University of Moratuwa, Sri Lanka

Faculty of Engineering

DEPARTMENT OF COMPUTER SCIENCE & ENG.
B. Sc. Engineering Honors Degree

CS3063 Theory of Computing (2 credits)
Semester 4, 21 Intake (Jan – Apr 2024)

Assignment 2 (Worth: 8%, Due: 22/04/2024 at 11:59 PM)

Read the following instructions carefully.

- Answer all the questions.
- You are allowed to discuss with your colleagues; however, plagiarism will lead to severe penalties.
- If you work with your colleagues to complete the assignment, mention their name and registration number.
- If you refer to other sources (books, web pages, etc.) to complete the assignment, provide references to those sources at the end of your answer script.
- This Assignment consists of 5 questions. Answer all questions.
- Maximum total marks for this Assignment is 100. Marks allocated for each question is indicated at the beginning of each question.
- Create a PDF file containing your answers to Questions 1-4. The file name should be your registration number (e.g., 210196B). Submit the PDF file to Moodle at the relevant Assignment activity.
- Question 5 (programming question) must be done on Moodle, as a Quiz/CodeRunner activity. Go through the instructions carefully before answering the question.

Question 1 [20 marks]

Consider the following CFG G_1.
(Λ is the empty string and 1, 0 are terminals. S is the starting symbol.)

S → A10B
A → 0A | Λ
B → 1B | 0B | Λ

Let L_1 be the language accepted by G_1.

a) Draw a state diagram of a non-deterministic FA (with not more than 3 states) which accepts L_1.
b) Describe L_1 in simple English terms.
c) Convert G_1 into Chomsky Normal Form. Show your work.

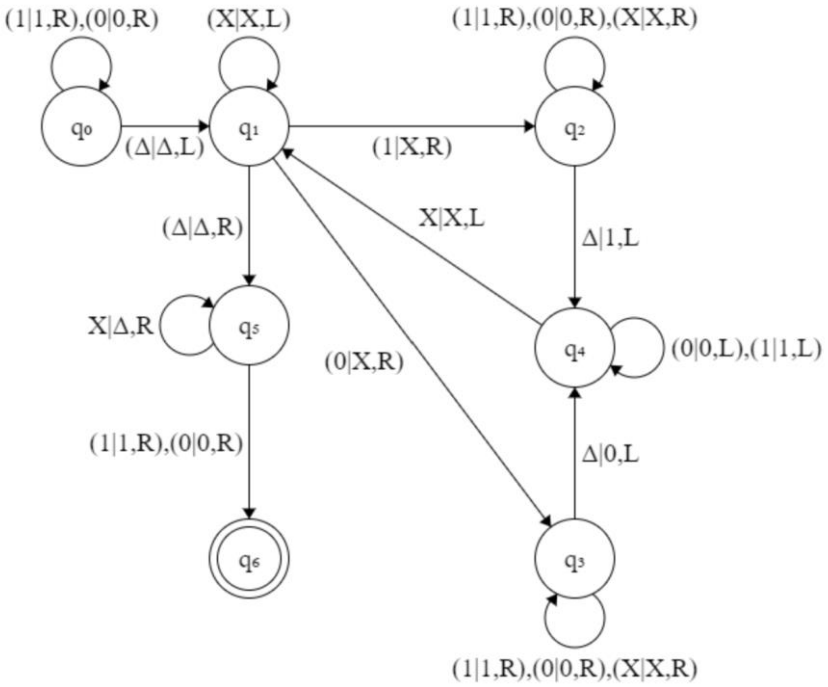
Question 2 [20 marks]

Construct the state diagram for the PDAs that accept the following languages. Note that non-determinism is allowed.

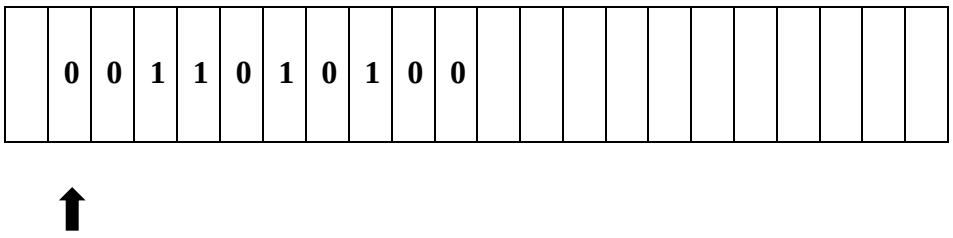
a) $L = \{a^n bbb^{2n} \mid n \geq 0\}$
b) The language over $\Sigma=\{a, b\}$ resembling palindromes but with the exception that characters are doubled on the mirrored half of the accepted string. Examples of accepted strings include: "**aaba**aabbaaaa", "**babba**aabbbbaabb", "**bab**bbaabb". An empty string is also an accepted string.

Question 3 [20 marks]

a) Consider the following Turing Machine



i) Following image shows the initial content (S_1) on the tape.



Show the final content (S_2) on the tape after S_1 is processed by the Turing Machine.

ii) If we need the Turing Machine to produce the final string by replacing '1's with '0's and '0's with '1's in the current S2, using the provided S1 as input, what modifications do we need to do to the given Turing machine? (by only modifying the transitions and keeping the states as it is) Draw the modified Turing machine.

b) Construct a Turing Machine to accept the language $\{10^n101^n \mid n>=0\}$.

Question 4 [20 marks]

Consider the language over parentheses symbols (**Σ={(,)}**) that consists of all strings containing balanced parentheses (each opening symbol has a corresponding closing symbol and the pairs of parentheses are properly nested). Examples of accepted strings include: "((()))", "()()()", "(()(()))". Examples of unaccepted strings include: "))((", "())", "()()(".

a) Construct a state diagram for the PDA that accepts the above language.

b) Construct a state diagram for the Turing Machine that accepts the above language.

Question 5 [15 marks]

This is a programming question. The question is available on Moodle as Quiz/CodeRunner activity labelled as "Assignment-2 Q5 (Programming Q)". You are given a partially completed Python program to implement a top-down parser for a simple programming language. Refer to the instructions in the Moodle question and complete the code.

You are required to design and implement a Python program that simulates a pushdown automaton (PDA) for recognizing strings of the form **ab^naba^nb**, where n is any non-negative integer.

A partially completed Python code is given to you. Fill the missing parts.
Complete the activity in https://online.uom.lk/mod/quiz/view.php?id=374202.

------ END OF THE ASSIGNMENT ------