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Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

Winter Semester 2023-24

Continuous Assessment Test – II

SLOT: B2+TB2

Programme Name & Branch: B.Tech

Course Name & Code: Theory of Computation & BCSE304L

Class Number (s): VL2023240500789, VL2023240501047, VL2023240501029, VL2023240500774, VL2023240500845, VL2023240500760, VL2023240501015, VL2023240500784, VL2023240501045, VL2023240500861, VL2023240501036, VL2023240500763, VL2023240501026, VL2023240500766, VL2023240500771, VL2023240501043, VL2023240500797, VL2023240501049, VL2023240501037, VL2023240501042, VL2023240501051, VL2023240501014.

Faculty Name (s): NAVAMANI T M, KONATHAM, SUMALATHA, KANAGARAJ R, KANNADASAN R, MADIAJAGAN M, SATHIYA KUMAR C, MOHANA CM, KRISHNA RANI, SAMAL K, UMAMAHESWARI M, SARITHA MURALI, ANAND BIHARI, ANAND M, KRISHNARAJ N, ARUMUGA, ARUN R, SHALINI L, SARWESH P, RAJARAJAN G, SABYASACHI KAMILA,SOMASUNDARAM S K, HUSSAIN AHMED CHOWDHURY, UMA PRIYA D, VISHNUPRIYA.

Exam Duration: 90 Min. **Maximum Marks: 50**

Q. No.	Question	Max Marks	CO	BL
1.	a) The derivative of a language for a string x is defined as follows: $L_x = \{ y \mid xy \in L\}$. 1) what is L_{aa} for the language $L=\{a^{n+1}b^n \mid n \geq 1\}$. (1mark) 2) what is L_b for the language $L=\{a^{n+1}b^n \mid n \geq 1\}$. (1 mark) 3) Prove that when L is regular, the derivative of L (ie., L_x) is also regular. (3 marks)	5	CO3	BL3
	b) Consider the language $L_1=\{a^pb^qa^r \mid pq,r \geq 1$ and $p+q \neq r\}$. Prove or disprove that the language L is regular.	5	CO3	BL2
2.	a) Design a CFG for the language Υ = **$\{a^nb^ma^{2n}$: n, m ≥ 0}.**	5	CO3	BL2
	b) Consider the grammar S → 0S1 | 1S0 | λ, where S is the start symbol, {0,1} are terminals . You can see that for every 0 there is a 1 and vice versa in the rule (other than S →λ). Is the grammar generates the language $L_2 = \{w : |w|_0 = |w|_1\}$ where $|w|_a$ refers to the occurrences of a in w. If not, justify with a string in the language L_2 that cannot be produced by the given grammar rules. What further changes you need to do in the given grammar in order to generate L_2.	5	CO3	BL2
3.	a) Construct the CYK algorithm for the following CFG and check whether the string **"aabcb"** is derivable from the grammar. The Start Symbol is A.	10	CO3	BL3

	A→ CB **B → DC | b** **C → BD | a** **D → AD | c**			
4.	a) Construct the given Context Free Grammar **G=(V,T,P,S)** into Chomsky normal form. P is the start symbol. **P→ RPT** **Q→ RP/Ra** **R→ bRPR|b|**ε **T→ PaP|R|aa**	5	CO3	BL3
	b) Derive the CFG for the given Context Free Language **L= {v^r i^{r+s} t^s | r, s ≥ 0}** and check the ambiguity of the given grammar.	5	CO3	BL3
5.	The language L have a strings of balanced "#" symbol and "@" symbol : every "#" symbol can be paired with a unique subsequent of "@" symbol , and every "@" symbol can be paired with a unique preceding "#" symbol. Moreover, the string between any such pair has the same property. Derive the language for the given condition and Construct the PDA for the derived language.	10	CO4	BL4

CAT 2 — B2 + TB2.

1. a) i) $L_x = \{ y \mid xy \in L \}$ $\quad L = \{ aab, aaabb, aaaabbb, \ldots \}$

$L_{aa} = \{ a^{n+1} b^n \mid n \geq 1 \}$ $\quad L_{aa} = \{ b \mid aab \in L \}$

$L_{aa} = \{ aa \rightarrow \underbrace{a^{n-1} b^n}_{y} \}$

$= \{ a^{n-1} b^n \mid n \geq 1 \}$

$L_{aa} = \{ b^n, ab^n, a^2 b^n, a^3 b^n \ldots \}$ ✓

(ii) $L_b = \{ y \mid by \}$ $\quad xy \in L$

$L_b = \phi$ because the string doesnot starts with b.

(iii) if L is regular Then the derivative also regular

$L_a = \{ a^n b^m \mid n \geq 1, m \geq 1 \}$

it is possible to construct FA.

1. b

1. b. $L_1 = \{ a^p b^q a^r \mid p, q, r \geq 1 \text{ and } p+q \neq r \}$ is Regular?

There is no mechanism to keep record of p+q is whether equal or not equal to r. Therefore it is not possible to implement by an automata. Therefore given language is not regular.

2) a) $Y = \{a^n b^m c^{2n} / n, m \geq 0\}$ Give CFG.

$n=0, m=0$ ε.

$n=1$ $m=0$ a cc

$n=0$ $m=1$ b

$n=1$ $m=1$ a b cc.

$S \rightarrow aScc \mid A$.

$A \rightarrow bA \mid \varepsilon$.

Derivation. w = a a b cccc

$S \rightarrow aScc$

$\rightarrow aaScccc$

$\rightarrow aaAcccc$

$\rightarrow aabAcccc$

$\rightarrow aab\varepsilon cccc$

$\rightarrow aabcccc$.

2) b)

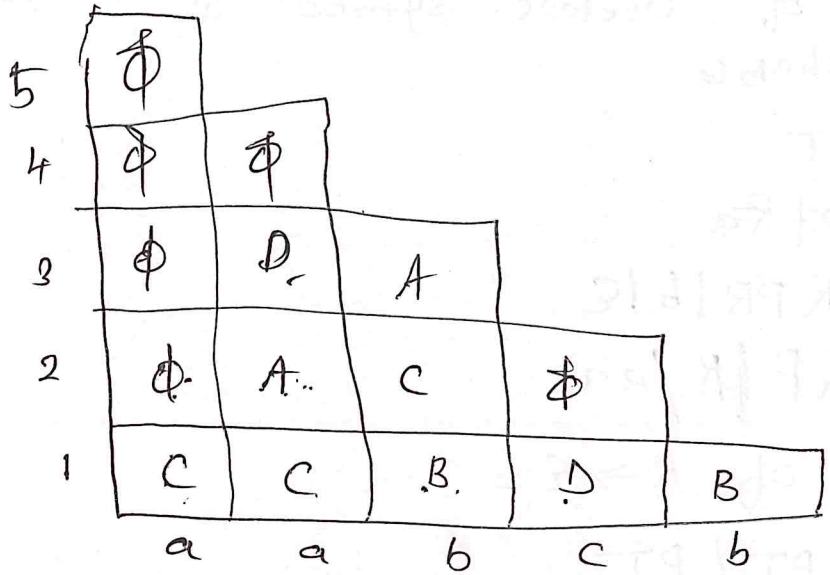
3) $A \to CB$

$B \to DC/b$

$C \to BD/a$

$D \to AD/c$. $w = aabcb$

Given grammar is in CNF.



$i=1, j=3\ k=1$

$V_{13} = V_{11}\ V_{22}$

$C\ \ A$

CA.

$= \phi$

$i=1\ j=3\ k=2$

$V_{13} = V_{12}\ V_{31}$

$\phi \cdot B$

$= B$

$= \phi$

$i=2\ j=3\ k=1$

$V_{23} = V_{21}\ V_{22}$

$= C\ \ A$

$= CA$

$= \phi$

$i=2\ j=3\ k=2$

$V_2 = V_{22}\ V_{31}$

$= A\ \ D$

$= AD \in D$

$= D$

$w = aabcb$ is not belongs to the given grammar.

4) a) G: $P \to RPT$

$Q \to RP / Ra$

$R \to bRPR / b / \varepsilon$

$T \to PaP / R / aa$.

(i) Removal of useless symbol Q since it is not reachable.

$P \to RPT$

~~$Q \to RP / Ra$~~

$R \to bRPR / b / \varepsilon$

$T \to PaP / R / aa$.

(ii) Removel of $R \to \varepsilon$.

$P \to RPT / PT$

$R \to bRPR / bRP / bPR / bP / b$

$T \to PaP / R / \varepsilon / aa$.

Removal of $T \to \varepsilon$

$P \to RPT / RP / PT / P$

$R \to bRPR / bRP / bPR / bP / b$

$T \to PaP / R / aa$.

(iii) Removal of Unit productions $P \to P$, $T \to R$

$P \to RPT / RP / PT$

$R \to bRPR / bRP / bPR / bP / b$

$T \to PaP / bRPR / bRP / bPR / bP / b / aa$.

(iv) Reducing length.

$P \rightarrow RA \mid RP \mid PT$

$R \rightarrow bB \mid bD \mid bC \mid bP \mid b$

$T \rightarrow PE \mid bB \mid bD \mid bC \mid bP \mid b \mid aa$.

$A \rightarrow PT$

$B \rightarrow RC$

$C \rightarrow PR$

$D \rightarrow RP$

$E \rightarrow aP$

(v) Replacing terminal by introducing new NT

$P \rightarrow RA \mid RP \mid PT$

$R \rightarrow GB \mid GD \mid GC \mid GP \mid b$

$T \rightarrow PE \mid GB \mid GD \mid GC \mid GP \mid b \mid FF$.

$A \rightarrow PT$

$B \rightarrow RC$

$C \rightarrow PR$

$D \rightarrow RP$

$E \rightarrow FP$

$F \rightarrow a$.

$G \rightarrow b$

4) b) $L = \{ v^r i^{r+s} t^s \mid r, s \geq 0 \}$ Ambiguity.

Grammar is

$L = v^r i^r i^s t^s$

$S \rightarrow XY$

$X \rightarrow vXi / \varepsilon$

$Y \rightarrow iYt / \varepsilon$.

This

LMD

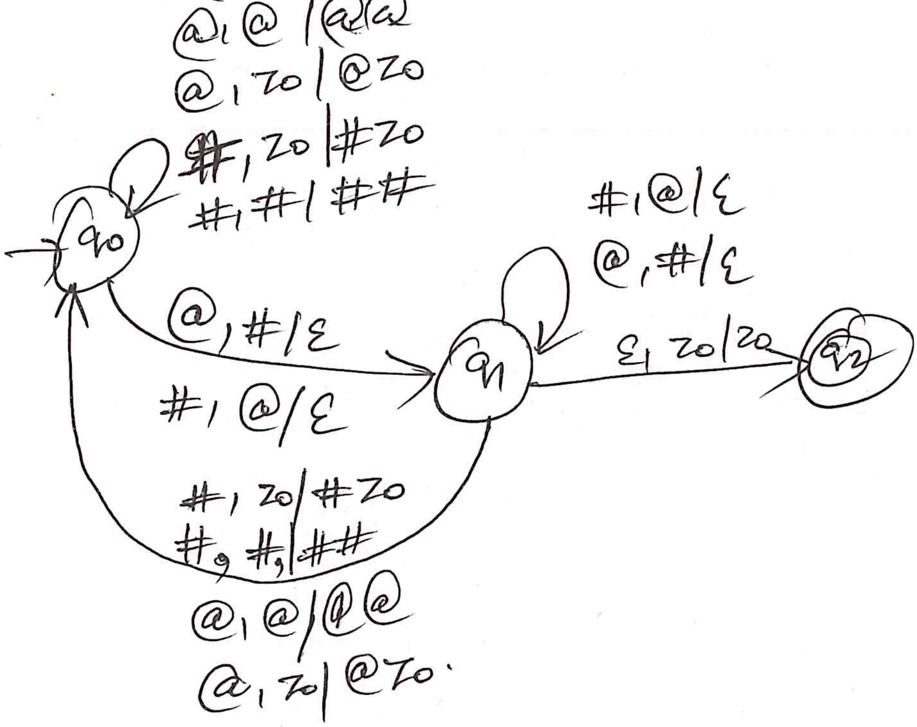
$S \rightarrow XY$
$\rightarrow vXiY$
$\rightarrow vvXiiY$
$\rightarrow vviiY$
$\rightarrow vviiiYt$
$\rightarrow vviiit \in L$.

$S \rightarrow XY$

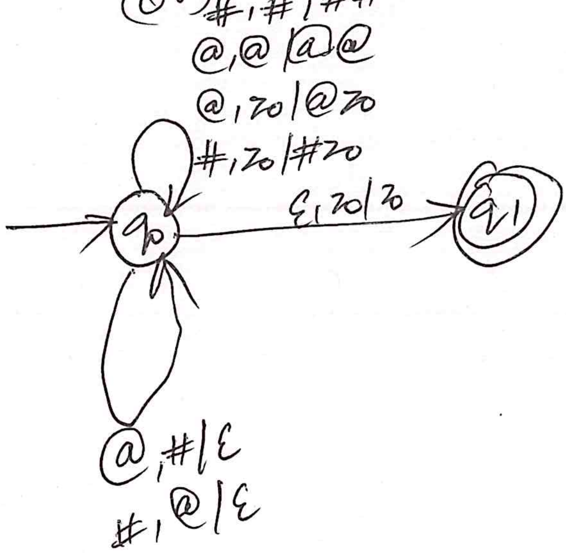
No way to drive..

⑤

"#@###@#@@#@@"


@,@|@@
@,Z0|@Z0
#,Z0|#Z0
#,#|##
q0
@,#|ε
#,@|ε
q1
#,@|ε
@,#|ε
ε,Z0|Z0
q2
#,Z0|#Z0
#,#|##
@,@|@@
@,Z0|@Z0.

(or)


#,#|##
@,@|@@
@,Z0|@Z0
#,Z0|#Z0
q0
ε,Z0|Z0
q1
@,#|ε
#,@|ε