RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

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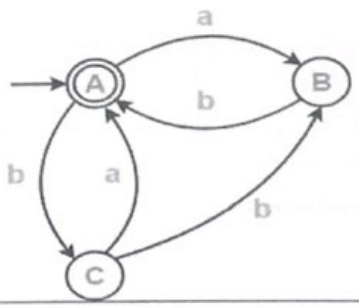
4G2 - V2 (25 - 49)

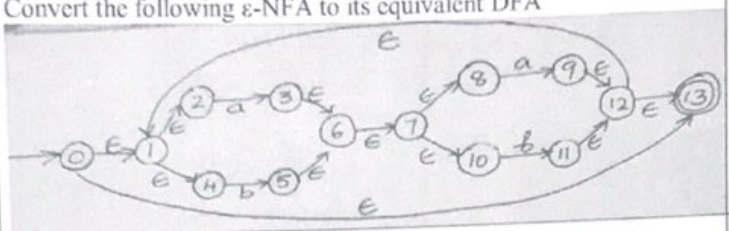
Academic year 2020-2021 (Even Sem)

DEPARTMENT OF

INFORMATION SCIENCE & ENGINEERING

Date	4th June 2021	Maximum Marks	50
Course Code	18IS46	Duration	120 Min
Sem	IV Semester	Closed Book Online Test-1	
THEORY OF COMPUTATION			

Sl. No.	Questions	M	BT	CO
1.a	Convert the below grammar to CNF form: S → ASB | ε A → aAS | a B → SbS | A | bb	06	L3	CO3
1.b	Write regular expressions for the following languages: Σ ={a,b} i) L1 = {W | W has exactly 2 number of a's} ii) L2 = { W | W has starting and ending with the same symbol}	04	L4	CO1
2.a	Given ∑ = {a, b}, Construct NFA where second symbol from RHS is 'a'. Convert the NFA to its equivalent DFA using subset construction method.	06	L4	CO1
2.b	Find CFG's to generate the following languages: i) $L1 = \{a^n b^n c^m d^m \mid n, m \geq 1\}$ ii) $L2 = \{a^i b^j c^k \mid j = i \text{ or } j = k\}$	04	L5	CO3
3.a	State and prove pumping lemma for regular languages.	05	L3	CO1
3.b	Obtain Regular Expression for the given Finite Automata using State Elimination Method. 	05	L3	CO1

4.a	Convert the following ε-NFA to its equivalent DFA 	06	L3	CO1
4.b	Eliminate left recursion from the following grammar: i) S → A A → Ad / Ae / aB / ac B → bBc / f	04	L3	CO3
	ii) E → E + T / T T → T * F / F F → id			
5.a	Show that class of regular languages are closed under Kleene star and difference.	04	L2	CO1
5.b	Define the following: i) DFA ii) Yield of a tree iii) Ambiguous grammar iv) Linear grammar and its types v) Greibach Normal Form vi) ε-CLOSURE	06	L1	CO1

BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars		CO1	CO2	CO3	CO4	L1	L2	L3	L4	L5	L6
	Test	Max Marks	36	--	14	--	6	4	26	10	4	--

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ToC CIE-1 Solution. 04/06/2021.

V-2

1. a] Given: $S \to ASB \mid \varepsilon$

$A \to aAS \mid a$

$B \to SbS \mid A \mid bb$.

Eliminate ε-production

$S \to ASB \mid AB$ → 02M.

$A \to aAS \mid a \mid aA$

$B \to SbS \mid A \mid bb \mid Sb \mid bS \mid b$

Eliminate unit production → 01M

$S \to ASB \mid AB$

$A \to aAS \mid a \mid aA$

$B \to SbS \mid bb \mid Sb \mid bS \mid b \mid aAS \mid a \mid aA$

No useless variables, → 01M

~~Eliminate~~ convert to CNF:

$S \to X_1D \mid AB$

$A \to XaX_1 \mid Xa \mid XaA$ → 02M

$B \to SX_2 \mid XaXb \mid SXb \mid XbS \mid Xb \mid XaX_1 \mid Xa \mid XaA$.

$X_1 \to AS$

$X_2 \to XbS$

$Xa \to a$

$Xb \to b$

$\Sigma = \{a, b\}$

1b] $L_1 = \{ w \mid w$ has exactly 2 number of a's $\}$

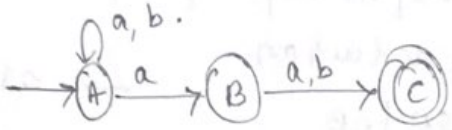
$\cdot b^* a b^* a b^*$ → 2M

$L_2 = \{ w \mid w$ has starting & ending with the same symbol $\}$

$[\, a\ (a+b)^*\ a]_+ [b\ (a+b)^* b] + [a+b+\varepsilon]$

↳ 2M.

2a]



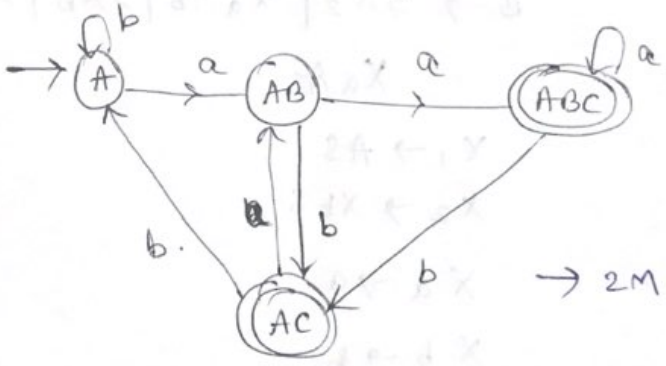
→ 2M.

	a	b
→ A	{A, B}	A
B	C	C
* C	{ }	{ }.

⇒

	a	b
→ [A]	[AB]	[A]
[AB]	[ABC]	[AC]
* [ABC]	[ABC]	[AC]
* [AC]	[AB]	[A]

→ 2M



→ 2M

2b] $L_1 = \{ a^n b^n c^m d^m \mid n, m \geq 1 \}$

$S \rightarrow AB$

$A \rightarrow aAb \mid ab$ $\rightarrow 2M$

$B \rightarrow cBd \mid cd$

$L_2 = \{ a^i b^j c^k \mid j = i \text{ or } j = k \}$ $\rightarrow 2M$

$S \rightarrow AT \mid UC$

$A \rightarrow aA \mid \epsilon$

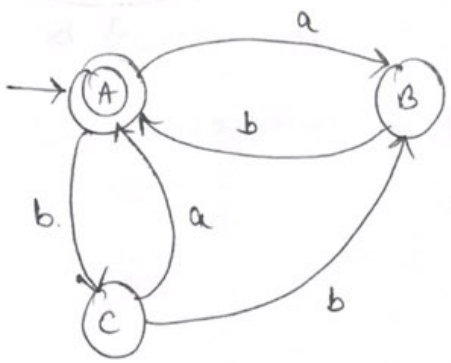
$B \rightarrow cC \mid \epsilon$

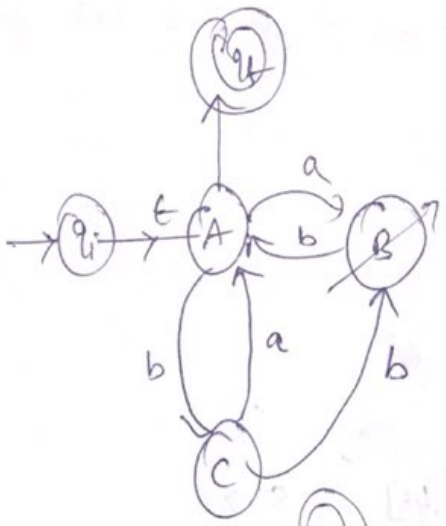
$T \rightarrow bTc \mid \epsilon$

$U \rightarrow aUb \mid \epsilon$

3a] Statement of pda - 2M
general proof - 3M.
don't consider any lang.

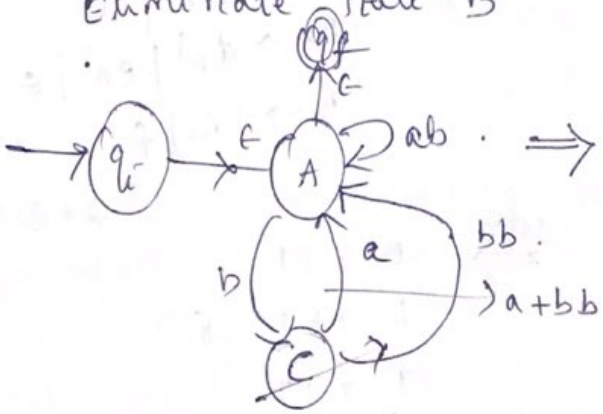
3b]

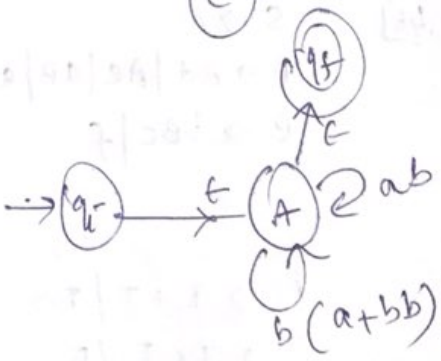




Each step carries 1M

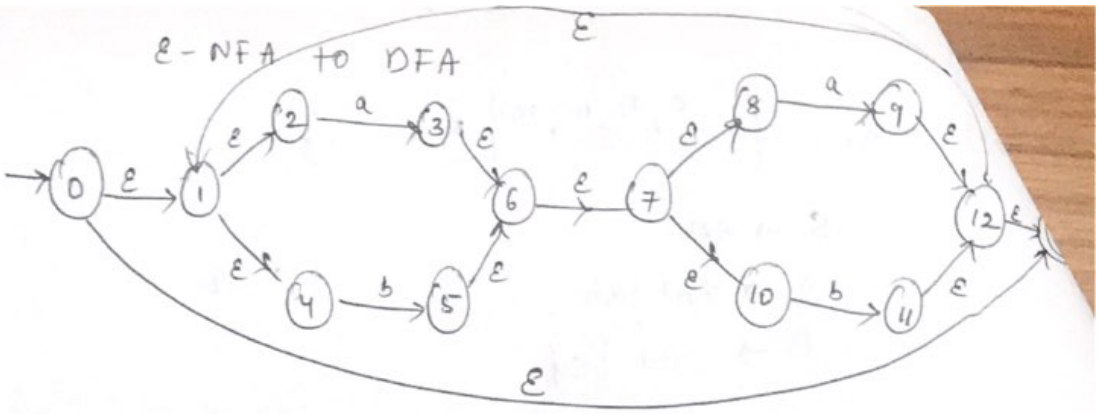
Eliminate state B





Eliminate A $\Rightarrow (ab + b(a+bb))^*$

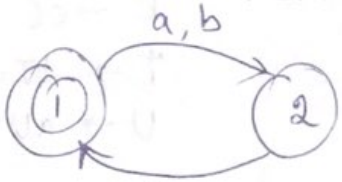
4a] ε-NFA to DFA



Find ECLOSE of given states on $\Sigma = \{a, b\}$ → 4M

Find initial & final states. → 1M.

Final DFA is



→ 1M

4b] $S \to A$
$A \to Ad \mid Ae \mid aB \mid ac$
$B \to bBc \mid f$

Soln ⟹

$S \to A$
$A \to aBA' \mid acA'$
$A' \to dA' \mid eA' \mid \epsilon$
$B \to bBc \mid f$

2 * 2 = 4M

$E \to E + T \mid T$
$T \to T * F \mid F$
$F \to id$

Soln ⟹

$E \to TE'$
$E' \to +TE' \mid \epsilon$
$T \to FT'$
$T' \to *FT' \mid \epsilon$
$F \to id.$

5a] Proof: Class of regular Languages are closed under Kleene star & difference → 2 * 2 = 4
with diagram

5b] Definition

i) DFA: @ $M = (Q, \Sigma, \delta, q_0, F)$
Define all the components.

ii) Yield of a tree: read only leaves of a parse tree without reading ε.

iii) Ambiguous grammar: string has 2 LMD, 2 RMD or 2 parse trees.

iv) Linear grammar → def^n
↳ Left
↳ right.

v) GNF: $A \to a\alpha$.
$a \in T$ & $\alpha \in V^*$.

vi) ε-closure: ECLOSE(q) is the set of all states which are reachable from q on ε transitions only.
i.e ECLOSE(q) = q.