CS 3350 Automata, Computability, and Formal Languages Fall 2018, Test 1

Last 4 digits of your UTEP ID number: ________ ____________ 100/100

General comments:

- you are allowed up to 5 pages of handwritten notes;
- if you need extra pages, place the last 4 digits of ID number on each extra page;
- the main goal of most questions is to show that you know the corresponding algorithms; so, if you are running of time, just follow the few first steps of the corresponding algorithm;
- each question will be graded on its own merit; so, for example, if when answering to the first part of the question, you got a wrong automaton, but on the second part, you correctly traced the new automaton, you will get full credit for the second part.

Good luck!

1-4. In class, we studied an automaton for recognizing valid Java identifies. This automaton has 3 states: start (s), identifier (i), and error (e). Start is the starting state, identifier is the only final state. The transitions are as follows:

- from s, any letter (a, ..., z, A, ..., Z) leads to i, any other symbol leads to e;
- from i, any letter, any digit (0, ..., 9), or an underscore symbol _ lead back to i, while any other symbol leads to e;
- from e, every symbol leads to e.

10/10 1. Is any of the three states a sink state? Explain your answer.

2-3. Trace, step-by-step, how this finite automaton will check whether the following two words (sequences of symbols) represent a valid Java identifier:

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- the word number2 (which this automaton should accept) and
- the word 2ndNumber (which this automaton should reject).

4. Write down the tuple <Q, Σ, δ, q_0, F> corresponding to this automaton:

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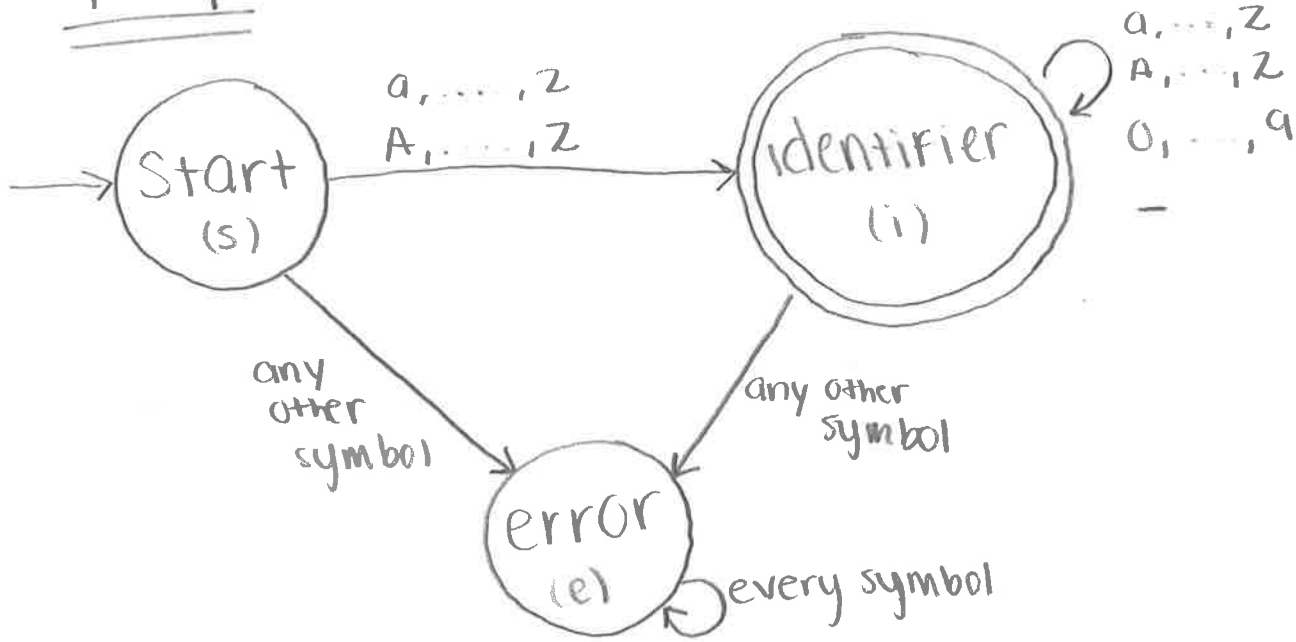
- Q is the set of all the states,
- Σ is the alphabet, i.e., the set of all the symbols that this automaton can encounter;
- δ: Q x Σ → Q is the function that describes, for each state q and for each symbol s, the state δ(q, s) to which the automaton that was originally in the state q moves when it sees the symbol s (you do not need to describe all possible transitions this way, just describe two of them);
- q_0 is the staring state, and
- F is the set of all final states.

1-4



1. Error is a sink state because it is a black hole, once you are in that state, you can not get out, it only produces an error. The automaton rejects the input once it reaches the error state.

2. | n | u | m | b | e | r | 2 |

s i i i i i i (i)

accepted ✓

3. | 2 | n | d | N | u | m | b | e | r |

s e e e e e e e e e

rejected ✗

→

4.) $Q = \{start, identifier, error\}$

$\Sigma = \{a, \ldots, z, A, \ldots Z, 0, \ldots, 9, \_, \text{every other symbol}\}$

$\delta(start, b) = identifier$

$\delta(identifier, +) = error$

$q_0 = Start$

$F = \{identifier\}$

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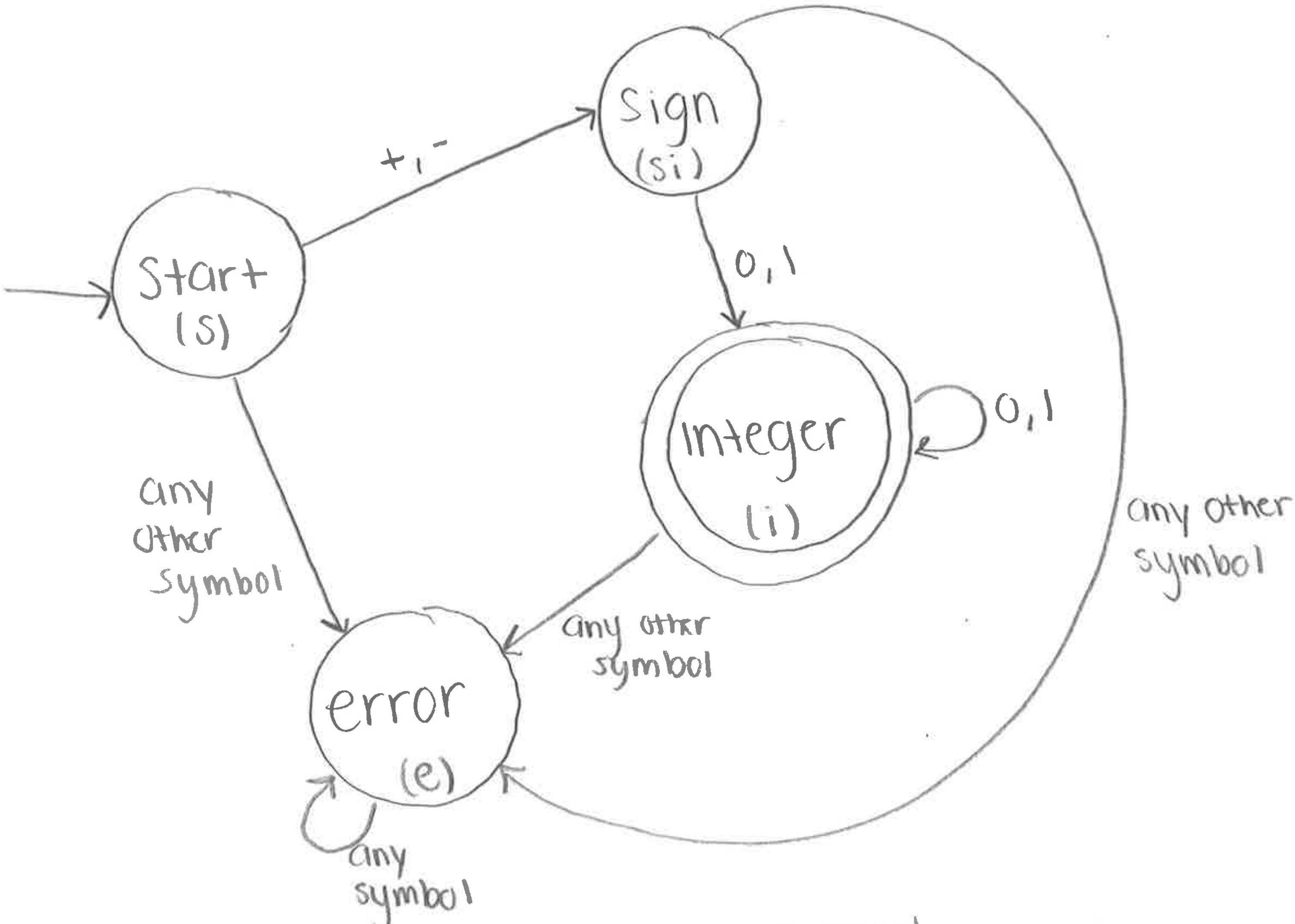
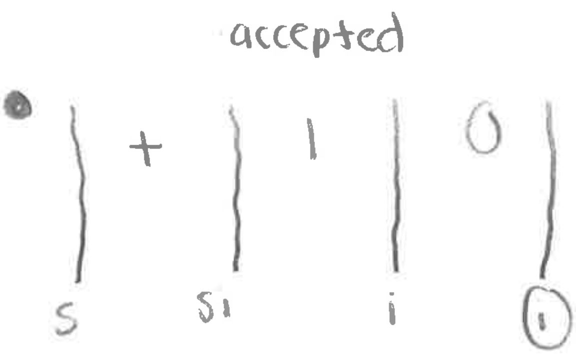
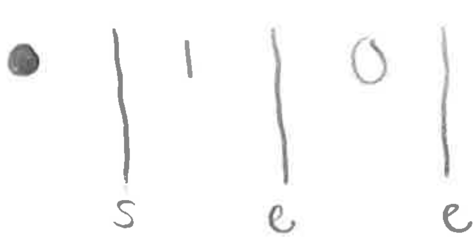
5. Draw an automaton for recognizing all possible binary signed integers. Trace this automaton on the example of numbers +10 (that it should accept), −10 (also accepted), and 10 (should be rejected).







6-8. Let A be an automaton described in Problem 1. Let B be the following automaton that accepts all the strings that contain only letters but not any other symbols. This automaton has two states: the start state which is also a final state, and the sink state. The transitions are as follows:

- from the start state, any letter leads back to the start state, every other symbol leads to sink;
- from the sink state, any symbol leads back to sink.

6. Use the algorithm that we had in class to describe the following two new automata:

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- the automaton that recognizes the union A U B of the two corresponding languages, and
- the automaton that recognizes the intersection of the languages A and B.

7-8. Test these two new automata step-by-step on the following words:

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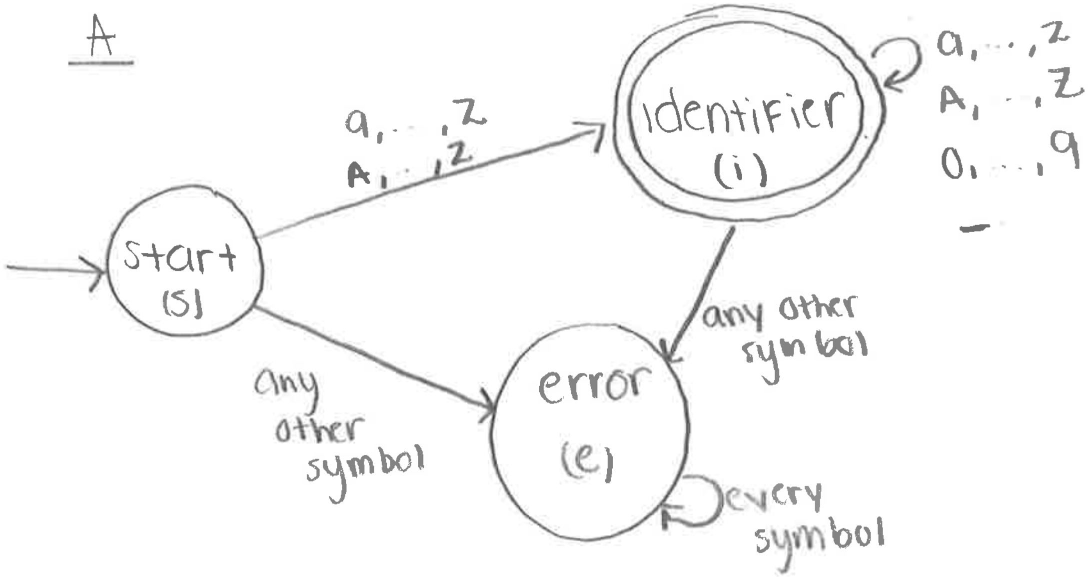
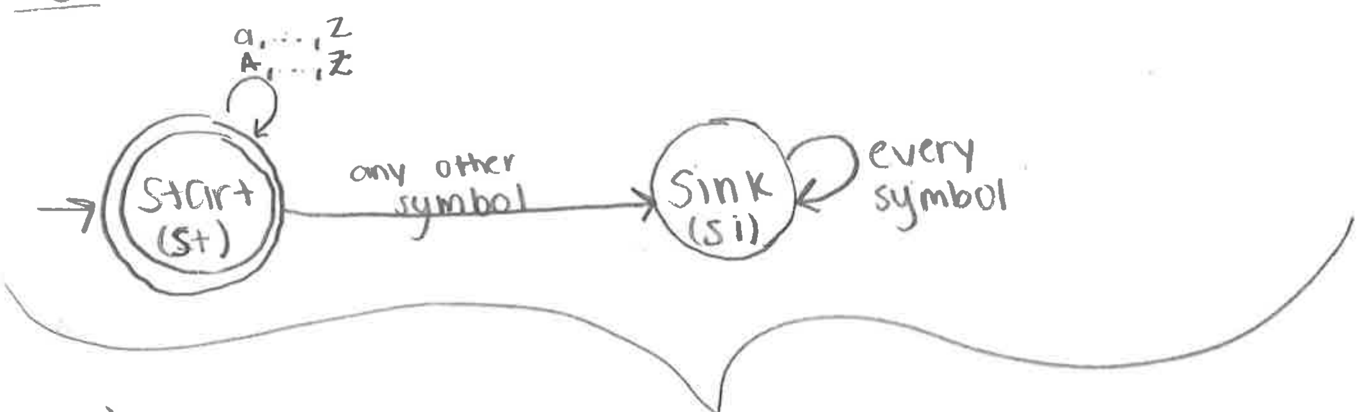
- test the union automaton on the example of the words Var (that it should accept) and 2words (that it should reject);
- test the intersection automaton on the example of the words Var (that it should accept) and Var2 (that it should reject).

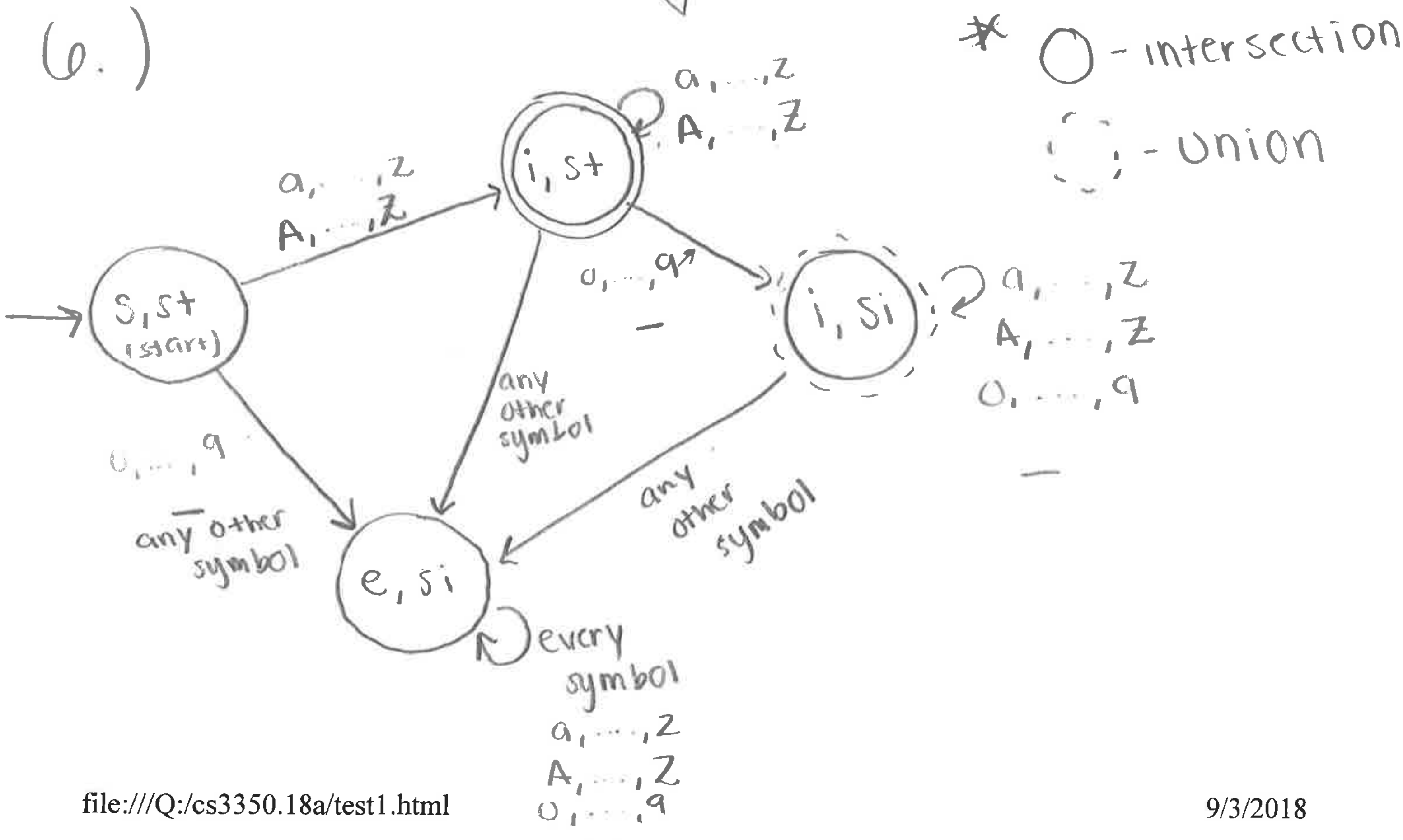
A


Start
(S)
a, ... ,z
A, ... ,Z
Identifier
(i)
a, ... ,z
A, ... ,Z
0, ... ,9
_
any other symbol
error
(e)
every symbol

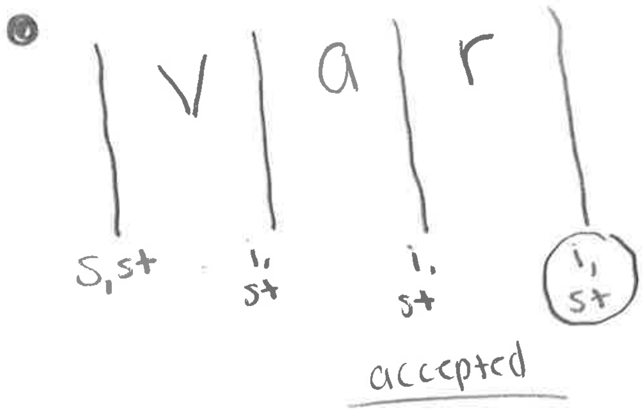
B


a, ... ,z
A, ... ,Z
Start
(St)
any other symbol
Sink
(Si)
every symbol

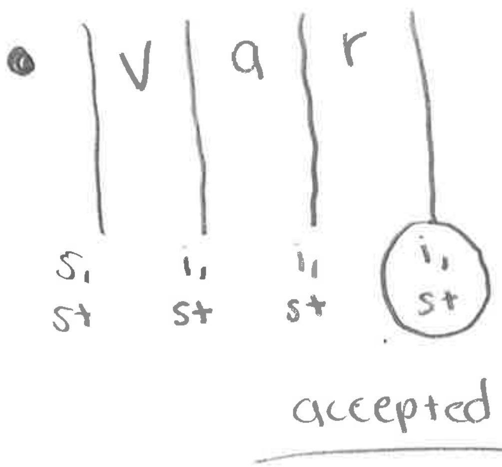
6.)


* ◯ - intersection
◌ - union
s, st
(start)
a, ... ,z
A, ... ,Z
i, st
0, ... ,9
_
i, si
any other symbol
e, si
every symbol
a, ... ,z
A, ... ,Z
0, ... ,9
_

7.) union



8.) intersection



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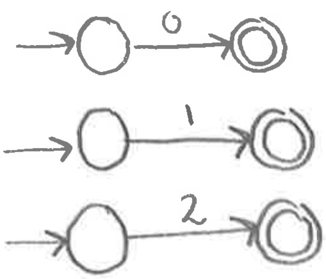
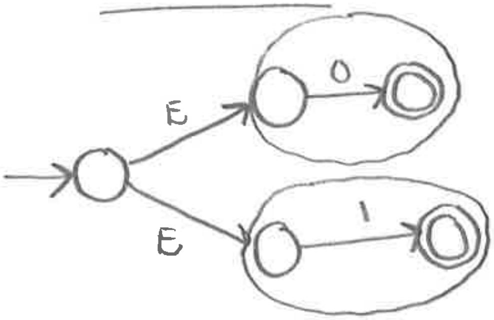
9-10. Use the general algorithm that we learned in class to design a non-deterministic finite automaton that recognizes the language (0 U 1)(1 U 2):

- first, describe the automata for recognizing 0, 1, and 2;
- then, combine them into the automata for recognizing the unions 0 U 1 and 1 U 2;
- finally, combine the two union automata into an automaton for recognizing the composition (0 U 1)(1 U 2) of the two union languages.

- 0, 1, 2



- 0 U 1



- 1 U 2