Problem 1 (6 points)
Consider the following logic circuit with inputs $a$ and $b$ and output $z$ and intermediate outputs $x$ and $y$.
(a) (2 points) Write $x$ as a logical function of $a$ and $b$.
(b) (2 points) Write $y$ as a logical function of $a$ and $b$.
(c) (2 points) Write $z$ as a logical function of $a$ and $b$.

Problem 2 (4 points)
Draw two periods of a 0V/5V pulse waveform with a frequency of 10 Hz and a duty ratio of 0.4. Be sure to indicate the vertical levels and the horizontal (time) values carefully.
Problem 3 (10 points)
Consider the digital circuit shown below.
(a) Determine the truth table for the circuit with inputs $x$, $y$ and output $w$. Also determine the truth table columns for intermediate variables $p$, $q$ and $r$.
(b) Determine $w$ as a function of $x$ and $y$.

\begin{table}[h]
\centering
\begin{tabular}{c|c|c|c|c|c}
$x$ & $y$ & $p$ & $q$ & $r$ & $w$ \\
\hline
0 & 0 & & & & 0 \\
0 & 1 & & & & 1 \\
1 & 0 & & & & 0 \\
1 & 1 & & & & 1 \\
\end{tabular}
\end{table}
Problem 4 (5 points)
Given the logical function \( w = [ \text{xyz}' + (x'y)' + (x+z)']' \), design a logic circuit with inputs \( x, y, z \) and output \( w \). **Hint:** start working with the innermost parentheses first.

Problem 5 (5 points)
Given the logical function \( w = [ \text{xyz}' + x(y' + z') + y(x+z)']' \), design a logic circuit with inputs \( x, y, z \) and output \( w \). **Hint:** start working with the innermost parentheses first.
Problem 6 (6 points)
Consider the truth table shown below. Determine a logical function for $w$ in terms of $x$, $y$ and $z$ using the sum-of-products procedure.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
<th>$z$</th>
<th>$w$</th>
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<tbody>
<tr>
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</tbody>
</table>

Problem 7 (4 pts) Sketch the voltage $v_s(t) = -2 + 4 \cos(2\pi t)$ V for three cycles. Label the x- and y-axes and use proper units. Be sure to identify the period, frequency, etc.