**CS109B Quiz**

Monday, Feb. 11, 10–10:50 am

## Directions

The exam is *open book*; any written materials may be used. Answer all 5 questions on the exam paper itself. The total number of points is 100. You may make additional comments at the bottoms of pages or at the end if you feel the need to clarify or justify your answers. Do not forget to **sign the pledge** below.

I acknowledge and accept the honor code.

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Print your name here: ________________________________________

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|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| Total | |

**Problem 1:** (20 points) Below are certain pairs of cities in Michigan and the mileage between them.

| City 1 | City 2 | Dist. |
|---|---|---|
| Marquette | Sault St. Marie | 153 |
| Saginaw | Flint | 31 |
| Grand Rapids | Lansing | 60 |
| Detroit | Lansing | 78 |
| Escanba | Sault St. Marie | 175 |
| Ann Arbor | Detroit | 28 |
| Ann Arbor | Battle Creek | 89 |
| Battle Creek | Kalamazoo | 21 |
| Kalamazoo | Grand Rapids | 45 |
| Escanba | Marquette | 78 |
| Battle Creek | Lansing | 40 |
| Flint | Detroit | 58 |

Draw a minimal spanning tree for each connected component of this graph in the space below. *Note*: It is suggested that you use scratch paper for your first try, unless you have a really good knowledge of the geography of Michigan. Also, to save time, you can use the first letter of each city name to stand for the city.

**Problem 2:** (20 points) Consider the directed graph $G$ with set of nodes $\{a, b, c, d, e\}$ and set of arcs

$$\begin{array}{ccc} a \to b & a \to e & c \to a \\ c \to d & d \to b & \end{array}$$

a) In the space below, show one possible depth-first spanning forest for $G$ that consists of a single tree. That is, you must pick a starting node so that you get a single tree. Indicate the tree arcs by solid lines, and other arcs by dashed lines. Attach postorder numbers to the nodes.

b) Find another depth-first spanning forest for $G$ that has the *maximum* number of trees. Again, show the tree arcs solid and other arcs dashed, and attach postorder numbers to the nodes.

c) There are a number of possible topological orders for the graph $G$. List all of them here:

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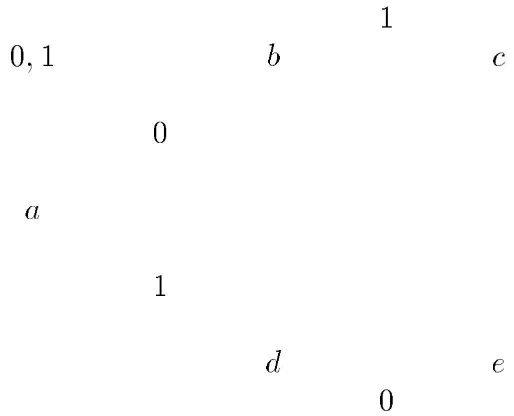
**Problem 3:** (20 points) Convert the following nondeterministic finite automaton




into a deterministic finite automaton, below, by using the subset construction.

**Problem 4:** (20 points) Write regular expressions denoting each of the following languages.

a) The set of strings of 0's and 1's of length three.

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b) The set of strings of 0's and 1's that begin with 0 and end with 1.

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c) The set of strings of 0's and 1's that have at most one 1.

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**Problem 5:** (20 points) In the following problem you *must* use the regular-expression-to-automaton conversion algorithm described in Section 10.8 of the notes. We shall convert the regular expression $\mathbf{0}|\mathbf{10}$.

a) Show the expression tree for this regular expression:

b) Convert the expression to an automaton with $\epsilon$-transitions:

c) Eliminate $\epsilon$-transitions from your answer to (b):