Q1. (10 points) Solve Problem 6.1 (page 281).

Answer:
Since the circuit is fanout-free, we can apply the algorithm in Fig. 6.3 (p183) and 6.4 (p184) to find a test vector 001100 as shown below. Furthermore, all other faults detected by this vector can be found via critical path tracing: $a_1, b_1, i_1, k_1, l_1$. 

```
\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{circuit.png}
\caption{Circuit diagram for Problem 6.1 solution.}
\end{figure}
```
Q2. \((10\text{ points})\) Solve Problem 6.3 (page 281 and 191).

Answer:

As shown below, to detect \(f\) s-a-0 requires to propagate 1 backward and \(D\) \((0/1)\) forward from \(f\). We start with the unique D-drive to \(h\) that requires \(e\) and \(g\) to be 0 (green). Then, two backward implications set inputs of top and bottom NAND gates to 1 (blue). Two more backward implications on the branches set both \(b\) and \(c\) to 1 and the inputs of the middle NAND gate to 1 (red). Finally two forward implication across the the middle NAND gate lead to a conflict on \(f\) (purple). Therefore, \(f\) s-a-0 is not detectable.
Q3. (15 points) Apply the $D$-algorithm to solve Example 6.2 (page 186).

**Answer:**

As shown below, to detect $s-a-1$ at output of $G1$ requires to propagate 0 backward and $D$ ($1/0$) forward. Forward implications on $D$ will add $G5$ and $G6$ to the $D$-frontier. Then backward/forward implications starting from 0 will set many signal values and remove $G5$ from the $D$-frontier (red). Unique $D$-drive on $G6$ implies 1 backward and finally sets $e$ to 1 (blue). Therefore, the fault is detected by 111x0.
Q4. (15 points) Apply the $D$-algorithm to solve Example 6.3 (page 186 – 187).

**Answer:** As shown below, to detect $h \ s-a-1$ requires $h$ to be 0 and to propagate $D \ (1/0)$ forward from $h$. We starts with the unique D-drive to $p$ that eventually implies values on $e$, $f$, and $o$ (red). Another unique D-drive to $s$ can then be applied that leads to the end of the first round of implications, where the error is at the PO and the J-frontier is $\{q, r\}$.

We choose $r$ from the J-frontier and select $m$ to be 1 (green). The second round of implications then starts, setting various signal values and removing $q$ from the J-frontier (green). Finally it finishes with the error at the PO and the J-frontier being empty. Therefore, the fault is detected by 110x110.