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PES University, Bangalore

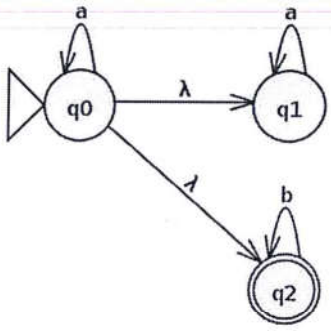
(Established under Karnataka Act No. 16 of 2013)

UE19CS205

END SEMESTER ASSESSMENT (ESA) - B.TECH III SEMESTER – December, 2020

Automata Formal Languages & Logic

Time: 3 Hrs **Answer All Questions** **Max Marks: 100**

1	a	Answer the following: a) Construct a minimal DFA(DFA with minimum states) to accept binary strings that contain at most one occurrence of the string "00". b) Describe the language (i.e., set of all strings) accepted by the following automaton:	8 (5+3)
	b	Construct an NFA/ λ -NFA that accepts the language over the alphabet {a, b} where words contain either **"baa"** as substring or where any ' a' is immediately followed by at least two b's.	6
	c	Given the NFA answer the following :  1) What is the lambda closure of q0, q1 and q2. **[3 marks]** 2) Convert the NFA to DFA using Subset Construction and provide a Transition diagram of converted DFA,clearly mention the start and the final state(s). **[3 marks]**	6 [3+3]
2	a	Construct a regular expression for the regular language of strings over $\{a, b\}$ in which some number of a's is followed by some number of b's with the total length of the string being divisible by 3.	4

State	Input = a	Input = b
$\rightarrow q_0$	q_2	q_1
q_1	q_1	q_1
q_2	q_3	q_2
$^*q_3$	q_3	q_2

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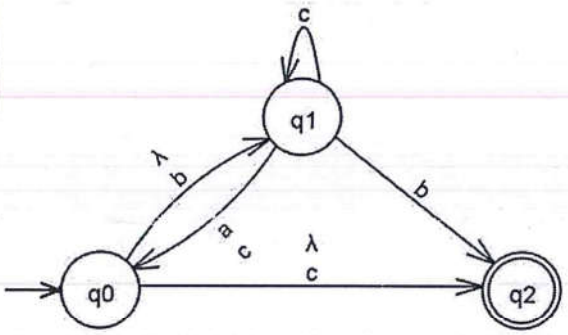
	b	Answer the following: a) What is the reversal of the given language L defined by regular expression 01^*+10^* b) True or False: Regular expressions that do not contain the star operator can represent only finite languages.	4 (2+2)
	c	Consider the following language over $\Sigma = \{ O, E \}$: PARITY = { w | w has even length and has the form E^n or w has odd length and has the form O^n } For example, EE ∈ PARITY, OOOOO ∈ PARITY, EEEE ∈ PARITY, and ε ∈ PARITY, but EEE ∉ PARITY, EO ∉ PARITY, and OOOO ∉ PARITY. Write a **regular expression** and **regular grammar** for PARITY.	6 (3+3)
	d	Convert the finite automata to regular expression using state elimination method: Eliminate the states in the order : q1, q0 	6
3	a	Construct a PDA for the language L = {a^nb^m where m = n * 3 and m,n >=1}. Make sure that the PDA is **deterministic.**	5
	b	Show that the grammar G with productions S → a | aAb | abSb A → aAAb | bS is ambiguous.	5
	c	Consider a language called ADD, which consists of all strings describing unary encodings of two sums that equal one another. For example: 1 + 3 = 4 would be encoded as 1+111=1111 4 = 1 + 3 would be encoded as 1111=1+111 2 + 2 = 1 + 3 would be encoded as 11+11=1+111 2+0+2+0=0+4+0 would be encoded as 11++11+=+1111+ 0=0 would be encoded as = Notice that there can be any number of summands on each side of the =, but there should be exactly one = in the string; thus 1=1=1 ∉ ADD. **Answer the following :** I. Write a CFG that generates ADD. **[5 marks]** II. Show a parse tree for 1+1=11+ and +=+. **[5 marks]**	10
4	a	Prove using pumping lemma that the language L={ $a^nb^mc^m$, where $n \neq m$}, is not a context-free language. **[Note : list all the cases]**	8

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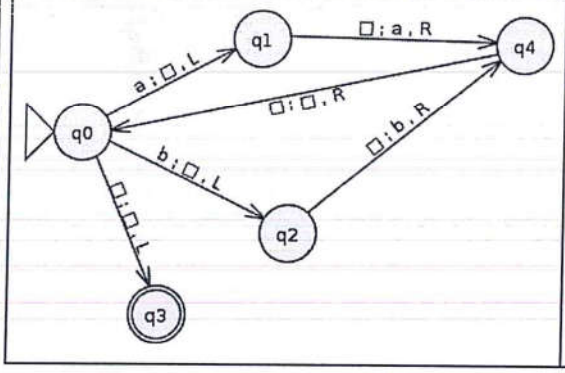
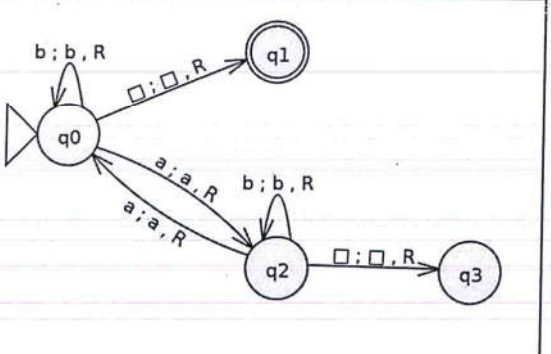
	b	Each of the languages below in the table is of one of the following types: Type DEC. - It is Turing-decidable. Type TMR. - It is Turing-recognizable, but not decidable. Type NTR. - It is not Turing-recognizable. Fill the column "TYPE" with an appropriate answer for each language (DEC or TMR or NTR).	4

#	Language	Type
1	$\mathbf{EQ}_{TM} = \{ <M_1, M_2> \mid M_1, M_2$ are TMs with $L(M_1) = L(M_2) \}$.	
2	$\mathbf{HALT}_{TM} = \{ <M, w> \mid M$ is a TM that halts on input w $\}$.	
3	$\mathbf{EQ}_{DFA} = \{ <M_1, M_2> \mid M_1, M_2$ are DFAs with $L(M_1) = L(M_2) \}$.	
4	$\overline{A_{TM}}$ [Complement of A_{TM}] where $A_{TM} = \{ <M, w> \mid M$ is a TM that accepts string w $\}$.	

	c	What is the function computed by the following Turing Machines:	8 (4+4)

Turing Machine 1	Turing Machine 2
	

5	a	Let P(x) be "x is a professor" Q(x) be "x is ignorant" R(x) be "x is vain" Express the following statements using quantifiers, logical connectives, and the predicates given above, where the domain consists of all people. (i) No professors are ignorant. (ii) All ignorant people are vain.	4 (2+2)
	b	Use Resolution Refutation to show that the hypotheses(premises) P1 : "If Superman were unable to prevent evil, then he would be powerless", P2 : "If Superman were unwilling to prevent evil, then he would be evil-minded", P3 : "If Superman were able and willing to prevent evil, then he would prevent evil", P4 : "If Superman exists, then he is neither powerless nor evil-minded", and P5 : "Superman does not prevent evil" imply the conclusion **Q :** "Superman does not exist".	10

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[Hint : Convert all the statements P1, P2, .. P5 and the conclusion Q to sentences in Propositional logic. Assume the following propositional symbols while doing the conversion:
prev: Superman prevents evil
able: Superman is able to prevent evil
willing: Superman is willing to prevent evil
pless: Superman is powerless
evilm: Superman is evil-minded
exists: Superman exists

Marks distribution:
5 marks : To convert the statements and the conclusion to sentences in Propositional logic using given propositional symbols.
5 marks : To prove the conclusion Q using resolution refutation.]

c) Consider a group of men and women. Let, — 6

M(x) : x is a man
W(x) : x is a woman
L(x, y) : x likes y

Match the following assertions with their equivalent logical expressions using the above predicates.

1	Some men like all the women	a	$\exists x(M(x) \wedge \forall y(W(y) \rightarrow L(y, x)))$
2	For every man, there is at least one woman who likes him	b	$\exists x(M(x) \wedge \forall y(W(y) \rightarrow L(x, y)))$
3	Some women does not like any man	c	$\exists x(M(x) \wedge \exists y(W(y) \wedge L(x, y)))$
4	There is a man whom all women like	d	$\forall x(M(x) \rightarrow \exists y(W(y) \wedge L(y, x)))$
5	There is a man who likes a woman	e	$\forall x(W(x) \rightarrow \forall y(M(y) \rightarrow L(x, y)))$
6	All women like all men	f	$\exists x(W(x) \wedge \forall y(M(y) \rightarrow \neg L(x, y)))$

Provide your answer in the following format only:

Assertions	1	2	3	4	5	6
Equivalent logical expression(**write your answer as a,b,c,d,e,f only** - one of them matches each assertion).						