Instructions: The first part of the exam is comprised of 14 multiple choice and 3 true/false questions. Provide your answer to each question (circle only one entry per question) using the scantron sheet that has your name on it**.** No phones/calculators/laptops are permitted during the exam. You have 75 minutes to complete both parts of the exam.

1. Which of the following languages is **not** context-free? Assume *m* is a positive integer and $\Sigma = \{0,1,2\}$.

   A) $\{0^m1^m2^m\}$ B) $\{0^m1^m\}$ C) $\{01^m2^m\}$ D) $\{0^m1^m2\}$

2. A Turing machine is a **decider** if it …

   A) halts on all inputs except the empty string
   B) halts on all inputs
   C) rejects a reasonable number of strings not in the language
   D) never needs to read the entire input to reject an input string

3. Which of the following is **not** a property of a Turing machine?

   A) finite length tape
   B) can read from and write to the tape
   C) finite number of states
   D) can reject without reading entire input

4. Suppose you have a Turing machine with the following δ transitions for $\Sigma = \{0\}$. Assume $\Gamma = \{0, A, B, x\}$ and $Q = \{r, s, t, u, v, w\}$ with β representing a blank character.

$$\delta(r, 0) =< s, A, R >$$
$$\delta(s, 0) =< u, x, R >$$
$$\delta(t, \beta) =< w, \beta, L >$$
$$\delta(v, B) =< r, A, R >$$

   Which of the following is the next machine configuration after *s000* ?

   A) Axso
   B) xu00
   C) xsu0
   D) As00

5. For the same Turing machine from **Question 4**, which of the following is the next machine configuration after *ABr0* ?

   A) *Axwx*
   B) ABxs
   C) Axxu
   D) ABAs

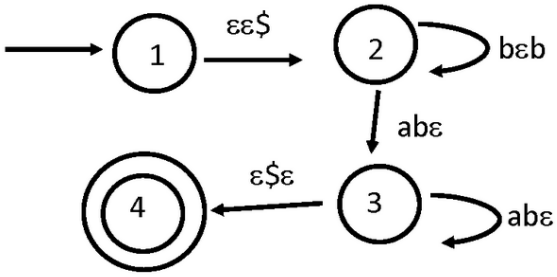
6. For the same Turing machine from **Question 4**, which of the following is the next machine configuration after *AAxt* ?

   A) *Axwx*
   B) Arx0
   C) Axxu
   D) AAwx

7. For the same Turing machine from **Question 4**, which of the following is the next machine configuration after x*vB0* ?

   A) Axwx
   B) xArx
   C) xAr0
   D) Ar00

8. Which string below would **not** be recognized by the PDA below? Assume $\Sigma = \{a, b\}$.



   A) bba B) ba C) bbaa D) bbbaaa

9. Which machine below **cannot** recognize or generate the language $\{1^n0^n | n \geq 0\}$ for terminals 0 and 1?

   A) CFG B) PDA C) DFA D) Turing Machine

10. (True/False) A Turing machine for a *Turing-recognizable* language is **not** guaranteed to halt on all inputs.

    A) true B) false

11. (True/False) The PDAs for non-regular languages **cannot** exploit nondeterminism to recognize words in the languages.

A) true B) false

12. Which of the following sequences of PDA stack operations will execute the grammar rule

$$S \rightarrow 0A1,$$

where 0 and 1 are terminals and *S* and *A* are variables?

A) $\varepsilon S1, \varepsilon\varepsilon A, \varepsilon\varepsilon 0$
B) $\varepsilon S0, \varepsilon\varepsilon A, \varepsilon\varepsilon 1$
C) $\varepsilon S0, \varepsilon A\varepsilon, \varepsilon 1\varepsilon$
D) $\varepsilon 0S, \varepsilon\varepsilon A, \varepsilon 1\varepsilon$

13. Assuming $\Sigma = \{a, b\}$, how many grammar rules in the CFG below are **not** in CNF format?

S → a S b | b Y
Y → b Y | a Y | a

A) 1
B) 2
C) 3
D) 4

14. Consider the language A=$\{0^n1^n0^n1^n \mid 0 \leq n \leq 4\}$. Suppose A is a CFL with pumping length 4. Choose the string $s = 0^3 1^3 0^3 1^3$ from A and partition it into $uvxyz$ so that all three conditions of the Lemma for CFLs hold. Let ε represent the empty string and assume that the statement $y = 0$ means that a single zero occupies the partition y. Which of the following is an **incorrect assumption** that follows according to Conditions 2 and 3 of the Pumping Lemma for CFLs?

A) if *y=0*, *v* could not be ε
B) both *v* and *y* could not contain different symbols (i.e., only one of them can have both 0's and 1's)
C) if $u = \varepsilon$, *y* could not contain more than one 1
D) if $v = 1$, x and y could contain different symbols (i.e., one could have 0s and the other has 1s or vice-versa)

15. Consider the language $B = \{ww^R \mid w \in \{0,1\}^*\}$. Suppose B is a CFL with pumping length *p*. Choose the string $s = 01^p1^p0$ from B and partition it into $uvxyz$ so that all three conditions of the Pumping Lemma for CLFs hold. Let ε represent the empty string and assume that the statement $y = 0$ means that a single zero occupies the partition y. Which of the following is an **incorrect assumption** that follows according to Condition 1 of the Pumping Lemma for CFLs?

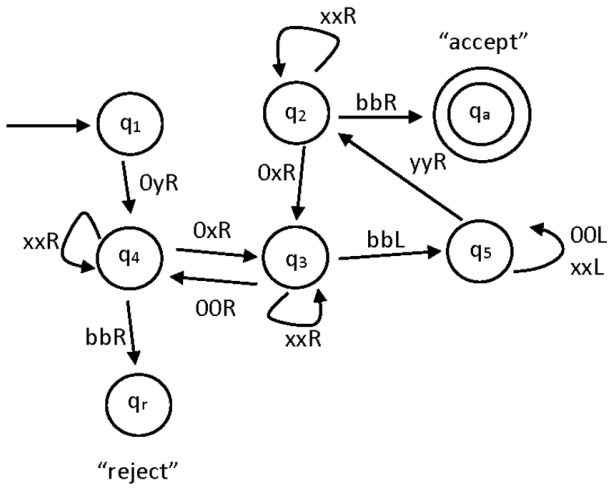
A) if $x = \varepsilon$, there is a way that s can be pumped up (i.e., $s = uv^2xy^2z$ is in B)
B) if *vxy* staddles the midpoint of *s* in anyway, then *s* can be pumped up (i.e., $s = uv^2xy^2z$ is in B)
C) if $x = \varepsilon$, there is a way that s can be pumped down (i.e., $s = uv^0xy^0z$ is in B)
D) if $u = \varepsilon$, then $s = uv^2xy^2z$ cannot be in B

16. (True/False) Any CFG for a CFL (Context-Free Language) can be used to construct a PDA that recognizes the CFL.

A) true B) false

17. Consider the 7-state Turing Machine below that decides a particular language L. The only symbols that can be read from or written to the tape are *x, y*, 0, or *b* (where **b** denotes a blank). The only symbol in the language L is 0 (i.e., zero).

Which of the following is the final machine configuration for the initial machine configuration **$q_1$0000** ?



A) yxb0xq_r B) yxxxbq_a C) yyxxq_a D) yxx0bq_r