Name:____________Key___________________________________ Grade:_____<-- instructor use

1. A DFSM M is a 5-tuple (K, Σ, δ, s, A). What do each of the symbols represent?

   K **set of states**

   Σ **alphabet**

   δ **transition function** $\delta : (\mathbf{K} \times \mathbf{\Sigma}) \to \mathbf{K}$

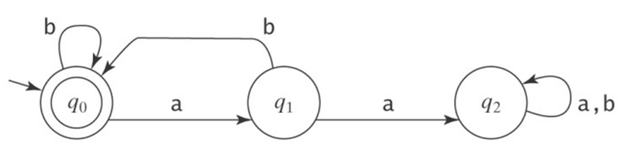
   s **start state (an element of K)**

   A **accepting states (subset of K)**

2. In the notation of problem 1, what is the initial configuration if M is to process the input string w?

3. $(q, w) \vdash_M (q', w')$ iff $\delta($ **q** , **a** $)$ = **q'** [The $\vdash_M$ symbol is read "yields in machine M" or simply "yields"] **where w =aw'**

4. For the following FSM, show the computation (sequence of configurations) if the input string is *abaab*.



$(q_0, \text{abaab}) \vdash (q_1, \text{baab})$
$\vdash (q_0, \text{aab})$
$\vdash (q_1, \text{ab})$
$\vdash (q_2, \text{b})$
$\vdash (q_2, \varepsilon)$

5. What does it mean for a DFSM to "accept" a string?
   Computation on that string ends in accepting state

6. Prove: Every DFSM *M*, in configuration (q, w), halts after |*w*| transitions.

   Base case: If w is ε, it halts in 0 steps.

   Induction step: Assume true for strings of length n and show for strings of length n+1.

   Let $w \in \Sigma^*$, $|w| = n+1$ for some $n \in \mathbb{N}$.

   Then w is ax for some $a \in \Sigma$, $x \in \Sigma^*$, $|x| = n$.

   Let q' be δ(q, a). Then $(q,w) \vdash_M (q', x)$

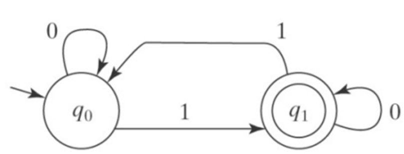
   By induction, from configuration (q', x), M halts in n steps.

   So, starting from the original configuration, M halts in n+1 steps.

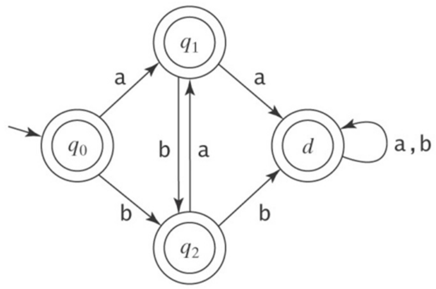
7. Is the following problem decidable? Given a DFSM M and a string $w \in \Sigma_M^*$, is $w \in L(M)$? **Yes** No
   Explain briefly. **The FSM M is a decision procedure. It always halts, and (by definition of L(M)) gives the correct answer.**

8. A language L is *regular* iff **it is L(M) for some DFSM M.**

9. Draw the transition diagram (or transition table) for a DFSM that accepts
   OddParity = {w∈{0, 1}* : w contains an odd number of 1s}



10. Draw the transition diagram (or transition table) for a DFSM that accepts
{$w \in$ {a, b}* : no two consecutive characters are the same}.



11. In terms of the formal definitions, what is the major difference between the five components of a DFSM and a NDFSM?

For a DFSM, a "return value" of the transition function is a state.
For an NDFSM, a "return value" of the transition function is a set of states.

12. What are the two sources of nondeterminism in a NDFSM diagram?

An ε-transition.

Two transitions out of the same state on the same input symbol.

13. Tell your instructor about anything from today's session (or from the course so far) that you found confusing or still have a question about. If none, please write "None". **Must have an answer**