



United International University

Department of Computer Science and Engineering

CSI 233/CSE 2233: Theory of Computing

Final Examination : Summer 2019

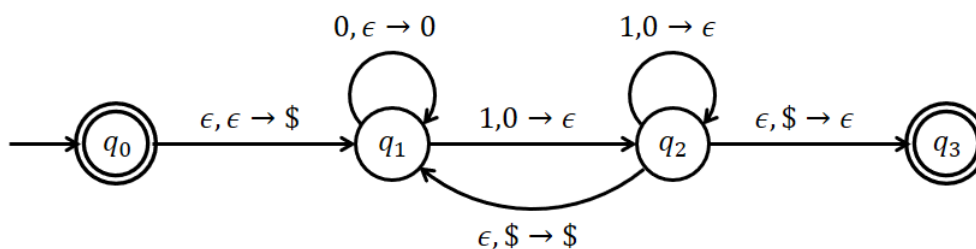
Total Marks: 30 Time: 2 hours

Answer all 8 questions. Numbers to the right of the questions denote their marks.

1. Consider the language $L = \{a^p b^q c^{3p+2} d^r \mid p, q, r \geq 0\}$ 6 + 2 = 8

- (a) Design a Pushdown Automaton for the given language.
 (b) Write the seven components of the PDA you designed.

2. Consider the following state diagram of a Pushdown Automata: 2 + 2 = 4



Show that the following strings are accepted by the given push-down automaton. Show the instantaneous descriptions of the automaton for both strings.

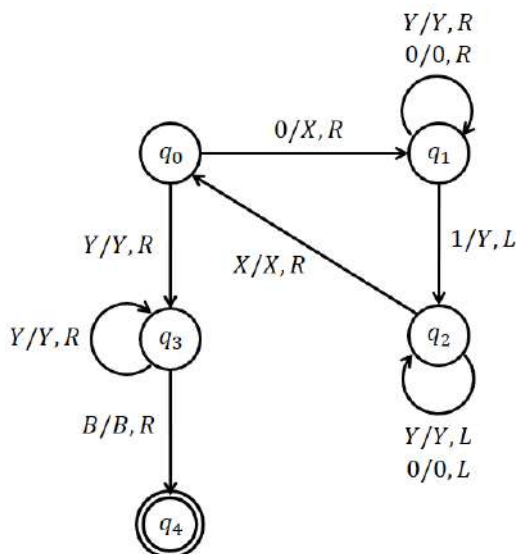
- i. 00011101 ii. 00110101

3. Draw the state diagram of a Turing Machine for the following language: 4

$$L = \{a^{n+2}(cd)^{2n} \mid n \geq 1\}$$

(Sample accepted strings: aaacded, aaaacdedcdcd, aaaaacdedcdcdcdcd)

4. Consider the following state diagram of a Turing Machine: 2 + 2 = 4



Find out whether the following strings are accepted in this Turing Machine. Show description of the input tape for each transition.

- i. 00001111 ii. 0000111

5. Convert the following grammar to Chomsky Normal Form:

4

$$\begin{aligned} S &\rightarrow AS \mid BAC \\ A &\rightarrow A1 \mid 0A1 \mid 0B1 \mid B \\ B &\rightarrow 0B \mid 0 \mid \epsilon \\ C &\rightarrow 1 \mid \epsilon \end{aligned}$$

6. Find out if the following grammar is ambiguous or not, using the string $x + (0 * 1 \% 0)$. If the grammar is ambiguous, show two different parse trees for this string.

4

$$\begin{aligned} E &\rightarrow E + E \mid E - E \mid (E) \mid V \\ V &\rightarrow x \mid y \mid z \mid A \\ A &\rightarrow A * A \mid A \% A \mid C \\ C &\rightarrow 0 \mid 1 \end{aligned}$$

7. Design Context-free Grammars for the following languages:

$4 + 4 = 8$

- (a) $L = \{a^i b^j c^k d^l \mid i = 2l \text{ and } 3j = k\}$
 (b) $L = \{0^x 1^y 2^z \mid x < y \text{ or } y < z\}$

8. Consider the following Context-free Grammar:

$2 + 2 = 4$

$$\begin{aligned} E &\rightarrow E + E \mid E * E \mid (E) \mid N \\ N &\rightarrow 0N \mid 1N \mid 0 \mid 1 \end{aligned}$$

Show a leftmost derivation and a rightmost derivation for the input string $(1 + 10) * 1$.