Key Concepts Regular languages, Nonregular languages, Pumping Lemma, Pushdown automata.

1. (8 points) Answer True or False. Justifications aren't required for credit for this question, but it's good practice to think about how you would explain why your answer is true. Fix Σ an arbitrary (but unknown) alphabet.

(a) If a language L over Σ is nonregular then its complement $\Sigma^* \setminus L$ is regular. **FALSE**

(b) The collection of all nonregular languages over Σ is countably infinite. **FALSE**

(c) The empty set is a regular language and is a subset of each nonregular language over Σ. **TRUE**

(d) Each nonregular language over Σ is infinite. **TRUE**

(e) For each $w \in \Sigma^*$, there is a regular language Lw such that $w \in Lw$. **TRUE**

(f) For each $w \in \Sigma^*$, there is a nonregular language Lw such that $w \in Lw$. **TRUE**

(g) Every regular language over Σ has exactly one positive integer that is a pumping length for that language. **FALSE**

(h) If a language over Σ is recognized by a PDA then it is nonregular. **FALSE**

2. (6 points) Consider the PDA M over the alphabet {0, 1} given by the state diagram below. For each string below, write ACCEP T if the string is accepted by M and REJECT if the string is rejected by M. Justifications aren't required for credit for this question, but it's good practice to think about how you would explain why your answer is true.

(a) ε **REJECT**

(b) 0 **ACCEPT**

(c) 01 **ACCEPT**

(d) 011 **REJECT**

(e) 001 **ACCEPT**

(f) 00111 **REJECT**

3. (6 points)

(a) Apply the construction to the DFA A with the state diagram below to obtain a PDA AP .

i. In the state diagram of the PDA AP what is/are the label(s) on self-loop arrow(s) from r to r? If there is no self loop at state r in the PDA, write NONE.

a, ε; ε

ii. In the state diagram of the PDA AP what is/are the label(s) on self-loop arrow(s) from s to s? If there is no self loop at state s in the PDA, write NONE.

a, ε; ε

b, ε; ε

iii. In the state diagram of the PDA AP what is/are the label(s) on arrow(s) from r to s? If there is no arrow from r to s in the PDA, write NONE.

b, ε; ε

iv. In the state diagram of the PDA AP what is/are the label(s) on arrow(s) from s to r? If there is no arrow from s to r in the PDA, write NONE.

NONE

(b) True or False: For all DFA M, L(M) = L(MP).

Justifications aren't required for credit for this question, but it's good practice to think about how you would explain why your answer is true.

TRUE