CECS 329 MW, LO Assessment 3, Fall 2026, Dr. Ebert

IMPORTANT: For each problem (LO5,LO6,GK,Advanced, All LO Makeups) write your solution using a **SINGLE** and **SEPARATE SHEET OF PAPER (FRONT AND BACK IF NECESSARY)**. Write your **FULL NAME** and **PROBLEM CODE** on each sheet.

25 Points Each

LO5 Do the following.

a. Given the CFG whose set of rules are

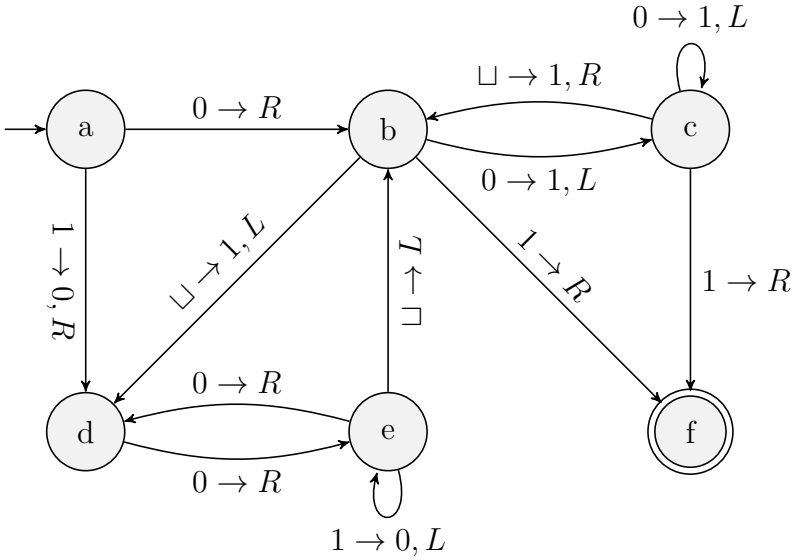
$$S \to S0S0S1S \mid S1S0S0S \mid S0S1S0S \mid \varepsilon$$

use these rules to provide a leftmost derivation of the word 000011. (10 pts)

b. Provide a context-free grammar that describes the language of all words over the alphabet {a,b} that have an even number of a's or (inclusive) and odd number of b's. (15 pts)

LO6 Do the following.

a. For the TM M whose state diagram is shown below, suppose M is performing a computation and the current configuration has memory word 1000, is in state a and the head is reading the 1. Draw this configuration and show the next five configurations of the compuation. (10 pts)



b. Provide the state diagram of Turing machine M that i) has tape alphabet $\Gamma = \{a,b,c,x,\sqcup\}$, ii) accepts only words in $\{a,b,c\}^*$ for which there is a "b" that follows (not necessarily immediately) after an "a" and (not necessarily immediately) precedes a "c", and iii) when M accepts, the current memory word is the original input word and the head is reading the first b that satisfies property ii). For example, if the input word is bbbcacacc**b**babbcbba, then it should be accepted and M should halt with the head reading the b printed in boldface, and the final memory word should still be bbbcacacc**b**babbcbba. (15 pts)

GK Which of the following statements are true? (3 pts each)

a. There are regular languages that are not context free.

b. When formally defining a context-free grammar there are four different components that must be defined. Hint: to define a DFA one must define five different components, and the set of states is one of them.

c. For the CFG from problem LO5a, $S \Rightarrow 110000$ is a true statement.

d. The CFG from problem LO5a is ambiguous.

e. For a language L to be **Turing decidable** it is sufficient for M to halt on only those input words that are in L.

f. If a language is Turing decidable, then it is also Turing recognizable.

g. A Turing machine configuration is completely determined by the memory word and the head location.

h. When formally defining a Turing machine there are six different components that must be defined.

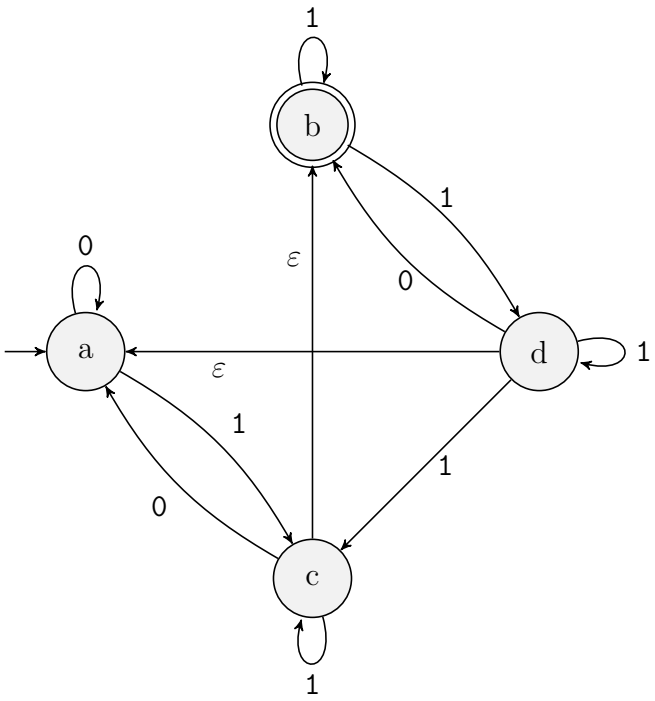
ADV Provide the state diagram of a Turing machine M that accepts the language $\{0^n1^n | n \geq 0\}$ (17 pts). Use your TM to provide a complete computation of M on input 000111. (8 pts).

Makeup LO's (Pass/No Pass)

LO1. Provide a DFA M that describes the language of all words over the alphabet {a,b} that have an even number of a's or (inclusive) and odd number of b's. Show the computation of M on input ababaaba.

LO2. Do the following.

(a) For the NFA N whose state diagram is shown below, provide a table that represents N's δ transition function.



(b) Use the table from part a to convert N to an equivalent DFA M using the method of subset states. Draw M's state diagram. Show the computation of M on input 111000.

LO3. Do the following.

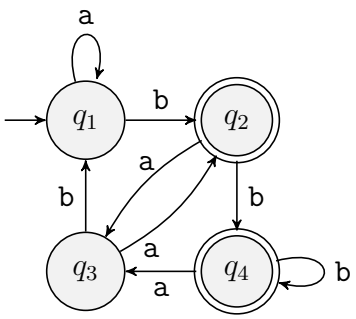
(a) Let A denote the language of binary words that begin with a 1 and represent a prime number (i.e. 2,3,5,7, etc.), while B is the language of all binary words that begin with 11 and have an odd number of 0's. Provide three different words that are members of $A \oplus B$, and three different words that are members of $A \cap B$.

(b) For the languages A and B described in part a, is 11000101101001100 a member of AB? Justify your answer.

(c) Provide a regular expression that describes the language consisting of all words over the alphabet {a,b} that have at least two a's, at most one b, but excludes the word aba.

LO4. Do the following.

(a) Consider the DFA M_1 below which accepts language A and the DFA M_2 shown in part b which accepts language B. Use these DFA's to provide the state diagram of an NFA that accepts the language $A \circ B$.



(b) The DFA M_2 shown below accepts some regular language L. Demonstrate each of the following steps of the GNFA-to-Regular-Expression algorithm to compute a regular expression that describes L: i) create a new accepting state and label it q_5, ii) remove state q_2, iii) remove state q_3, iv) remove state q_4. Redraw the GNFA after each step. Therefore, you must draw four different NFA's.

