EECS 579   *Exam No. 1*

Name (print) _____

ID number _____

Grades: 1. _____

2. _____

3. _____

4. _____

5. _____

Total Grade   _____ %

Instructions

1. The exam is ***closed book***, meaning no books, notes, or the like may be used.
2. Attempt ***any four*** of the five problems. Each problem is worth 25 points, for a maximum grade of 100 points. Mark with an X in the above grade list the problem you do ***not*** want graded.
3. Write your answers after the questions in this booklet. If you need more space, use the backs of the sheets with a pointer statement like "Go to back of p. 4". There is an extra blank page at the end.
4. When in doubt, state any assumptions you make.
5. Show all your work. You get partial credit for partial answers.

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Problem 1 (*Gate and their faults*)

(**a**) Let G be a four-input OR gate with inputs a,b,c,d and output z.

- How many possible SSL (single stuck-line) faults can affect G?   **Ans.** _____
- How many classes of equivalent SSL faults are there in G?   **Ans.** _____
- How many tests are needed to detect all SSL faults in G?   **Ans.** _____
- How many tests are needed to distinguish all distinguishable SSL faults in G? **Ans.** _____

(**b**) Let G_n be any elementary n-input gate of the AND, OR, NAND, NOR or NOR type, for n Š 1. Assume the gate is characterized by its controlling and inversion variables c and i, respectively, as well as by the number of inputs n.

- How many possible MSL (multiple stuck-line) faults can affect G_n?   **Ans.** _____
- How many classes of equivalent MSL faults does G_n have?   **Ans.** _____
- Specify clearly all of G_n's equivalent MSL fault classes below.
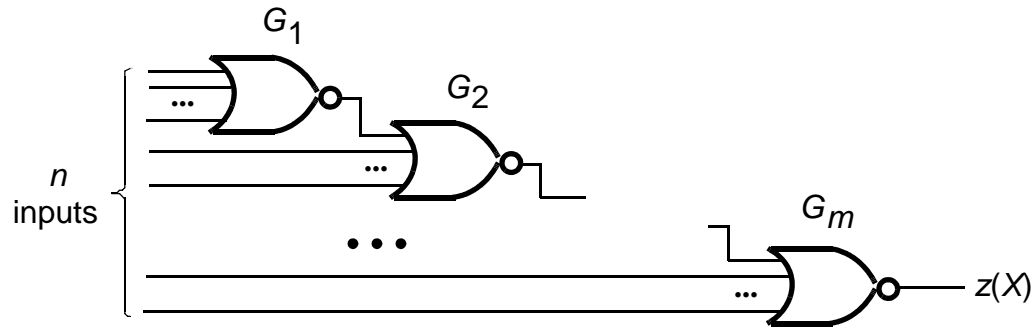
Ans.

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Problem 2 (*Boolean difference*)

Let N be a nonredudant logic circuit that realizes the following Boolean function:
$$z = (x_1 + x'_2)(x_1 + x'_2 x'_3 + x_4 x_5)' + x_1(x_2 + x_4 x_5)$$

(**a**) Derive in minimal sum-of-products form the Boolean difference of z with respect to x_1.

(**b**) Use the Boolean difference to find all test vectors that detect the SSL fault x_1 stuck-at-1 in N.

(**c**) Use the Boolean difference to find all test vectors that detect the double fault consisting of x_1 stuck-at-1 and x_2 stuck-at-0.

(**d**) Let a be any internal line in N. Use the Boolean difference to demonstrate that no single test exists that will detect the two (non-simultaneous) faults a stuck-at-1 and a stuck-at-0.
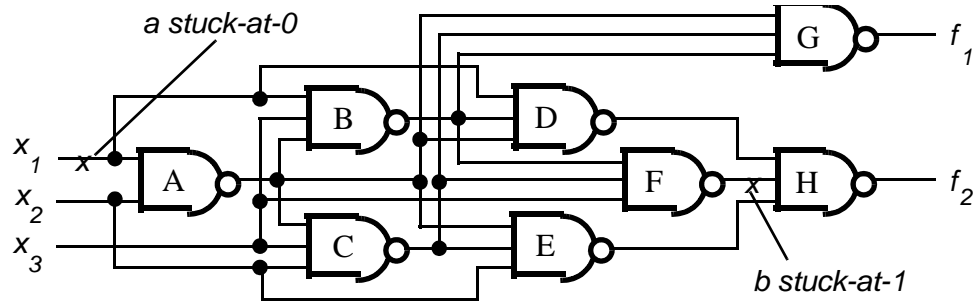
Problem 3 (*Fanout-free circuits*)

The above n-input circuit C is called a **cascade** circuit and realizes an n-input function $z(X)$ using m ð n NOR gates. The output of each gate except G_m is connected to exactly one other gate.

(**a**) Determine as a function of n and/or m, the minimum number of tests required to detect all SSL faults in C. (For less credit, determine a good upper bound in place of the minimum value.)
(**b**) Let T be any complete set of SSL tests for C. Determine whether T detects all MSL faults in C.
(**c**) Suppose that the cascade circuit is composed of XOR gates instead of NOR gates. Repeat *either* part (a) *or* part (b) of the problem—specify clearly which part you are doing—for the new cascade circuit C.

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Problem 4 (*PODEM*)

(**a**) Use the PODEM algorithm to generate a test for the fault *a* stuck-at-0 in the circuit *N* above. Give your answer in the tabular decision/implication style used in the text. Include comments to indicate the nature of each step.

(**b**) Repeat part (a), this time using PODEM to generate a test for the fault *b* stuck-at-1 in *N*.

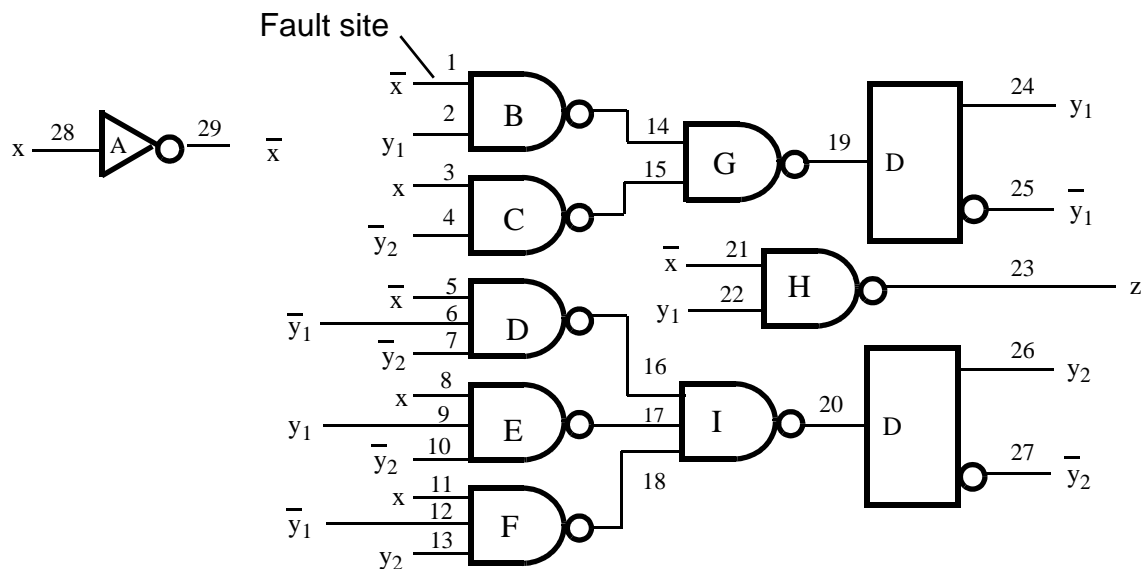| Decisions	Implications	Comments

Problem 5 (*Sequential testing*)

(**a**) Carefully define the following three terms using just one complete sentence for each:

- Self-initializing test:

- Synchronizing sequence:

- Homing sequence:

Fault site

(**b**) Consider the 1-input, 1-output, 4-state synchronous sequential circuit shown above; x is the primary input, and z the primary output. For clarity, fanout branches are not drawn explicitly. Do the following, showing all steps in your work and using any appropriate method:

Derive a minimum-length test sequence for the fault "line 1 s-a-1", assuming that the initial state is $y_1 y_2 = 11$.   (For less credit, find any <u>non</u>-minimal test for this fault.)