CptS 317: Automata and Formal Languages
Mid-Term Exam 1
March 1, 2021, 10:10–11:00am

Instructions:

1. Remember to write your name and WSU ID number on your answer sheet.
2. There are 6 questions on this exam. Some of the questions have multiple parts.
3. Each question has a point value listed in parentheses next to the problem number. Questions are not equally weighted, however questions with multiple parts will have each part equally weighted. The total value of all questions is 100 points.
4. You have 50 minutes to complete the exam. An additional 20 minutes are provided to submit your exam on Canvas to account for potential technical and connection-related issues. You should **NOT** use this time to continue working on the exam. If the exam is submitted past the Canvas deadline of 11:20 AM on March 1, 2021, one point will be deducted for each minute that it is late.

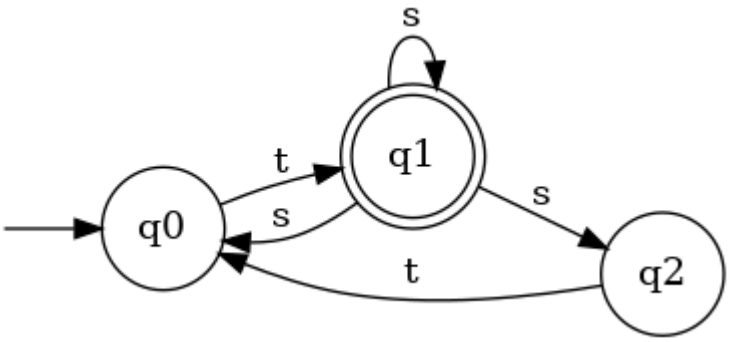
1. (20 Points) Give an English description for each of the languages generated by the following regular expressions.

   (a) $0^*10^*10^*10^*$
   (b) $(1\Sigma)^*$

2. (20 Points) Write regular expressions for the following languages (you may use the Σ character to signify "any character in the alphabet")

   (a) The language of all strings with the alphabet a-z which contain at least one vowel (note: vowels are "a", "e", "i", "o", and "u")
   (b) The language of all binary strings which do not contain the substrings "00" or "11".

3. (15 Points) Draw a finite automaton (NFA or DFA, at your choice) that accepts the regular expression: $(a \cup ba)^*$.
4. (15 Points) Convert this NFA to an equivalent DFA:



5. (20 Points) State True or False for each of the following questions. If your answer is False, provide a brief justification.

   (a) In a DFA every state has exactly one exiting* transition for each symbol in the alphabet.
   * *Note: We are also considering transitions from a state to itself as exiting transitions.*
   (b) In a DFA there may be a state that has an arrow labeled with the empty string ϵ.
   (c) An NFA may have a state with no exiting arrows for an alphabet symbol.
   (d) An NFA may recognize a language which is not recognized by any DFA.
   (e) The language of base-16 representations of the natural numbers is regular.

6. (10 Points) Show that the following language is not a regular language using the pumping lemma. $A = \{0^n1^n2^n | n \geq 0\}$