EE 121 October 22, 2002
Digital Design Laboratory Handout #15

Homework #2

Due: Tuesday, October 29

1. Using only three 2-input multiplexers, build a logic circuit for the majority function of three inputs, whose formula is $\mathsf{F} = \mathsf{X} \cdot \mathsf{Y} + \mathsf{X} \cdot \mathsf{Z} + \mathsf{Y} \cdot \mathsf{Z}$.

2. (*DDPP* 4.20b) Find a minimal product-of-sums expression for the following logic function.

$$\mathsf{F} = \sum_{\mathsf{W},\mathsf{X},\mathsf{Y},\mathsf{Z}}(0, 1, 2, 8, 11) + \mathsf{d}(3, 9, 15)$$

3. (*DDPP* 4.22c,e) For each of the following logic expressions, find all of the static hazards in the corresponding two-level AND-OR or OR-AND circuit, and design a hazard-free circuit that realizes the same logic function.

   a. $\mathsf{F} = \mathsf{W}' \cdot \mathsf{Y} + \mathsf{X}' \cdot \mathsf{Y}' + \mathsf{W} \cdot \mathsf{X} \cdot \mathsf{Z}$

   b. $\mathsf{F} = (\mathsf{W} + \mathsf{X} + \mathsf{Y}) \cdot (\mathsf{X}' + \mathsf{Z}')$

4. (*DDPP* 4.45) After completing the design and fabrication of an SSI-based digital system, a designer finds that one more inverter is required. However, the only spare gates in the system are a 3-input OR, a 2-input AND, and a 2-input XOR. How should the designer realize the inverter function without adding another IC?

5. (*DDPP* 5.36) Suppose that you are asked to design a new component, a decimal decoder that is optimized for applications in which only decimal input combinations are expected to occur. How can the cost of such a decoder be minimized compared to one that is simply a 4-to-16 decoder with six outputs removed? Write the logic equations for all ten outputs of the minimized decoder, assuming active-high inputs and outputs and no enable inputs.

6. (*DDPP* 5.54) Design a 3-input, 5-bit multiplexer that fits in a 24-pin IC package. Write the truth table and draw a logic diagram and logic symbol for your multiplexer.

7. (*DDPP* 5.75) Design a 24-bit comparator using three 74x682s 8-bit comparators (p. 242) and additional gates as required. Your circuit should compare two 24-bit unsigned numbers P and Q and produce two output bits that indicate whether $\mathsf{P} = \mathsf{Q}$ or $\mathsf{P} > \mathsf{Q}$.

8. (Bonus) There are $2^{2^3} = 256$ Boolean functions of three variables. How many of these 3-input Boolean functions depend on all three variables?