R = 5\,\Omega$, $L = \frac{1}{2}\,\text{H}$ and $C = \frac{1}{8}\,\text{F}$. Assume that the initial conditions are $i_{L}(0^-)=4\,\text{A}$ and $v_{C}(0^-)=4\,\text{V}$.

(a) Determine $V_{C}(s)$ as a function of $V_{in}(s)$.
(b) Determine $I_{L}(s)$ as a function of $V_{in}(s)$.
(c) Determine $v_{C}(t)$ if $v_{in}(t) = 5u(t)$.
(d) Determine $i_{L}(t)$ if $v_{in}(t) = 5u(t)$. 

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Problem 7
Consider the system shown below where the \( x(t) \) is the input and \( y(t) \) is the output. If the system is characterized by the impulse response \( h(t) = \sin(\omega_0 t) u(t) \), determine the output \( y(t) \) if the input \( x(t) \) is a pulse with magnitude \( K \) of duration \( t_2 - t_1 \) as shown below. Recall that \( y(t) = x(t) * y(t) \).

\[
\begin{array}{c}
0 \quad t_1 \quad t_2 \\
K \quad x(t) \quad h(t) \quad y(t)
\end{array}
\]

Problem 8
Consider the \( LC \)-circuit shown below driven by an input voltage source \( v_{in}(t) \) where the output variable is the capacitor voltage \( v_{C}(t) \). Assume that the circuit is at rest, i.e., \( i_L(0^-)=0A \) and \( v_C(0^-)=0V \).

\[
\begin{array}{c}
i_L(t) \quad L \quad + \quad + \\
v_{in}(t) \quad C \quad v_C(t) \quad - \\

\end{array}
\]

(a) Determine \( V_C(s) \) as a function of \( V_{in}(s) \).

(b) Find the unit impulse response, i.e., find \( v_{C}(t) \) if \( v_{in}(t) = \delta(t) \).

(c) Find the unit step response, i.e., find \( v_{C}(t) \) if \( v_{in}(t) = u(t) \).