Department of Computer Science & Engineering
University of Asia Pacific (UAP)

Final Examination **Fall 2021** **3rd Year 1st Semester**

Course Code: CSE 307 **Course Title: Theory of Computation** **Credits: 3**

Full Marks: 150 **Duration: 3 Hours**

Instructions:

1. There are Six (6) Questions. Answer all of them. All questions are of equal value. Part marks are shown in the margins.
2. Non-programmable calculators are allowed.

1. a. Design a Turing Machine for the following expression: **[12]**
   $L = 10^*1^*$

   b. Design a Turing Machine for the following expression: **[13]**
   $L = 0^{n+1}1^n$

2. a. Pushdown Automata (PDA) is more powerful than Finite Automata (FA). Do you agree with the statement? If yes, provide reasoning. **[5]**

   b. Design PDA that recognizes **[20]**
   i) $\{a^n b^n \mid n>0\}$
   ii) $A = \{w \in \{0, 1\}^* \mid w \text{ contains at least three 1s }\}$

3. a. Begin with the grammar: **[25]**

$$
\begin{aligned}
S &\rightarrow 0A0 \mid 1B1 \mid BB \\
A &\rightarrow C \\
B &\rightarrow S \mid A \\
C &\rightarrow S \mid \epsilon
\end{aligned}
$$

   i) Eliminate Є-productions.
   ii) Eliminate any unit productions in the resulting grammar.
   iii) Eliminate any useless symbols in the resulting grammar.
   iv) Put the resulting grammar into Chomsky Normal Form.

4. a. Write Context-free grammars for the following languages: **[16]**
   i) All strings in the language $L = \{a^n b^{2n}, n \geq 0\}$
   ii) All nonempty strings of ‘a’ and ‘b’ that start and end with the same symbol.

b. Consider the context-free grammar: **[9]**

$S \rightarrow S + S \mid S\,S \mid (S) \mid S * \mid a$

Now, the given string is (a + a) * a.

i) Give a leftmost derivation for the string.

ii) Give a rightmost derivation for the string.

iii) Give a parse tree for the string.

5. a. Let L ={a, b} **[15]**

Suppose you have constructed the following language:

"The set of all strings consisting of zero or more instances of a or b, and having a substring *bab*."

i) Write the regular expression for this language.

ii) Draw the corresponding NFA.

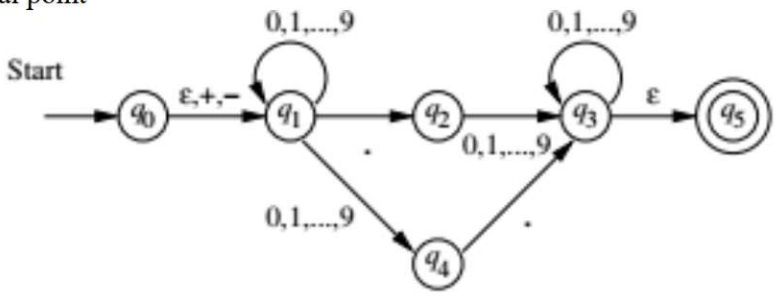
iii) Show the transition table as well DFA diagram.

b. Give a formal description of the Pumping Lemma. Use the Pumping lemma to show that $\{a^n b^n c^n \mid n>0\}$ is not regular. **[10]**

OR

5. a. Consider an NFA that accepts decimal numbers consisting of **[15]**

1. An optional + or - sign
2. A string of digits
3. A decimal point



An ∈-NFA accepting decimal numbers

i) Find out the ∈-closure for each state.

ii) Convert it into DFA.

iii) Construct the Transaction Table for the converted DFA.

b. What is the purpose of the Pumping Lemma in case of regular language? Use the Pumping lemma to show that $\{0^n \mid n \text{ is perfect square}\}$ is not regular. **[10]**

6 a. Minimize the following DFA **using table construction algorithm.** **[15]**

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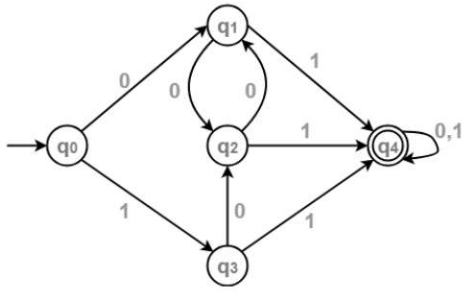

b. Write down the formal definition of Finite Automata. **[10]**

OR

6 a. Minimize the following DFA using **table construction algorithm.** **[15]**

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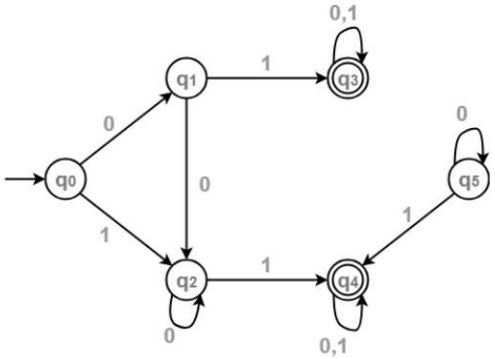

b. State differences: **[10]**

i) NFA and ∈-NFA

ii) NFA and DFA