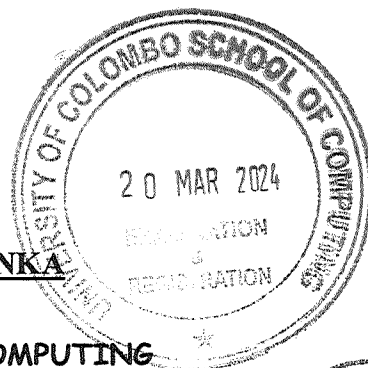# UNIVERSITY OF COLOMBO, SRI LANKA

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

BACHELOR OF SCIENCE IN COMPUTER SCIENCE

Second Year Examination - Semester II - UCSC AY20 [held in March/April 2024]

SCS 2212 – Automata Theory

253

TWO (2) HOURS

Answer ALL questions

Number of Pages = 12   Number of Questions = 4

To be completed by the candidate
Index Number:

Important Instructions to candidates:

I. Students should answer in the medium of English language only using the space provided in this question paper

II. Note that questions appear on both sides of the paper. If a page or a part of this question paper is not printed, please inform the supervisor immediately.

III. Write your index number CLEARLY on each and every page of the Question paper.

IV. This paper consists of 4 questions in 12 pages (including the Cover Page).

V. Answer ALL questions.

VI. Calculators and any electronic device capable of storing and retrieving text including electronic dictionaries, smart watches and mobile phones are NOT ALLOWED.

VII. Do not tear off any part of this answer book. Under no circumstances may this book, used or unused, be removed from the Examination Hall by a candidate.

To be completed by the examiners	
Question No	**Marks**
1	
2	
3	
4	
Total	

Question 1

(a) State the formal 5-tuple definition of a deterministic finite automaton (DFA) M, and formally define the language L, accepted by M.

[5 marks]

(b) Define the concept of a TRAP state in the context of a DFA, and illustrate it using a diagram.

[3 marks]

(c) Construct a deterministic-finite-automaton (DFA) over $\Sigma = \{a,b\}$ for the following criteria.

    i.   Each string accepted by the automaton must include the substring baab

    ii.   Each string accepted by the automaton must start with one symbol and conclude with a different symbol. (eg: awb, bwa, ab, ba,...etc., where w can be any string formed using $\Sigma = \{a,b\}$)

[8 Marks]

(i)

(ii)

(d) Let $M = (Q, \Sigma, \delta, S, F)$ be a non-deterministic finite automaton where $Q = \{q_0, q_1, q_2\}$, $\Sigma = \{a,b\}$, $F=\{q_2\}$, start state $S=q_0$ and the transition function δ defined by $\delta(q_0,a) = \{q_0\}$, $\delta(q_0,b) = \{q_1\}$, $\delta(q_1,a) = \{q_1,q_2\}$, $\delta(q_1,b) = \{q_1\}$, $\delta(q_2,a) = \{q_2\}$, $\delta(q_2,b) = \{q_1,q_2\}$. Let $L(M)$ be the language defined by M.

    i.   Draw a transition diagram and a transition table for M.   [4 Marks]

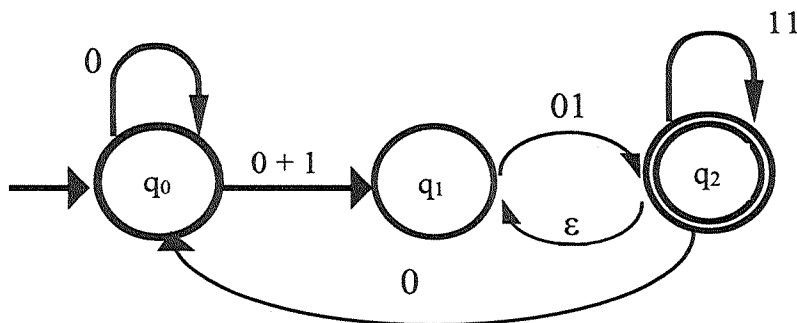   ii.   Convert the given NFA into an equivalent DFA.   [5 Marks]

(i)

(ii)

Question 2

(a) Find all strings in L((10 + 0)* 0 (1 + 10)*) of length less than four.　　[4 marks]

(b) Give a regular expression for $L = \{a^n b^m : n \geq 2, m \geq 1, nm \geq 2\}$

[6 marks]

(c) Consider the following generalized transition graph.

[10 marks]

(i)　　Derive an equivalent generalized transition graph with only two states.
(ii)　　What is the language accepted by this transition graph?

(i)

(ii)

(d) Show that the language $L = \{a^n b^k c^n d^k : n \geq 0, k > n\}$ is not regular. [5 Marks]

Question 3

(a) Statement: *"Finite automata cannot recognize all context-free languages."*

State whether the above statement is TRUE or FALSE, and justify your answer with the aid of examples.

[4 Marks]

(b) Show that the following grammar is ambiguous and construct an equivalent unambiguous grammar. [6 Marks]

```
S → PQ|aaaaaQ,
P → a|Pa,
Q → bb.
```

(c) Let $\Sigma = \{ (,) , [,] \}$; $L = \{$properly nested strings from Σ^* /balanced parenthesis$\}$. For example: [ ] ... [[[]]], ( ) ... ((())), ([]), [()], ( ) [ ], [ ] ( ) are in L, but strings such as [( ]), ([ )] are not.

Construct a Context Free Grammar to accept the above language.　　　　[8 marks]

(d) Consider the grammar with productions. [7 Marks]

S → 00B
A → 1B1|λ
B → A0

Show that the string 00110110 is not in the language generated by this grammar.

Question 4

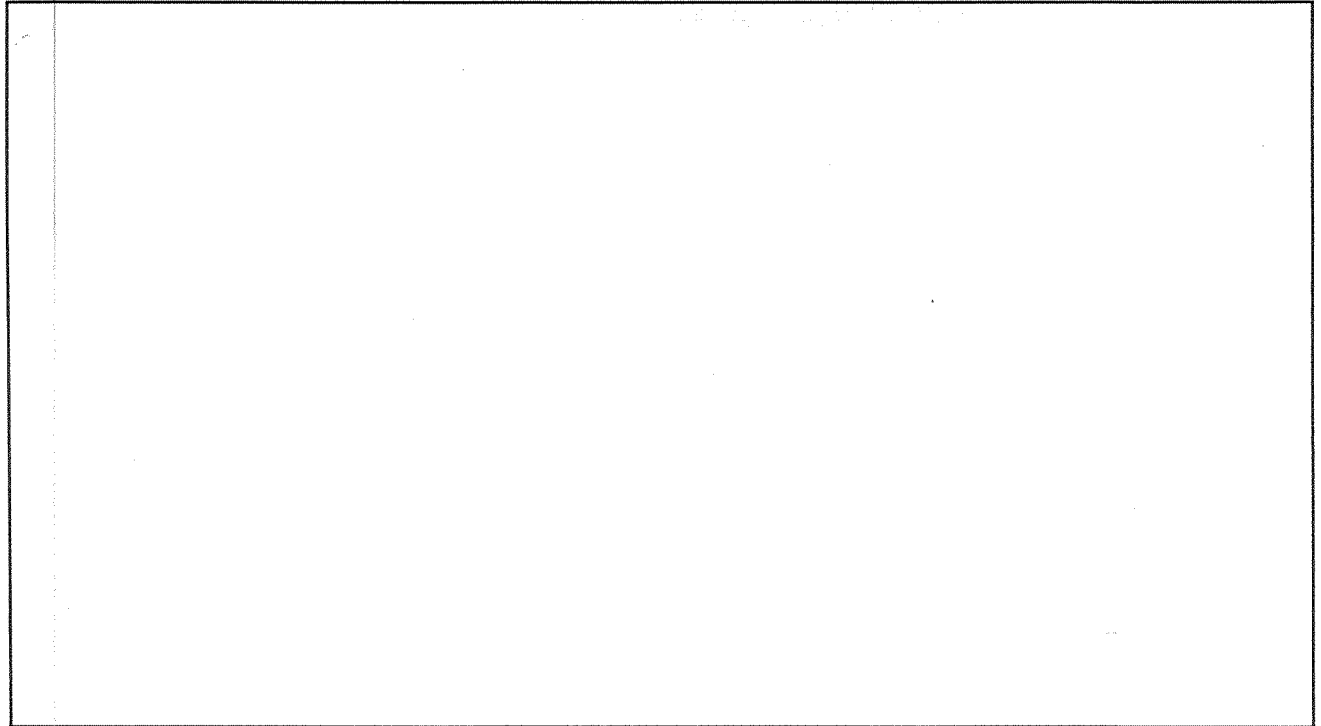(a). Give the formal definition of a Non-Deterministic Pushdown Automata (NPDA).
[3 Marks]

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(b) State two benefits of starting with the $ symbol on an empty stack before reading input characters in a PDA? [3 Marks]

(c) While the language $L_1 = \{wcw^R: w \in \{a,b\}*\}$ is deterministic, the closely related language $L_2 = \{ww^R : w \in \{a,b\}*\}$ is known to be non-deterministic. Explain while justifying your answer with suitable examples. [4 Marks]

(d) Remove all λ – productions, unit productions and useless productions from the following grammar. [7 Marks]

```
S → aA | aBB
A → aaA | λ
B → bB | bbC
C → B
```
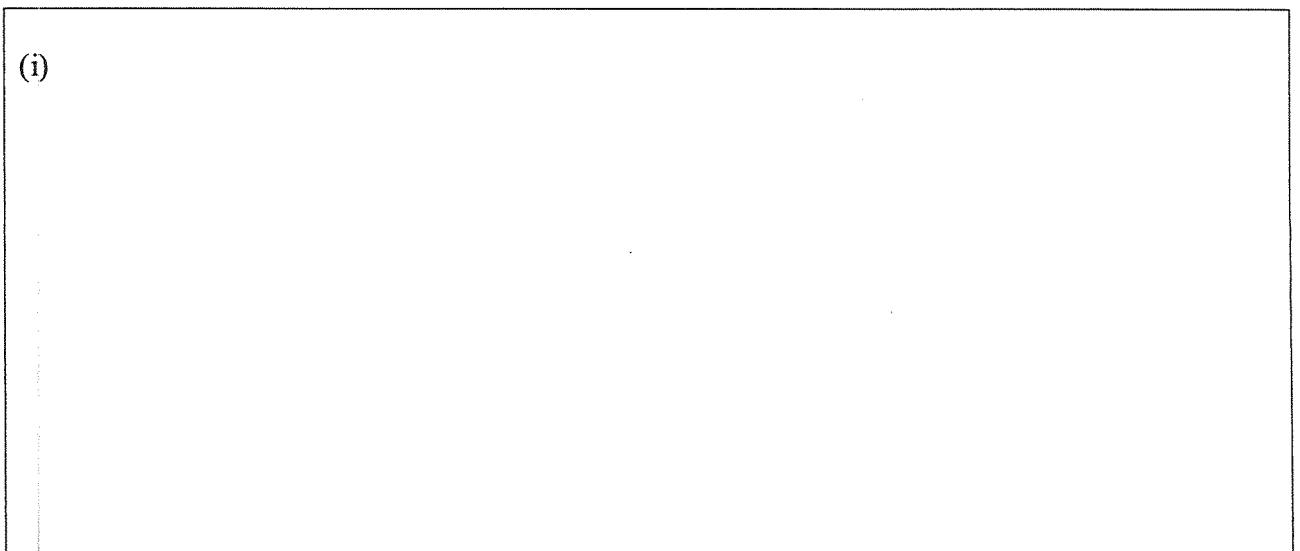
(e) Consider the following grammar:

S → aA
A → aABC |bB| a
B → b
C → c

(i) Transform the above grammar into Greibach normal form. [3 Marks]

(ii) Construct a Non-Deterministic Pushdown Automata that accepts the language defined by the grammar. (Hint: write down the transition rules first.) [5 Marks]

(i)

(ii)

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