Taibah University
College of Computer Science and Engineering
Department of Computer Science

Form A

Mid 1 – 1st Semester (2020/2021)

CS 301 Theory of Computation

Date: Thursday - 29/10/2020 **Total:** 20 Marks

Time: 09:00 AM **Duration:** one hour

Student Name: **Student No.:** **Section:**

Instructions to students:

1. MCQs answers are to be in the table on next page.
2. This is a closed-book, closed-note examination (NO examination materials).
3. **Mobile phones, calculators and any electronic device are not allowed** in this exam.
4. ...
5. …

For instructors:

CLO	Questions	Assigned marks	Awarded marks
1.1	MCQ (1-4, 8-11) Part2, (1)	4 1	
1.2	MCQ (7, 12-14) Part2, (2)	3 2	
1.4	Part2, (3,4)	4	
		…	
2.1	Part2, (6)	2	
		…	
		…	
2.2	Part2, (5, 7)	4	
	…	…	
Total		**…**	

Part 1 [0.5 mark for each question]

1- Let $\sum = \{ a , b \}$ is an alphabet and the language $L = \{ a^n \ b^n \ : \ n >= 1 \}$ is a language on $\sum$. Find the first (smallest) **four** strings in L. CLO1.1

A		λ , ab, abab , abaaba
B		ab, aabb , aaabbb , aaaabbbb
C		λ , ab, aabb , aaabbbb
D		None of the above

2- Let the language $L = \{ \lambda , ab, aabb \}$. Find its reverse;$L^R$? CLO1.1

A		$L^R = \{ \sum^*, ba, bbaa \}$
B		$L^R = \{ \lambda , ba, baba \}$
C		$L^R = \{ \lambda , ba, bbaa \}$
D		None of the above

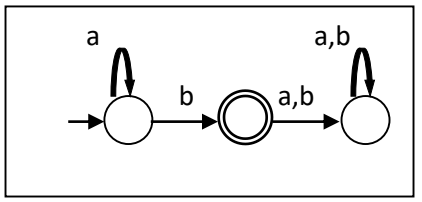
3- Consider the grammar G ={ {S}, {a,b}, S, P} where P is given by the following production rule:S→aSb| λ. Does this grammar accept the sentence: *aab*? CLO1.1

A		Yes
B		No

4- For the grammar in question 3; it generates the language L(G) which can be described as: CLO1.1

A		$L(G) = \{ a^n b^n : n >= 0 \}$
B		$L(G) = \{ a^n b^n : n >= 1 \}$
C		$L(G) = \{ a^n b^m : n >= 0 , m >= 0 \}$
D		None of the above

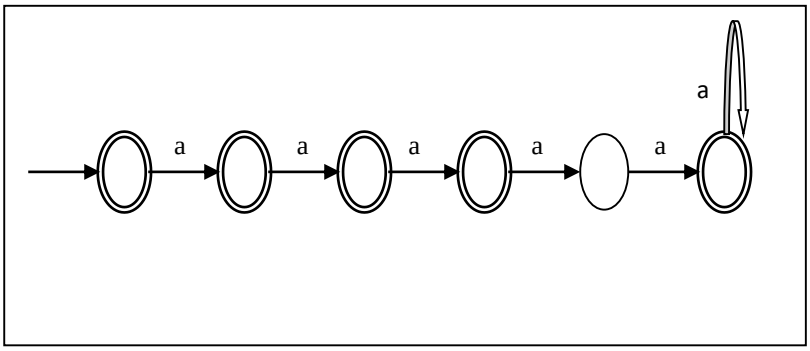
5- The DFA shown in the next figure, has the following regular expression: CLO2.2



A	B	C	D
$(a^* b).(a+b)^*$	$(a^* b).(a+b).(a+b)^*$	$(a^* b)$	None of the above

6- Describe the language represented by the DFA in the next figure: CLO2.2

A	B	C	D
$L = \{ a^n : n >= 0 \}$	$L = \{ a^n : n >= 5 \}$	$L = \{ a^n : n >= 4 \}$	$L = \{ a^n : n >= 0, n \neq 4 \}$



7- What is the language that can be generated by the next grammar? CLO1.2

A	L = *{ λ, ab, abab, ababab, …}*
B	L = *{ab, aabb, aaabbb, …}*
C	L = *{ λ, ab, aabb, aaabbb, …}*
D	L = *{ab, abab, ababab, … }*

G= ({S, A, B}, {a,b}, S, P);

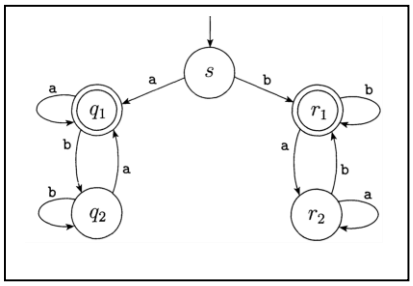
S→aA;

A→bB;

B→aA| λ

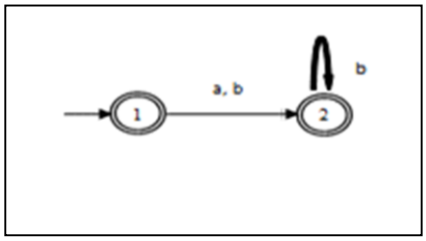
8- The DFA shown in the next Figure describes the following language: CLO1.1

A	Every string starts and ends with the same letter.
B	Every string starts and ends with a different letter.
C	Every string contains only a's or b's but not both
D	Every string must contain some a letters and some b letters.



9- The language of the NFA shown in the next figure is: CLO1.1

A	L= { λ, ab, abb, abbb, abbbb, …, bb, bbb, bbbb, …}
B	L= { a, ab, abb, abbb, abbbb, …,b, bb, bbb, bbbb, …}
C	L= { λ, a, ab, abb, abbb, abbbb, …,b, bb, bbb, bbbb, …}
D	L= { λ, ab, abb, abbb, abbbb, …, b, bbb, bbbbb, …}



10- If the alphabet Σ = {0,1}, the regular expression **r = (0 + 1)* . (0 + 11)** denotes the following language: CLO1.1

A	{ λ , 0 , 1 , 00 , 01 , 10 , 11 , …}	**B**	{ 0 , 1 , 00 , 01 , 10 , 11 , …}
C	{ 0 , 11 , 00 , 011 , 10 , 111 , …}	**D**	{ 11 , 011 , 110 , 111 ,0001 , …}

11- The set of all strings on { 0 , 1 }, terminated by either an 0 or 11 is denoted by CLO1.1

A	(0.1)*(0.11)	B	(0+1)*(0+11)
C	$(0+1)^{+}(0+11)$	D	((0+1) (0+11))*

12- If the alphabet Σ = {0 , 1}, the regular expression r = (0 +1)*.0 (0 + 1)*0.(0+1)* denotes the following language: CLO1.2

A	L = {w∈ Σ^*: w has only two 0's.}	B	L = {w ∈ Σ^*: w has at most two 0's.}
C	L = {w ∈ Σ^*: w has at least two consecutive 0's}	D	L = {w ∈ Σ^*: w has at least two 0's}

13- If the expression, (a+b.c)* stands for the star-closure of {a} ∪ {bc}. Then, which of the following language will be generated? CLO1.2

A	*{ λ, a, bc, aa, abc, bca, bcbc, aaa, aabc, …}*	B	*{ λ, a, bc, aa, abc, cba, bcbc, aaa, aabc, …}*
C	*{ λ, a, cb, aa, abc, bca, bcbc, aaa, aabc, …}*	D	*{ a, bc, aa, abc, bca, bcbc, aaa, aacb, …}*

14- The language generated by the Grammar: S → AS_1, S_1 →aS_1b | λ, A →aA | a is: CLO1.2

A	L(G)={a^nb^m : n>m}
B	L(G)={a^nb^m : n ≥ m}
C	L(G)={a^nb^m : n=m}
D	L(G)={a^nb^m : n<m}

Fill the following table with the final selections (the table only will be checked):

1	2	3	4	5	6	7	8	9	10	11	12	13	14

Part 2

1- If the alphabet Σ = {a,b}, the regular expression **r = (a + b)* . (a + bb).** Create the shortest four strings of this language [1 marks] CLO1.1:

a, aa, ba, bb,

2- Let Σ = {a,b} and μ = {a,b,c} and *h* is defined as: [2 marks] CLO1.2

h(a)= ab,

h(b) = bbc.

If L = {aa, aba}, Find *h(L)*

h(L) =

{abab, abbbcab}

3- If L = {$a^n b^n$: n>=0}, then L^2 = {$a^n b^n a^m b^m$: n>=0, m>=0} [2 marks] CLO1.4

4- Let L = {ab, aa, baa}, what are the shortest three strings in L^* ? [2 marks] CLO1.4

{ λ , ab, aa}

5- Create the language associated with the regular expression r = (aa)*a(bb)*b [2 marks] CLO2.2

Answer

L(r) = $\{a^{2n+1}b^{2m+1} : n\geq 0, m\geq 0\}$

6- Create the Regular Expression associated with the NFA of Figure 4 [2 mark] CLO2.1

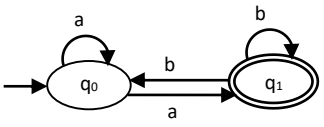


Figure 4

Answer

$a^*\, a(b+ ba^*a)^*$ **OR** $a^+ (b+ ba^+)^*$

7- Construct DFA for the language L= $\{a^nb: n \geq 0\}$ [2 marks] CLO2.2

Answer