MA/CSSE 474 Exam 2 Spring, 2018 Name__________________ Section: 01 (2^{nd}) ____ 02 (3^{rd})___ 03(4^{th}) ___

No books or papers except the "Notation and Formulas" sheet supplied by the instructor. In the exam, it referred to as the Notes Page.

You may not use any devices with WI-FI/Bluetooth, headphones, or earbuds.

No communication about this exam's contents with anyone besides the instructor before 11:45 AM.

Scores:

Problem	Possible	Score
1	40	
2	5	
3	4	
4	24	
5	9	
6	15	
7	15	
8	15	
9	6	
Total	**133**	

1. (40 points) Circle T or F to indicate whether it is *True* or *False*. IDK means *I don't know*. If the statement can ever be False, then False is the correct answer. **You do not need to give proofs or counterexamples.** For each part, you earn **2 points** for circling IDK, **4** points for circling the correct answer, **-1** for circling the incorrect answer, and **0** if you leave it blank. Leaving it blank is silly, since you get more points for IDK.

   a) T F IDK The complement of an infinite language must be infinite.
   b) T F IDK The complement of a non-regular language must be non-regular.
   c) T F IDK Every subset of a regular language must be regular.
   d) T F IDK If L is regular, then so is $\{xy : x \in L \text{ and } y \notin L\}$.
   e) T F IDK The intersection of an infinite number of regular languages must be regular.
   f) T F IDK If for each element w in language L, there is a DFSM that accepts w, when L must be regular.
   g) T F IDK Let M be a DFSM such that $|K_M| = 100$, $\Sigma_M = \{a, b\}$, and $L(M)$ is finite. Then $a^{100}b^{100} \notin L(M)$.
   h) T F IDK The finite languages are closed under intersection with the regular languages.
   i) T F IDK $(L_1 - L_2 \text{ is regular}) \rightarrow (L_1 \text{ is regular})$.
   j) T F IDK If *chop*(L) is regular then L is regular. (The *chop* function is defined on the Notes Page)

2. (5 points) Consider the contrapositive to the Pumping Theorem (the details are on the Notes Page). If we are using this to prove that a language L is non-regular, which of the values mentioned in the theorem do we get to choose? Circle them (and do not circle the ones that we are not allowed to choose).

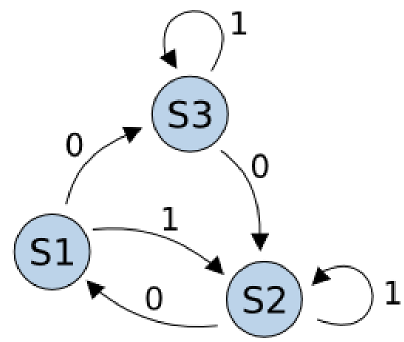
   k w x y q

3. (4 points) Write the English name for each of these Greek letters that we frequently use in the course. For example, if one of the letters was α, you would write *alpha*.

   ε Σ δ κ

4. (24 points) **In the pictured DFSM M, the start state is S1, and the accepting states are S1 and S2.** Consider the algorithm from class for finding a regular expression α such that L(α) = L(M).

(12) Write your answers in the simplest form that you can. What is the value of



r_{220}?

r_{221}?

r_{312}?

(8) For each the following two r_{ijk} values, fill in the four sets of three subscripts that tell how to calculate the given r value using the recursive formula.

r_{221} = r ∪ r r* r

r_{313} = r ∪ r r* r

(4) Write a regular expression that defines L(M). Express your answer in terms of a union of some of the r_{ijk}. You do not have to actually evaluate the r_{ijk}.

L( ) = L(M)

5. (9 points) This problem is the same as a problem in HW5, but you do not have to prove your answer here. Just show that you understand the construction. Let $M_1=(K_1, \Sigma, \delta_1, s_1, A_1)$ and $M_2=(K_2, \Sigma, \delta_2, s_2, A_2)$ be DFSMs that accept the regular languages $L_1 = L(M_1)$ and $L_2= L(M_2)$. Let $L = L_1 \cap L_2$. Show that L is regular by directly constructing a DFSM M=(K , Σ, δ, s, A) such that L=L(M). I do not expect you to have memorized the solution; you should be able to figure out the details again.

(2) K =

(4) δ is defined as δ( ) =

(1) s =

(2) A =

6. (15 points) L = { $u \in \{a, b\}^*$: $\exists s, t$ ($u=st$ $\wedge$ $|s| = |t|$ $\wedge$ $\#_a(s) \geq \#_a(t)$ }.

Regular or not? Prove your answer. 5 points for the correct answer, 10 for the informal proof.

Circle the correct answer: REGULAR NOT REGULAR

Proof:

7. (15 points) L= { $w \in \{a, b\}^*$: the number of occurrences of the substring *ab* in *w* equals the number of occurrences of the substring *ba* in *w*}.

Regular or not? Prove your answer. 5 points for the correct answer, 10 for the informal proof.

Circle the correct answer: REGULAR NOT REGULAR

Proof:

8. (15 points) $L = \{ w = xyzy : x, y, z \in \{a, b\}^+ \}$.
Regular or not? Prove your answer. 5 points for the correct answer, 10 for the informal proof.

Circle the correct answer: REGULAR NOT REGULAR

Proof:

9. (6 points)

a) Give an example of a non-regular language L such that L* is regular.
Your L can be a language that we have seen in this course. No proof is required.

b) Give an example of a non-regular language L such that L* is not regular.
Your L can be a language that we have seen in this course. No proof is required.