1. Examples handout questions 9 through 13

2. Consider the following circuit:

   $F(A, B, C, D) = ABD + B\overline{C}D + \overline{A}C$

   (a) Are there any static-0 hazards in the circuit? If so, what input transitions could potentially produce a hazard?

   (b) Are there any static-1 hazards in the circuit? If so, what input transitions could potentially produce a hazard?

   (c) Give an alternative circuit with the same output as F that does not have any hazards.

3. The circuit in problem 2 was in sum-of-products form. Provide a circuit in *product-of-sums* form that produces a static-0 hazard.

4. Using a 1-of-8 decoder and OR gates create a circuit that takes a 3-bit number $A_2A_1A_0$ and outputs the number of 1's in the input as a 2-bit number Z_1Z_0.

5. Logic designers often create logic blocks with some desired behavior by composing existing components with additional logic. In this exercise we will create a logic block that behaves like a J-K flip-flop by using a D flip-flop plus some additional logic.

   To do this, first, add a second output $\overline{Q}$, to provide the complemented output in addition to the regular output. Next, observe that our new logic block needs to have inputs called J and K. Since a D flip-flop only has a single input, we need to build some logic that uses J, K, and the current output of the D flip-flop Q to compute a single input into the D flip-flop.

   (a) Explain why the combinational logic feeding into the input of the D flip-flop needs the current output Q.

   (b) Draw your circuit that uses a D flip-flop to implement a J-K flip-flop.

6. The capacity of memory chips (RAM and ROM) is often described by giving how many rows of data the chip contains and the word-size, in bits, of each row. For instance, a 32Kx8 RAM has 32000 8-bit entries.

   (a) How many total bits of storage does a 16Kx16 ROM contain?

(b) Your application needs to store 1024Kb of data but you only have the above 16Kx16 ROM chips available. Design a circuit that appears as a 64Kx16 (1024Kb) ROM to the outside world using the 16Kx16 ROM chips and some multiplexors.