ASSIGNMENT/ASSESSMENT ITEM COVER SHEET

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Course Code	**Course Title**
COMP2270	Theory of Computation
(Example) ABCD1234	*(Example)* Intro to University

Campus of Study: Callaghan (eg Callaghan, Ourimbah, Port Macquarie)

Assessment Item Title: Assignment 2 Due Date/Time: 17/05/2020

Tutorial Group (If applicable): Wednesday 8-10am Word Count (If applicable):

Lecturer/Tutor Name: Dr Nasimul Noman

Extension Granted: ○ Yes ○ No Granted Until:

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Assignment 2 – COMP2270

1.

a. True;
For a finite language A and another language B,
where $|L_1| = \{n_1 : n_1$ is a finite number and $B \subseteq A\}$,
$\forall B = |B| = \{n_2 : n_2 \leq n_1\}$

b. True;
For a regular language L_1, where L_1 is composed of strings $\boldsymbol{s_1, s_2, \dots s_n}$ or regular expression $\boldsymbol{s_1} \cup \boldsymbol{s_2} \cup \dots \cup \boldsymbol{s_n}$, every possible subset has an equivalent regular expression.

c. False;
Proof by counter-example:
Where $B = \{w \in \{a, b\}^* : w$ has an a followed by zero or more $b\}$ and
$A = \{w \in \{a, b\}^* : w$ has an optional a is followed by zero or more a $b\}$
Each string in language A is a possible string in language B.
However, B is regular and A is not, as shown in *Fig. 1.1* and *Fig. 1.2.*

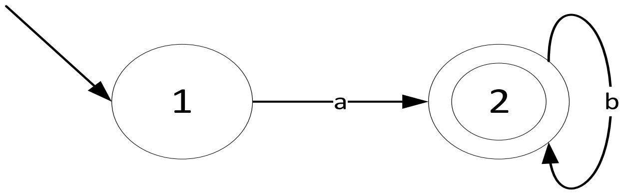

Fig. 1.1: DFSM for language B

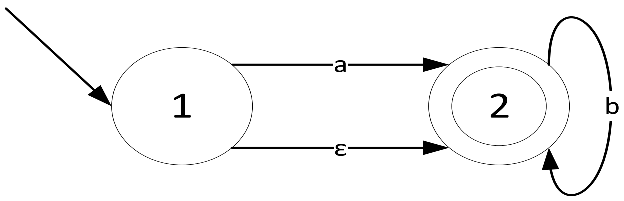

Fig. 1.2: NDFSM for language A

d. False;

2.

a. The context-free grammar G for language $L = \{a^i b^k : k = 4i + 2$ and $i, k \geq 0\}$ is:
$G = (\{S, a, b\}, \{a, b\}, R, S)$
where $R = \{$
$S \rightarrow aSbbbb \mid bb \}$

b. The context-free grammar G for language $L = \{a^n b^p : p \geq n, p - n$ is odd$\}$ is:
$G = (\{S, T, a, b\}, \{a, b\}, R, S)$
where $R = \{$
$S \rightarrow Tb \mid Sbb$
$T \rightarrow aS \mid \varepsilon\}$

3.

a. The bear shot Fluffy with the rifle:

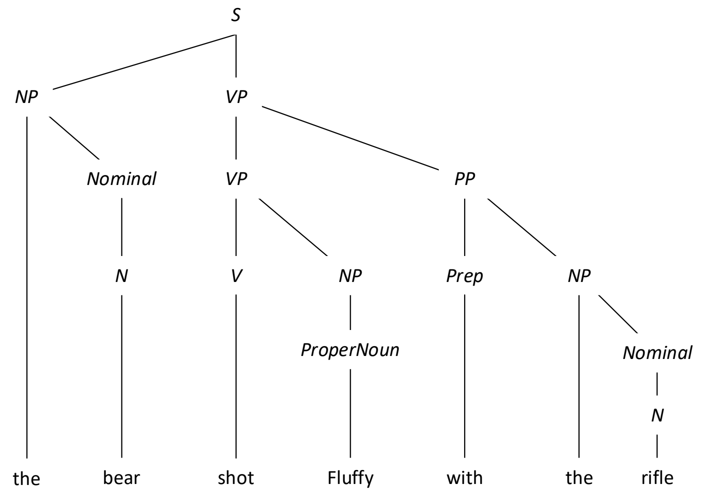

Fig. 3.1: likely parse tree for Q3 a)

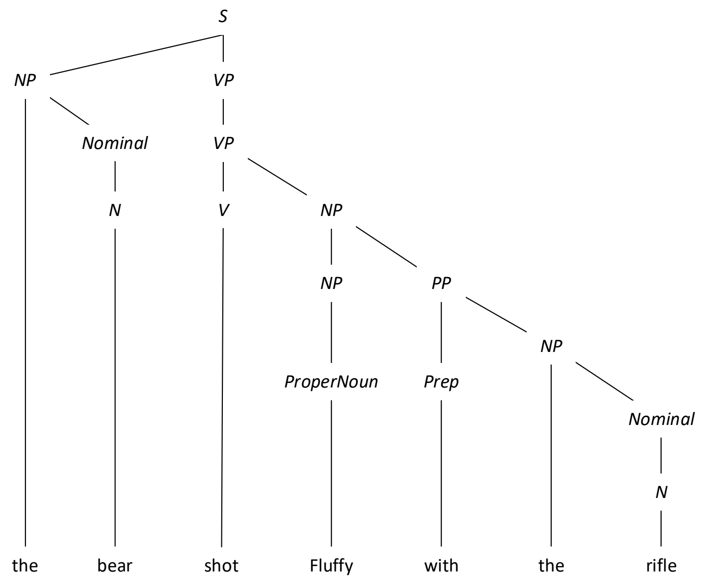

Fig. 3.2: unlikely parse tree for Q3 a)

The likely context is that the bear used the rifle to shoot Fluffy (*Fig. 3.1*). The less-likely interpretation is that the bear shot Fluffy while Fluffy had the rifle (*Fig. 3.2*). Hence, the most probable parse tree is ***Fig. 3.1***.

b. Fluffy likes the girl with the chocolate:

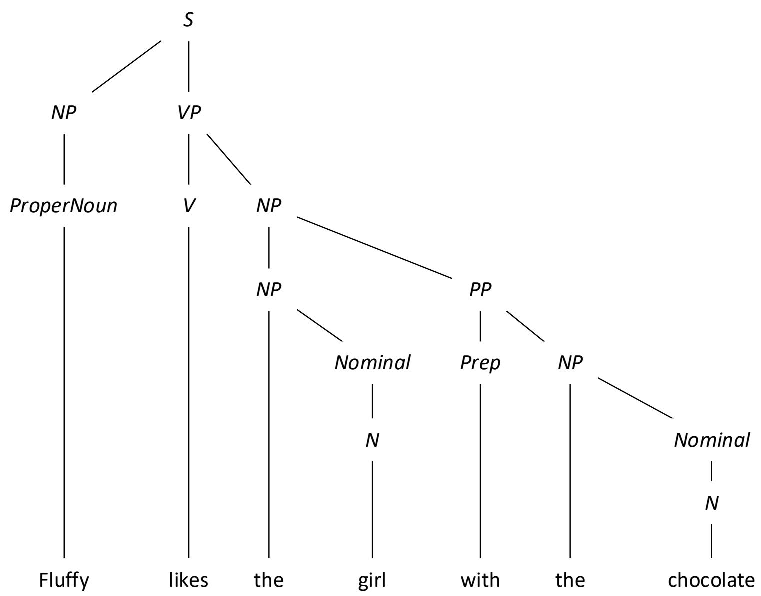

Fig. 3.3: likely parse tree for Q3 b)

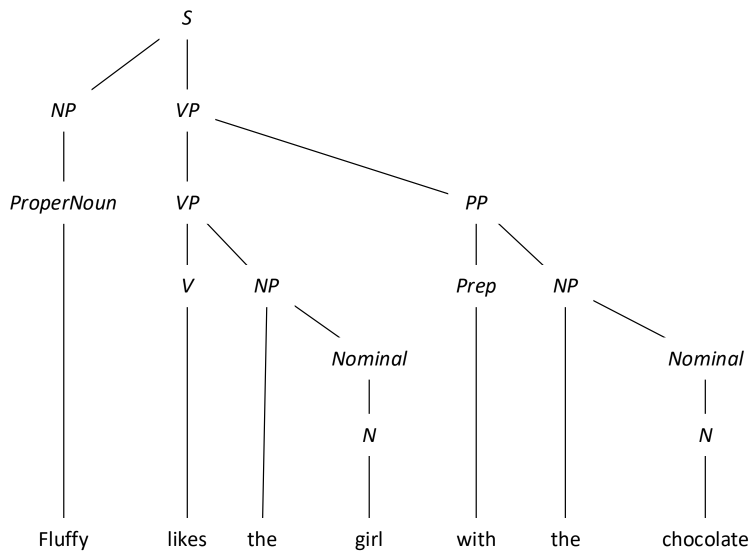

Fig. 3.4: unlikely parse tree for Q3 b)

The likely context is that Fluffy likes the girl who is in possession of the chocolate (*Fig. 3.3*). The less-likely interpretation is that Fluffy uses the chocolate to like the girl (*Fig. 3.4*). Hence, the most probable parse tree is ***Fig. 3.3***.

4.

a. The leftmost derivation of string **ab#cc** is:
S → *T#T* → *ABA#T* → **a** *ABA#T* → **a** *BA#T* → **ab** *BA#T* → **ab** *A#T* → **ab** *#T* → **ab#** *T* → **ab#** C → **ab#c** C → **ab#cc**

b. *G* can be proven ambiguous by showing that at least one string it produces is ambiguous. The string **a#cc** is ambiguous – two possible parse trees for this string are presented in *Fig 4.1* and *Fig 4.2*:

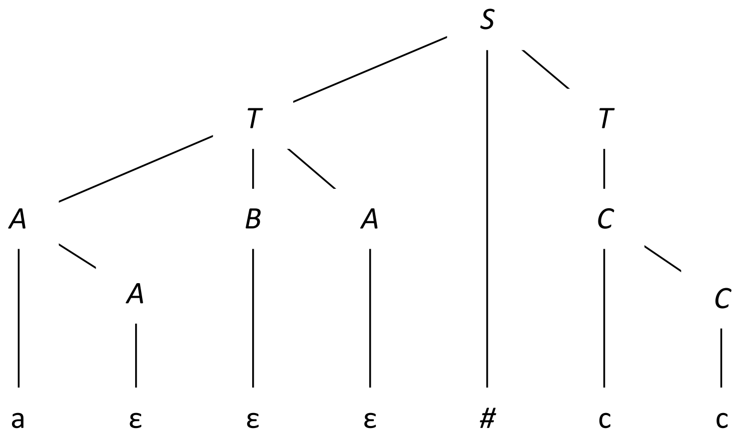

*Fig. 4.1: first parse tree for **a#cc***

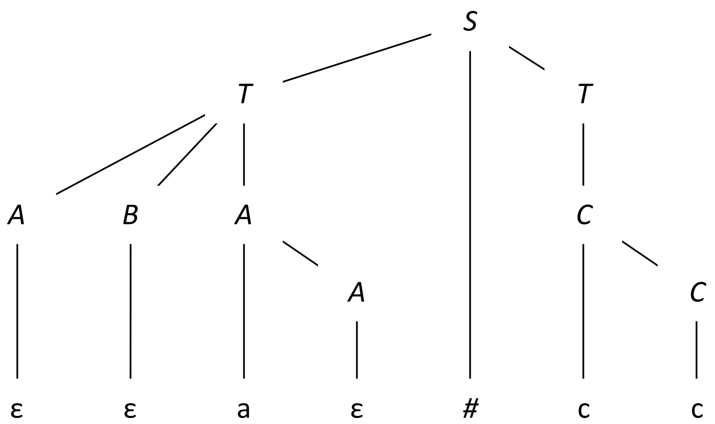

*Fig. 4.2: second parse tree for **a#cc***

5.

a. $L = \{a^i b^k : k = 3i + 3\}$
M = ({1, 2, 3}, {a, b}, {a}, Δ, 1, {3}), where
Δ = {
((1, a, ε), (1, a)),
((1, ε, ε), (2, ε)),
((2, b, aaa), (2, ε)),
((2, ε, aaa), (3, ε)) }

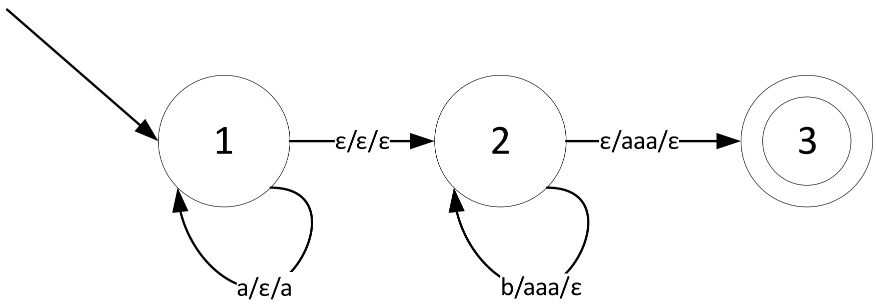

Fig. 5.1: FSM for $L = \{a^i b^k : k = 3i + 3\}$

b. $\{a^i b^j c^k , i > k, 0 \le j < 3, k \ge 0\}$
M = ({1, 2, 3, 4, 5, 6}, {a, b, c}, {a, b}, Δ, 1, {6}), where
Δ = {
((1, a, ε), (1, a)),
((1, a, ε), (2, a)),
((2, b, ε), (3, b)),
((2, ε, ε), (5, ε)),
((3, b, ε), (4, b)),
((3, ε, b), (5, ε)),
((4, ε, bb), (5, ε)),
((5, ε, a), (6, ε)),
((6, c, a), (6, ε)) }

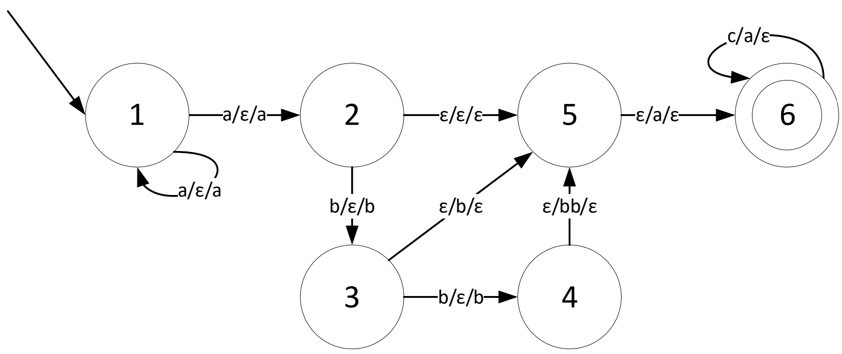

Fig. 5.2: PDA for $L = \{a^i b^k : k = 3i + 3\}$

6.

a. *aa*, *bb*, *aaaa*, *abba*

b. $G = (\{S, T, a, b\}, \{a, b\}, R, S)$, where $R =$
$\{ S \rightarrow aSa \mid aTa \mid bTb$
$T \rightarrow bTb \mid \varepsilon \}$

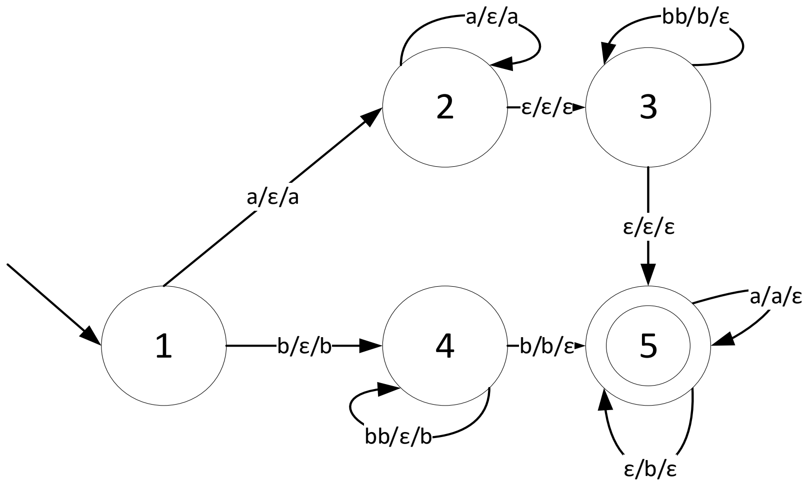

Fig. 6.1: PDA for $L = L_1 \cap L_2$, where $L_1 = \{ww^R : w \in \{a,b\}^*\}$, $L^2 = \{a^n b^* a^n : n \geq 0\}$

c.

d. L is not regular;
With Pumping Theorem and proof by construction,
let $L = \{w \in \{a^n(b \cup b)^* a^n\} : n \geq 0, |w| \geq 2\}$ where $L = L_1 \cap L_2$, and $w = a^k b^k b^k a^k$.
Also let $w = xyz$, $|xy| \leq k$, $y \neq \varepsilon$ and $y = \{a^p : p > 0\}$ and $y \in (aa)^+$.
Where $w_{q=0} = a^{k-p} b^k b^k a^k$, $w \notin L$, therefore L is not regular.

7.

a. True; if the Kleene plus of a language is context-free, then it is trivially obvious that the language itself is context-free. In other words, if $L^1 \cup L^2 \cup \ldots \cup L^n$ is context-free, than all elements of L^+ must be context-free, including L.
b. True;
c. False;

8.

a. $L = \{ww : w \in (ab)^n : n \geq 0\}$ is a regular language. Through proof by construction of a DFSM:

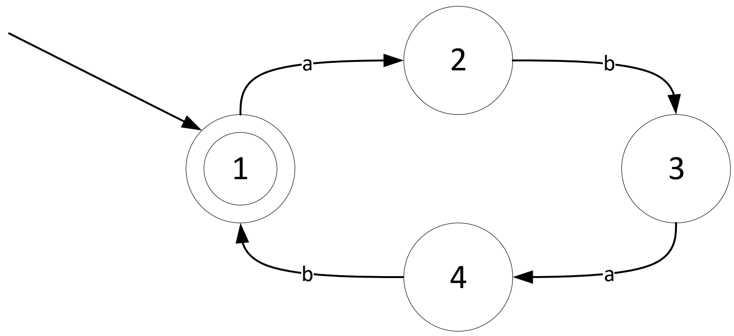

Fig. 8.1: DFSM for $L = \{ww : w \in (ab)^n : n \geq 0\}$

b. $L = \{a^i b^k c^i d^k : i, k \geq 0\}$ is not context-free.
Through proof by contradiction and the Pumping Theorem, assume L to be a context-free language.
Let $w = a^k b^k c^k d^k$.
Where can be written $w = uvxyz$, $|vxy| \leq k$, $|vy| \neq \varepsilon$ **and** ($uv^n xy^n z \in L\ \forall n \geq 0$), we designate sections $|a^k|b^k|c^k|d^k$ to be respectively 1 | 2 | 3 | 4.
If we pump section 1, the string $a^{k+n} b^k c^k d^k$ is not in L.