K i n g S a u d U n i v e r s i t y
College of Computer and Information Sciences
Computer Science Department

جـــامـــعـــة الملك سعود
King Saud University
College of Computer & Information Sciences
Computer Science Department

Course Code:	CSC 339	/ 10
Course Title:	Theory of Computation	
Semester:	2nd (1443)	
Exercises Cover Sheet:	Homework#1	
Due-Date :	**Thursday 24 March 11:59**	

Name		**ID**	

Course Learning Outcomes		**Relevant Question No**	**Full Mark**	**Student Mark**
CLO 1	Identify regular and non-regular languages (K1)	**Part 1**	**3**	
CLO 2	Identify decidable and non-decidable, NP-complete, and reducible problems (K1)			
CLO 3	Produce computing-based solutions using regular expressions, and context free grammar (K2)	**Part 2**	**4**	
CLO 4	Design different machine models (DFA, NFA, PDA, TM) (S1)	**Part 3**	**3**	
CLO 5	Evaluate the language accepted by a machine, a regular expression, and a context free grammar (S1)			
CLO 6	Evaluate the time and space complexity of a Turing machine (S1)			

Question 1

Prove that L = {w ϵ $\{0,1\}^*$ and w has more 1's than 0's }is not a regular language using the pumping lemma.

Assume that L ....regualr Language.................................

Since L is an ..infinite..............................., we can use the pumping lemma.

Let m be .....the critical length of L.....................

Pick a string w such that w ∈ L and length ...$|w| \geq m$................................. .

We choose w= ....$0^m 1^{m+1}$..

We can write w = ...xyz..

such that: |xy| ..$\leq m$.

|y|..≥ 1...

Complete the prove:

......$w = xyz \longrightarrow \overbrace{\underbrace{0\,0\,0}_{x}\underbrace{0\,0\,0\,0\,0}_{y}0}^{m}\underbrace{\overbrace{1\,1\,1\,1\,1\,1\,1\,\cdots\,1\,1}^{m+1}}_{z}$..............................

....

Thus $y = 0^k$ .... $1 \leq k \leq m$..

....

...from pumping lemma $xy^iz \in L$ .... $i \geq 0$ ....

....

......$w' = xy^2z = \overbrace{\underbrace{0\,0\,0}_{x}\,\underbrace{0\,0\,0}_{y}\,\underbrace{0\,0}_{y}\cdots 0\,0\,0}^{m+k}\underbrace{\overbrace{1\,1\,1\,1\cdots 1\,1\,1}^{m+1}}_{z}$..............................

....

.... $0^{m+k}\,1^{m+1} \in L$ ....

....

........but .... w' has more zeros than ones .... $\Rightarrow w' \notin L$.

there is contradiction, therefore our assumption that *L* is a regular language is not true. Thus, *L* is not a regular language.

Question 2

a. Answer each part for the following context-free grammar G.

$$R \rightarrow XRX \mid S$$
$$S \rightarrow aTb \mid bTa$$
$$T \rightarrow XTX \mid X \mid \lambda$$
$$X \rightarrow a \mid b$$

1. What are the variables of G? …………………………………
2. What are the terminals of G? …………………………………
3. Which is the start variable of G? …………………………………
4. Give three strings in L(G). …………………………………
5. Give three strings *not* in L(G). ………………………………
6. True or False: $T \Rightarrow^* aba$.
7. True or False: $T \Rightarrow aba$.
8. True or False: $T \Rightarrow T$.
9. True or False: $T \Rightarrow^* T$.
10. True or False: $XXX \Rightarrow^* aba$.
11. True or False: $X \Rightarrow^* aba$.
12. True or False: $T \Rightarrow^* XX$.
13. True or False: $T \Rightarrow^* XXX$.
14. True or False: $S \Rightarrow^* \varepsilon$.
15. Give a description in English of L(G). ……………………………………………..

(1) R,X,S,T; **(2)**a,b; **(3)** R; **(4)** Three strings in L(G) are ab,ba, and aab; **(5)** Three strings not in L(G) are a, b, and ε; **(6)** True; **(7)** False; **(8)** False; **(9)** True; **(10)** True; **(11)** False; **(12)** True; **(13)** True; **(14)** False; **(15)** L(G) consists of all strings over a and b that are not palindromes.

b. Construct a CFG to generate the following languages over $\Sigma = \{0,1\}$:

1. L={w| w contains at least three 1s}

$S \rightarrow X1X1X1X$
$X \rightarrow 0X \mid 1X \mid \lambda$

2. $L=\{0^{2n}1^n \mid n > 0\}$

$S \rightarrow 00S1 \mid 001$ OR $S \rightarrow 00X1$
$X \rightarrow 00X1 \mid \lambda$

Commented [HAA1]: خطأ متكرر عدم إضافة Xفي البداية أو النهاية

Commented [HAA2]: S→λ خطأ متكرر إضافة
أو
S→00X1
X→λ
هذه القاعدة generates one string only

c. Give a CFG that generates the same language as the regular expression

$$(\mathbf{a} + \mathbf{b})^*(\mathbf{a}^* + (\mathbf{ba})^*)$$

$S \to AB$

$A \to aA \mid bA \mid \lambda$

$B \to C \mid D$

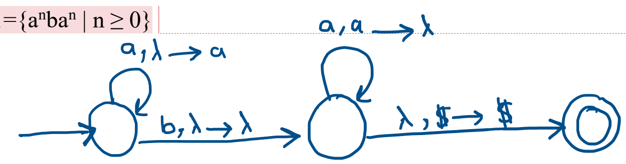
$C \to aC \mid \lambda$

$D \to baD \mid \lambda$

Question 3

Design push-down automaton that recognises the following languages.

a. $L1=\{a^n b a^n \mid n \geq 0\}$

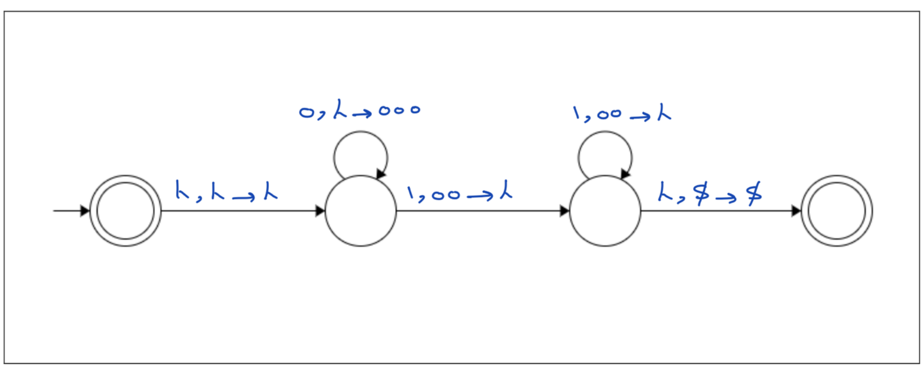


Commented [HAA3]: ملاحظة لا حاجة لإضافة λ transition لهذه PDA لأن أقصر string هو b

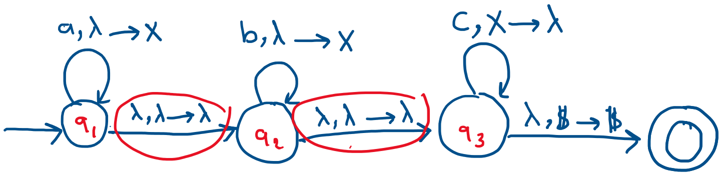
b. $L2=\{ a^{2n} b^{3n} \mid n \geq 0 \}$

Commented [HAA4]: لهذه الفقرة أكثر من طريقة حل وهذه أبسطها بالاستفادة من إمكانية push string in to stack

لكن المهم في الحل أن تقبل جميع الstring التي تنتمي ل L



c. $L3 = \{ a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i + j = k \}$



Commented [HAA5]: خطأمتكرر

الانتقال من q1 ل q2
لا يجب أن يكون على أساس وجود ال b
وضع b, λ→ X يلزم أن تحتوي string على b وهذا غير صحيح