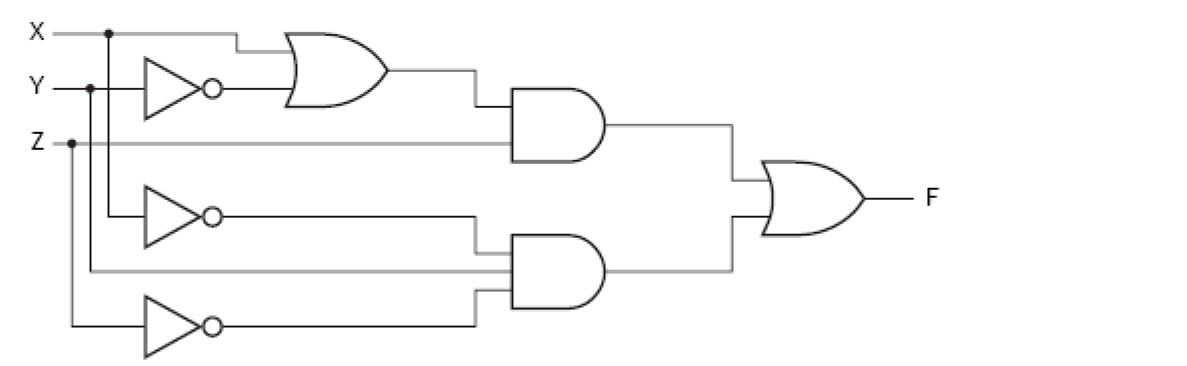
Digital Logic Gates

Quiz 06 ::::

Name:

1. For the circuit below:



(a) Obtain the logic equation directly from the schematic
(b) Obtain the truth table
(c) Obtain the SOP formula

2. Write the truth table for each of the following logic functions

(a) $F = \bar{X}\bar{Y}\bar{Z} + XYZ + X\bar{Y}Z$
(b) $F = AB + A\bar{B}\bar{C} + \bar{A}BC$
(c) $F = X\bar{Y} + YZ + \bar{Z}X$

3. Write the SOP and POS in literal form (حروف) for each of the following logic function

(a) $F = \sum(1,2)$
(b) $F = \sum(2,4,6,7)$
(c) $F = \pi(0,1,3,4,5)$
(d) $F = \pi(0,1,2)$

4. Write the SOP and POS for each of the following table

(a) $F = \sum(0,3)$
(b) $F = \Pi(0,1,3,6,7)$
(c) $F = \bar{X} + Y\bar{Z} + Y\bar{Z}$
(d) $F = \bar{A}B + \bar{B}C + A$

5. Using Karnaugh maps, find a minimal SOP expression for each of the following logic functions

(a) $F = \sum(1,3,5,6,7)$
(b) $F = \sum(1,4,5,6,7,9,14,15)$
(c) $F = \Pi(0,1,3,4,5)$
(d) $F = \Pi(1,7,9,13,15)$

6. Using Karnaugh maps, find a minimal SOP for each of the following

(a) $F = \sum(0,1,3,5,14) + d(8,15)$
(b) $F = \sum(3,5,6,7,13) + d(1,2,4,12,15)$

(c) $F = \sum(1,5,9,14,15) + d(11)$ (d) $F = \sum(0,1,2,8,11) + d(3,9,15)$

7. After completing the design and fabrication of a 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?

8. Any set of logic-gate types that can realize any logic function is called a **complete set of logic gates**. For example, **2-input AND gates, 2-input OR gates, and inverters are a complete set**, because any logic function can be expressed as a sum of products of variables and their complements, and AND and OR gates with any number of inputs can be made from 2-input gates. Do 2-input NAND gates form a complete set of logic gates? **Prove your answer**.

9. Do 2-input NOR gates form a complete set of logic gates? Prove your answer.

10. Do 2-input XOR gates form a complete set of logic gates? Prove your answer.

11. A 3-bit "comparator" circuit receives two 3-bit numbers, $P = P_2P_1P_0$ and $Q = Q_2Q_1Q_0$. Design a minimal sum-of-products circuit that produces a 1 output if and only if $P > Q$.

12. Find minimal multiple-output sum-of-products expressions for
    $F = \sum(0,1,2)$
    $F = \sum(1,4,6)$
    $F = \sum(0,1,2,4,6)$

13. Design a 1-out-of-4 checker with four inputs, A, B, C, D, and a single output ERR. The output should be 1 if two or more of the inputs are 1, and 0 if no input or one input is 1. (Hint: It can be done with seven two-input inverting gates.)

14. Design a combinational circuit whose inputs are two 8-bit unsigned binary integers, X and Y, and whose output is an 8-bit unsigned binary integer **Z = max(X,Y)**. For this exercise, you may use any of the 74x SSI and MSI components introduced in this chapter except the 74x682.

15. Find a function to detect an error in the representation of a decimal digit in BCD. In other words, write an equation with value 1 when the inputs are any one of the six unused bit combinations in the BCD code, and value 0, otherwise

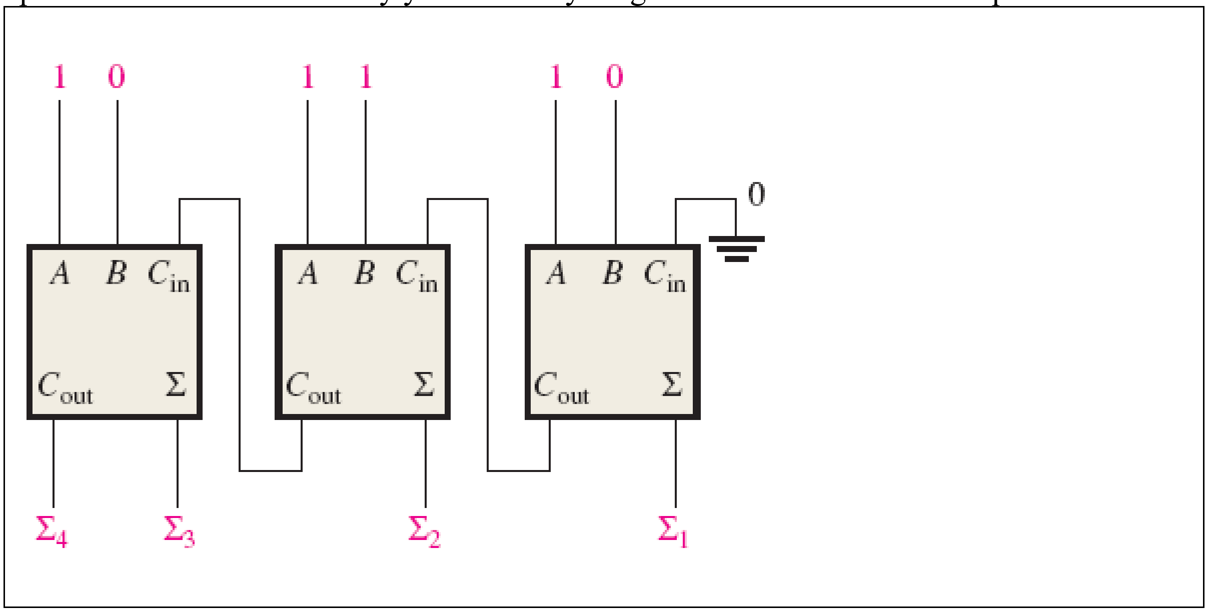
16. Design an Excess 3 to BCD code converter that gives output code 0000 for all invalid input combinations

17. Design an Excess-3 to BCD code converter using a 4-bit adders MSI circuit

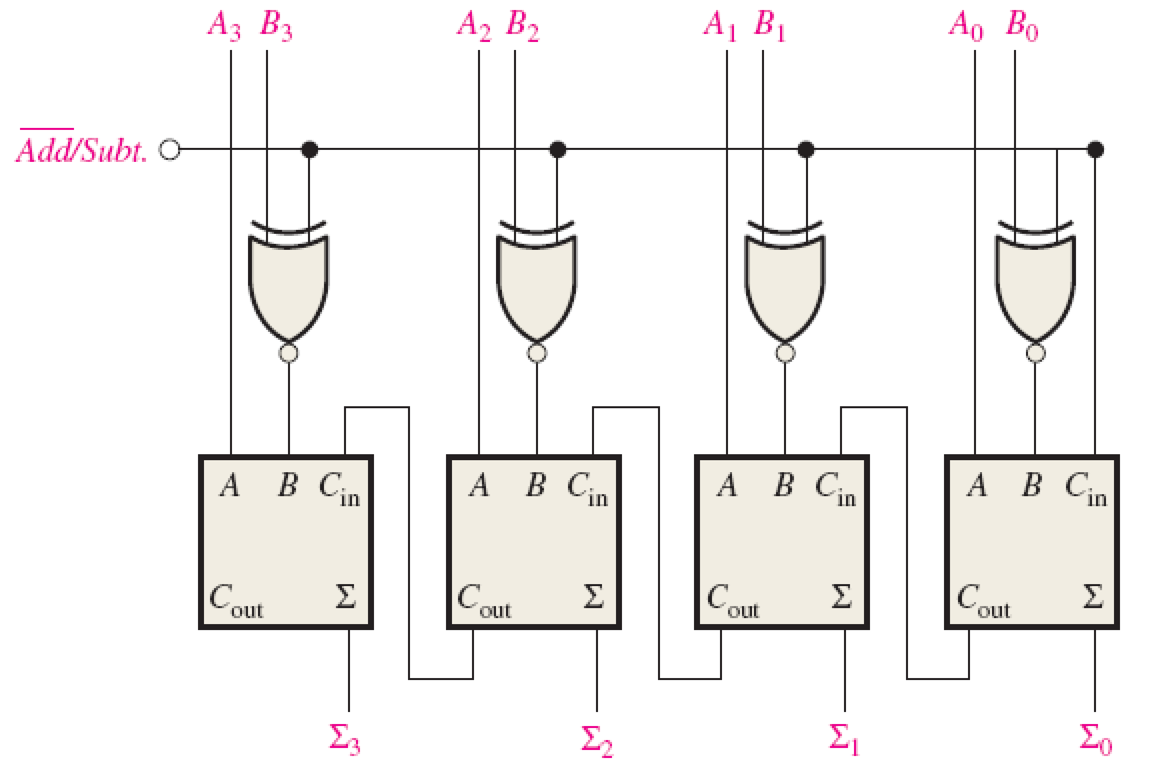
18. Design a combinational circuit that accepts a 4-bit number and generates a 3-bit binary number output that approximates the square root of the number. For example, if the square root is 3.5 or larger, give a result of 4. If the square root is < 3.5 and ≥ 2.5, give a result of 3

19. Design a circuit with a 4-bit BCD input A, B, C, D that produces an output W, X, Y, Z that is equal to the input +6 in binary. For example, 9 (1001) +6 (0110) = 15 (1111)

20. For the parallel adder in Figure below, determine the complete sum by analysis of the logical operation of the circuit. Verify your result by longhand addition of the two input numbers.

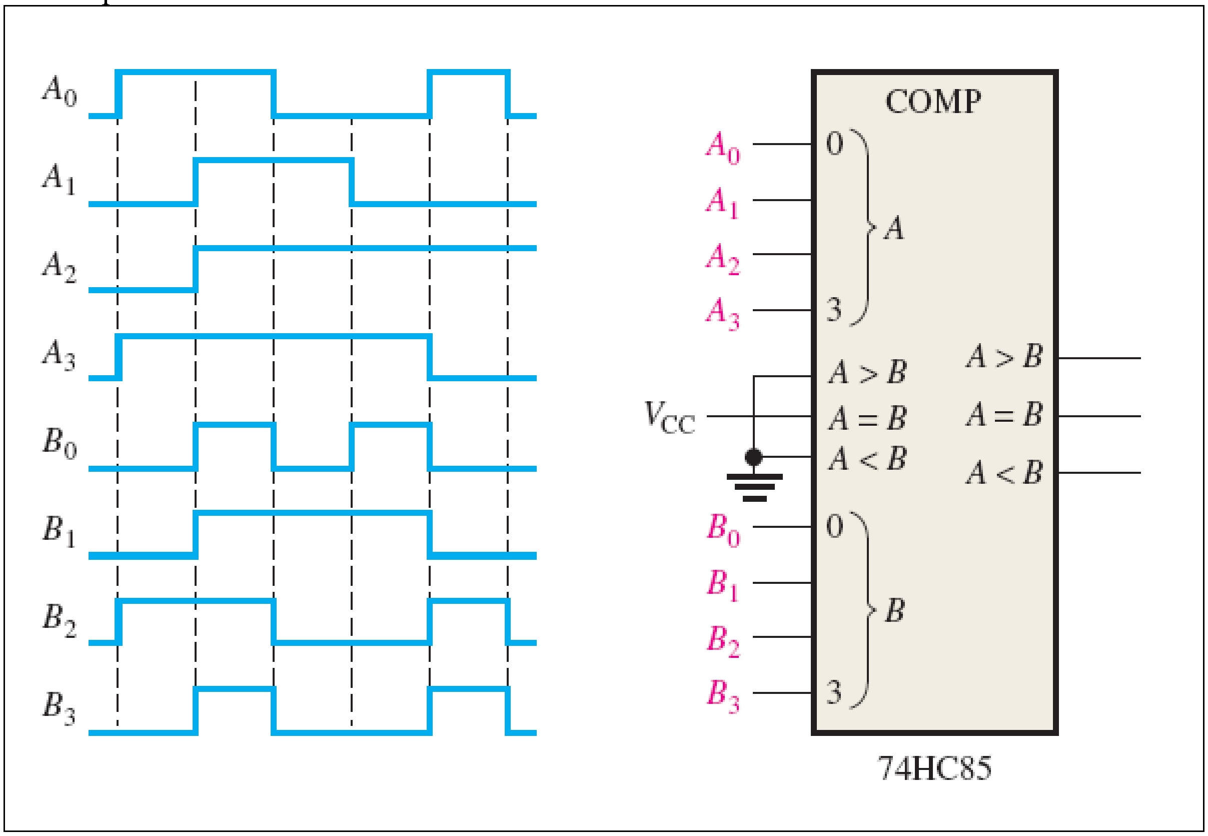


21. The circuit shown in Figure below is a 4-bit circuit that can add or subtract numbers in a form used in computers (positive numbers in true form; negative numbers in complement form).

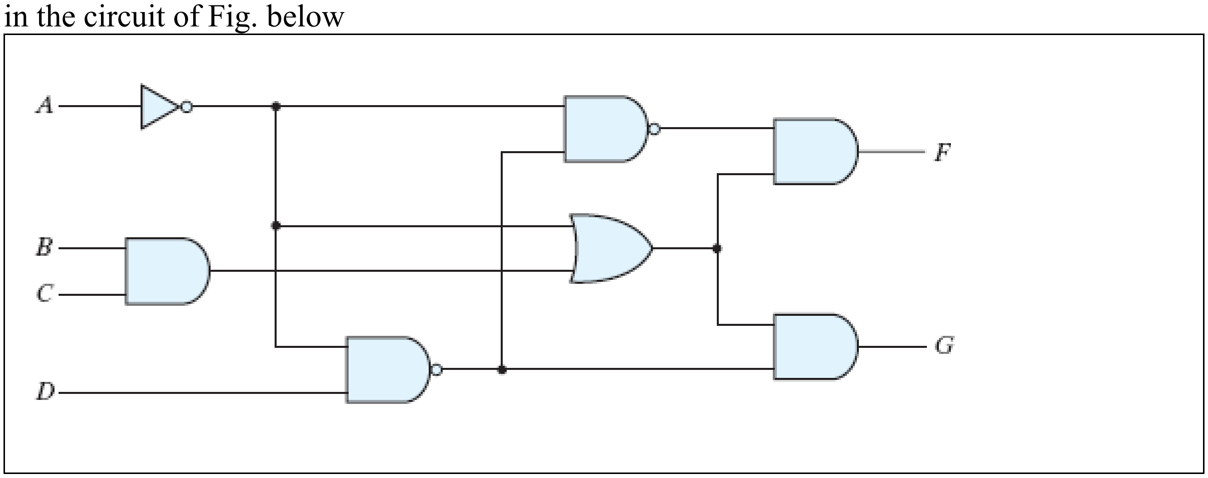


(a) Explain what happens when the $\overline{Add}/Subt.$ input is HIGH
(b) What happens when $\overline{Add}/Subt$ is LOW?
(c) Assume the inputs are $\overline{Add}/Subt = 1$. $A = 1010$, and $B = 1101$. What is the output?

22. For the 4-bit comparator in Figure below, plot each output waveform for the inputs shown. The outputs are active-HIGH.



23. Obtain the simplified Boolean expressions for output F and G in terms of the input variables in the circuit of Fig. below



24. Design a combinational circuit with three inputs, x, y, and z, and three outputs, A, B, and C. When the binary input is 0, 1, 2, or 3, the binary output is one greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is two less than the input.
25. Design a digital circuit that generate the 9's complement of a BCD number.