REG.NO.:

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

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2024-2025

SLOT: F2+TF2

Programme Name & Branch : B.Tech CSE and Specialization
Course Code and Course Name : BCSE304L Theory of Computation
Faculty Name(s) : Prof.Kannadasan R, Prof. Mohana C M , Prof. Annapurna Jonnalagadda, Prof. Navamani T M , Prof. Arpan Garai, Prof. Anand Bihari , Prof. Uma Priya D , Prof. Saravanan R , Prof. Naga Priyadarsini R , Prof. Krishnaraj N , Prof. Gunavathi C , Prof. Viswanathan P, Prof. Vijayarajan V, Prof. Vishnu Priya A , Prof. Sridevi S , Prof. Prabakaran N, Prof. Sri Preethaa K R , Prof. Katari Balakrishna
Class Number(s) : VL2024250501656, 1634, 1622, 1628, 1648, 1632, 1644, 1640, 1654, 1642, 1618, 1620, 1616, 1638, 1636, 1624, 1650, 1614
Date of Examination : 21.03.2025 FN
Exam Duration : 90 minutes **Maximum Marks: 50**

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes(CO):
  CO2: Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
  CO3: Identify limitations of some computational models and possible methods of proving them.
  CO4: Represent the abstract concepts mathematically with notations.

Q. No	Question	M	CO	BL
1.	(a) Convert the following Grammar into Finite automata S→aA|bB A→aA|bS|c B→bB|a (3 Marks) (b) Let R_1 and R_2 be regular languages over $\sum$. Then, exclusive of R_1 and R_2 is defined as $EXC(R_1,R_2) = \{ x \in \Sigma * : x$ in $\{R_1-R_2\}$ or x in $\{R_2-R_1\}\}$. If x in {Ri – Rj} means x is in Ri and not in Rj. Prove that $EXC(R_1,R_2)$ is regular. (3 Marks) (c) Using pumping lemma, demonstrate that the given language **L= $\{x^i y^j z^k \mid k \leq i+j\}$** is not regular. (4 Marks)	10	CO 2	BL2

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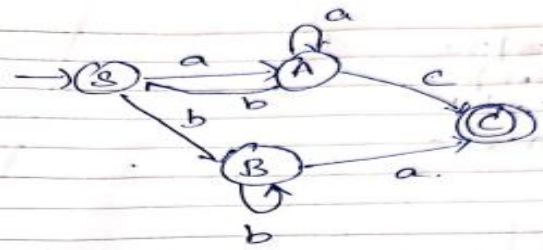
1 a)



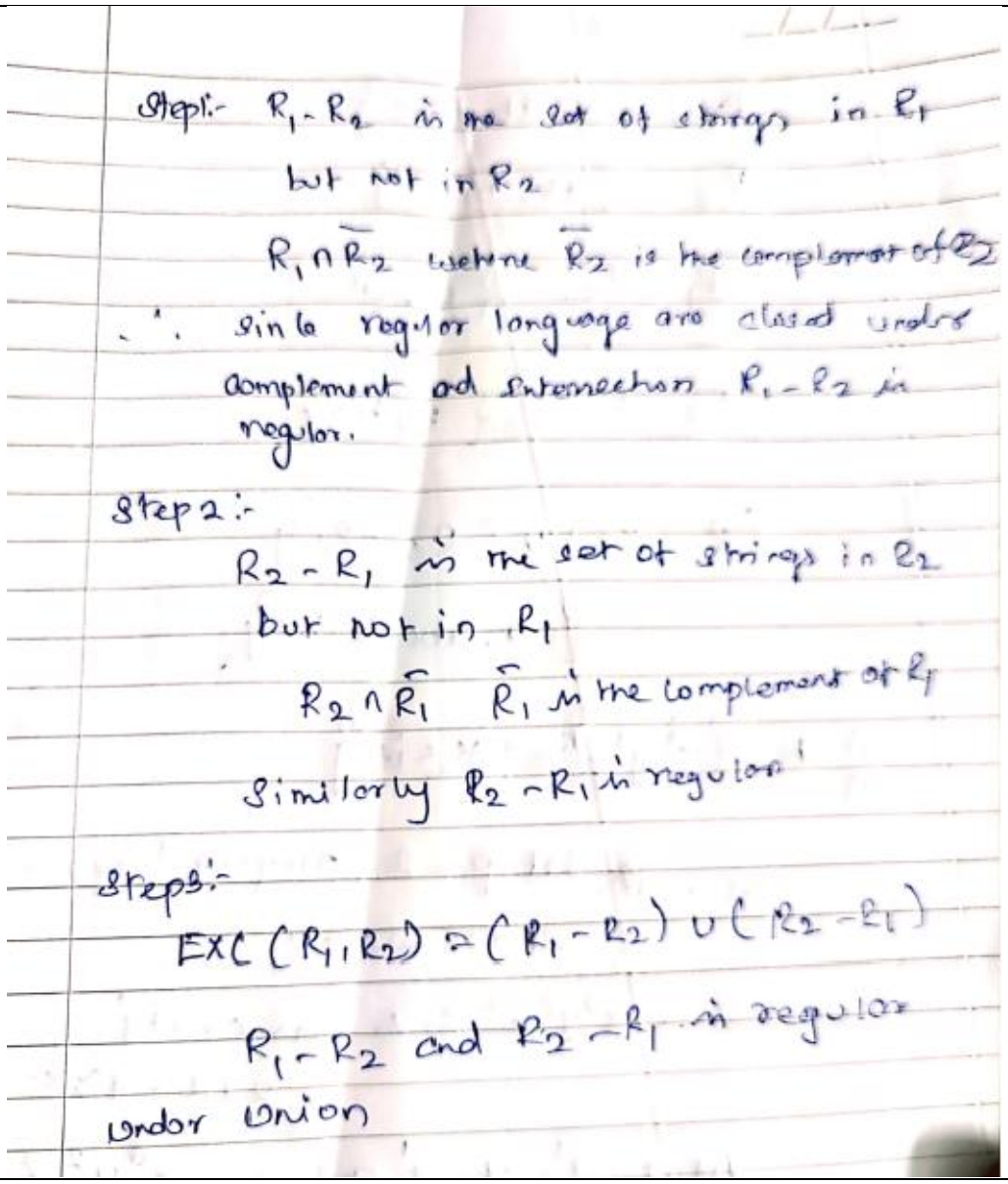
b) $EXC(R_1, R_2) = \{x \in \Sigma^* \mid x \in (R_1 - R_2) \text{ or } x \in (R_2 - R_1)\}$

$(R_1 - R_2) = \{x \in R_1, x \notin R_2\}$

$(R_2 - R_1) = \{x \notin R_1, x \in R_2\}$

Regular language closed under
→ Intersection
→ union
→ Complement
→ Set difference.

We use the closure properties prove $EXC(R_1, R_2)$ is regular.



Step1:- $R_1 - R_2$ is the set of strings in R_1 but not in R_2

$R_1 \cap \bar{R}_2$ where $\bar{R}_2$ is the complement of R_2

∴ Since regular language are closed under complement and intersection $R_1 - R_2$ is regular.

Step 2:-

$R_2 - R_1$ is the set of strings in R_2 but not in R_1

$R_2 \cap \bar{R}_1$ $\bar{R}_1$ is the complement of R_1

Similarly $R_2 - R_1$ is regular

Step3:-

$EX((R_1, R_2)) = (R_1 - R_2) \cup (R_2 - R_1)$

$R_1 - R_2$ and $R_2 - R_1$ is regular under union

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$R_1 = \{a, ab, abc\}$

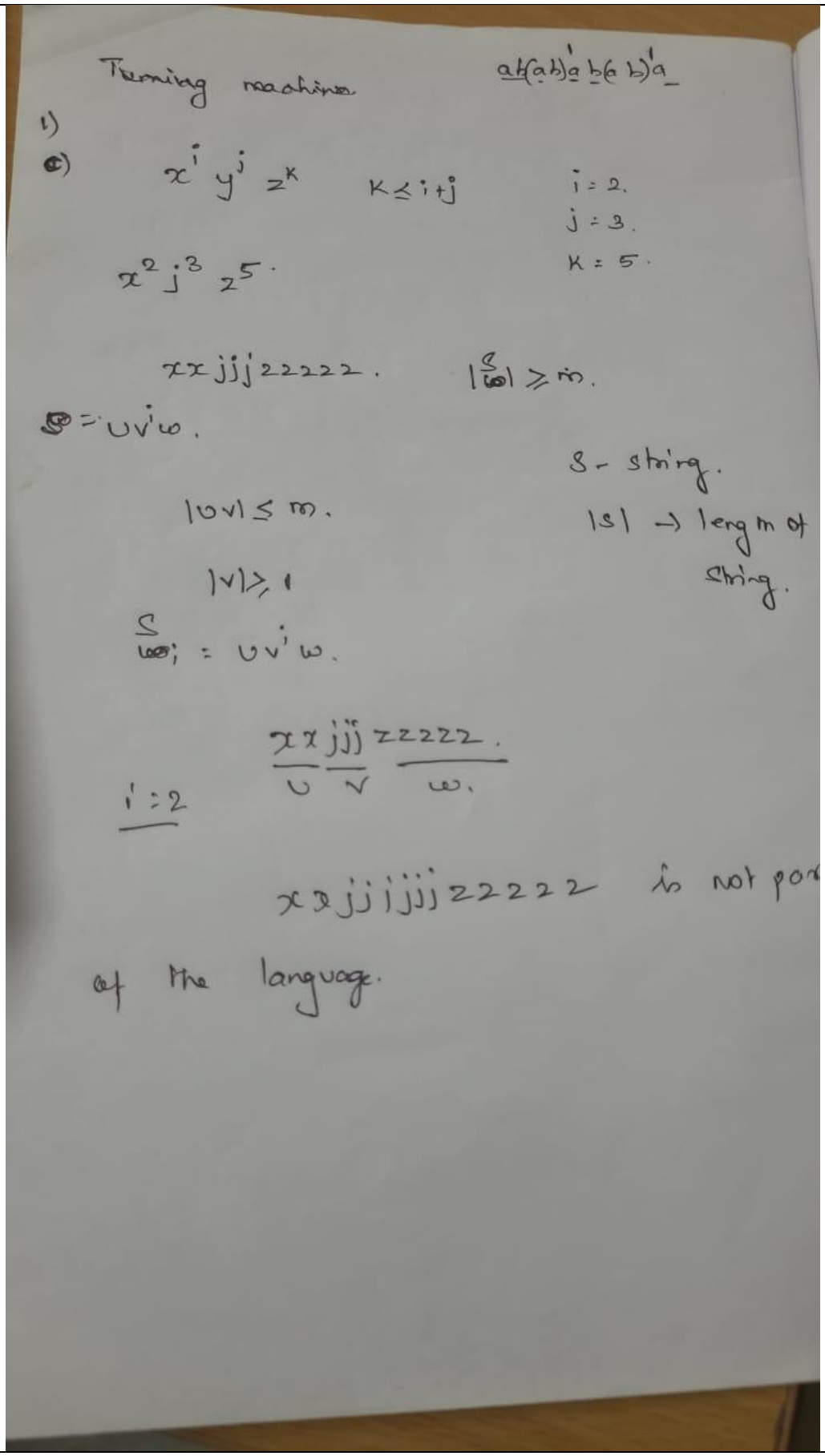
$R_2 = \{ab, b, bc\}$

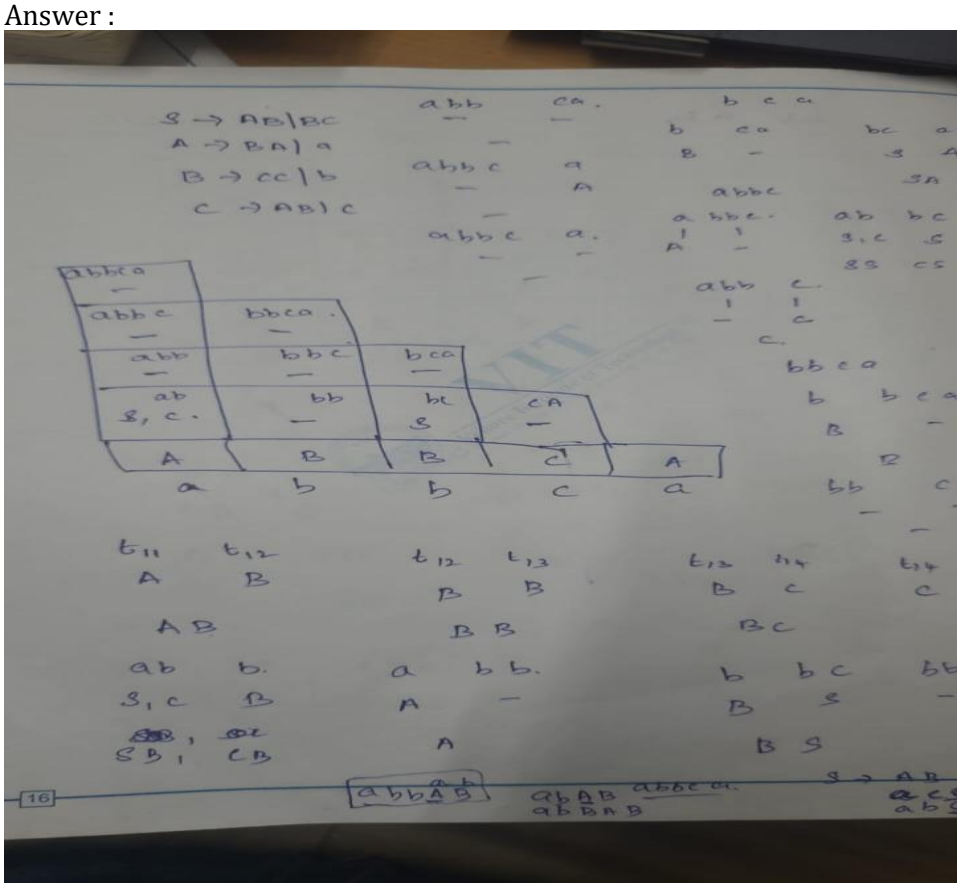
$R_1 - R_2 = \{a, abc\}$

$R_2 - R_1 = \{b, bc\}$

$(R_1 - R_2) \cup (R_2 - R_1)$

$\{a, abc, b, bc\}$.


Turning machine
a b' (a b)' a b (a b)' a
1)
a) $x^i y^j z^k$ $k \leq i+j$
$i = 2.$
$j = 3.$
$k = 5.$
$x^2 j^3 z^5.$
xxjjjzzzzz. $|s| \geq m.$
$w = uv^i w.$
S - string.
$|uv| \leq m.$
$|s|$ → length of string.
$|v| \geq 1$
$s = uv^i w.$
xxjjjzzzzz.
u v w.
i = 2
xxjjijjjzzzzz is not part
of the language.

2.	Consider the following context free grammar (where S is the start symbol) S→AB |BC A→BA |a B→CC |b C→AB |c Apply CYK algorithm with all required steps for the input string "abbca". Answer : 	10	CO 3	BL3
3.	a) Consider the following grammar (where U is the start symbol) remove all unit-productions, all useless productions, and all λ - productions from the grammar where **Σ**= {0,1} U → 0V|0WW, V → 0V| λ , W→ 1W|11X, X → W. After simplification convert the grammar into an equivalent grammar in Chomsky normal form (7 Marks)	10	CO 3	BL3

Step1: Remove λ production.

$V \to \lambda$

Replace V in all other rules with V

$U \to oV \mid oWo \mid o$

$V \to oV \mid o$.

$W \to 1W \mid 11X$

$X \to W$

Removal of unit production

$X \to W$

Replace $X \to W$ with rules $(W \to 1W \mid 11)$

$X \to 1W \mid 11X$

After removing unit production

$U \to o \mid oV \mid oWo$

$V \to oV \mid o$

$W \to 1W \mid 11X$

$X \to 1W \mid 11X$

Steps:- Removal of useless production.
No useless production in the above production.

Convert to CNF
$A \to BC$.
$A \to a$.

Steps:
1. Introduce new non-terminal for terminal 0, 1.
Let $T_0 \to 0$
$T_1 \to 1$
2. Replace terminals in rules that have more than one symbol

$U \to 0 | 0V | 0WW$ becomes.

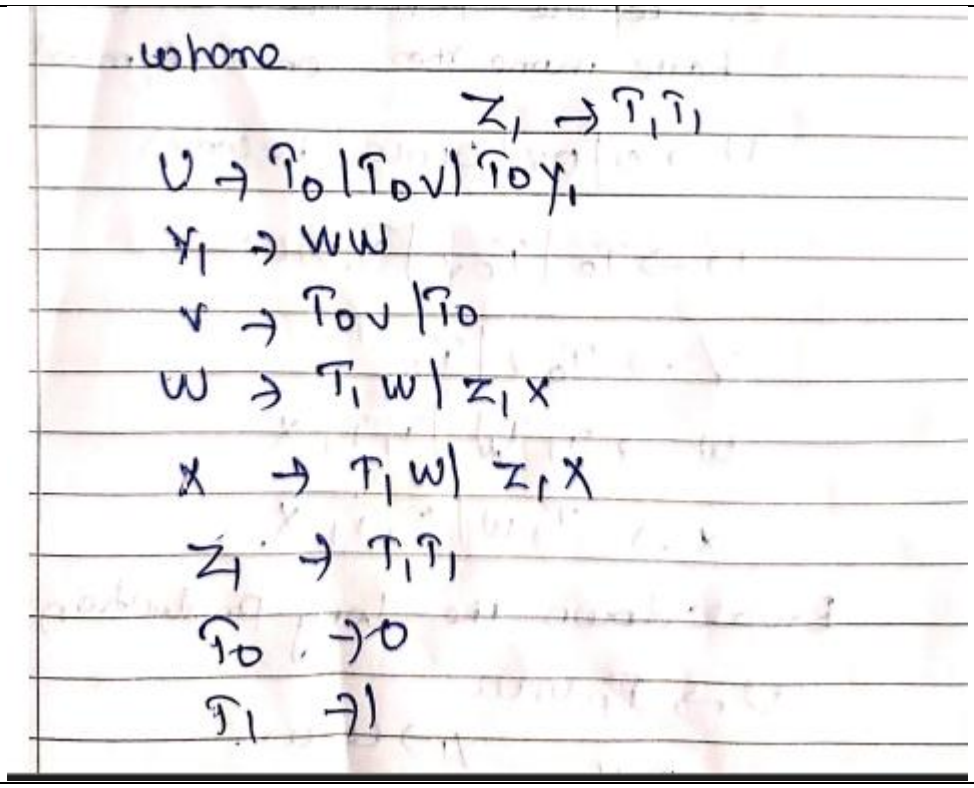
$U \to T_0 | T_0V | T_0WW$

$V \to T_0 V | T_0$

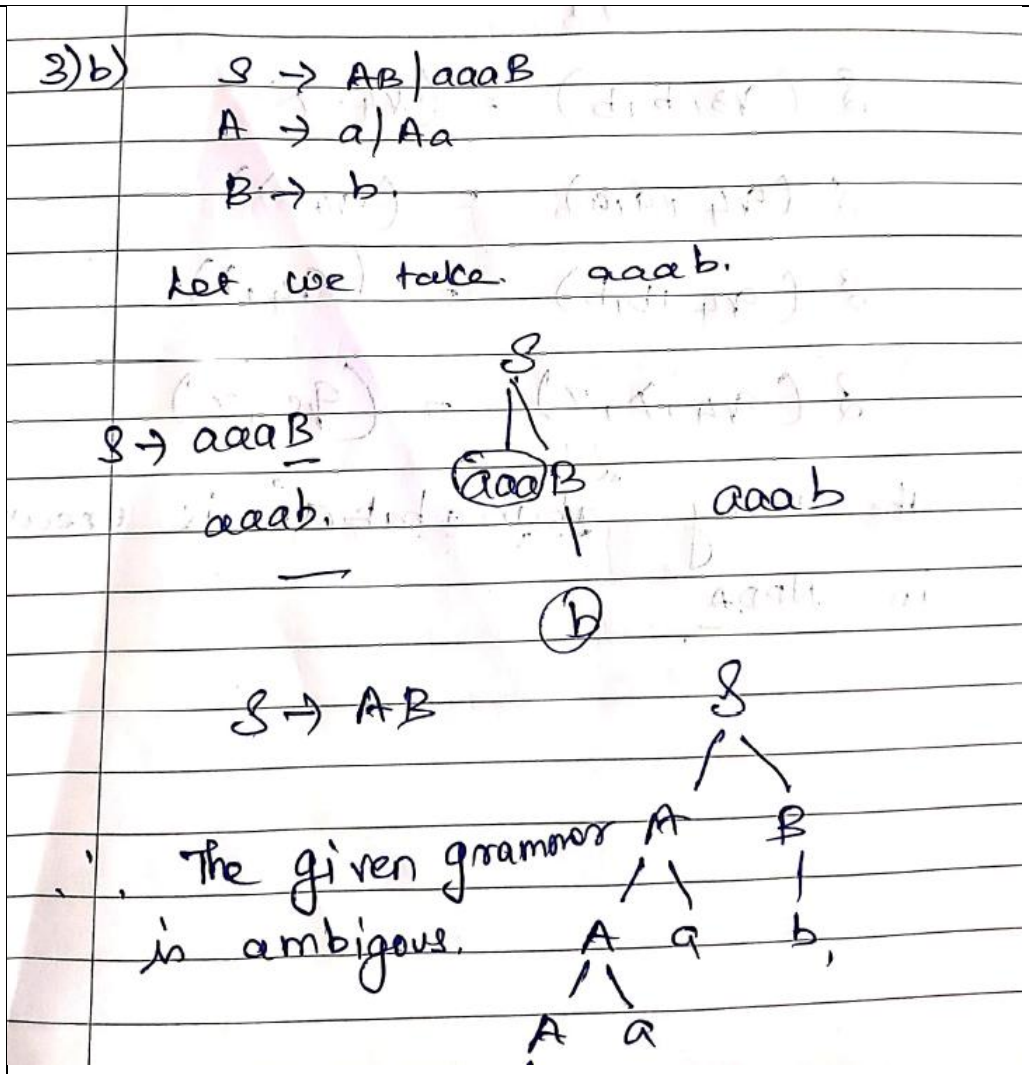
$W \to T_1 T_W | T_1 T_1 X$

$X \to T_1 W | T_1 T_1 X$.

Break down the long production



b) Show that the following grammar is ambiguous. What happens for the following string aaaab. Discuss in terms of parse tree.
S → AB|aaaB,
A → a|Aa,
B → b. (3 Marks)

				
4.	a) Convert the following grammar to an equivalent grammar in GNF $S \rightarrow AB$ $A \rightarrow BB \mid a$ $B \rightarrow AB \mid a$ (6 Marks) Answer :	10	CO 3	BL3

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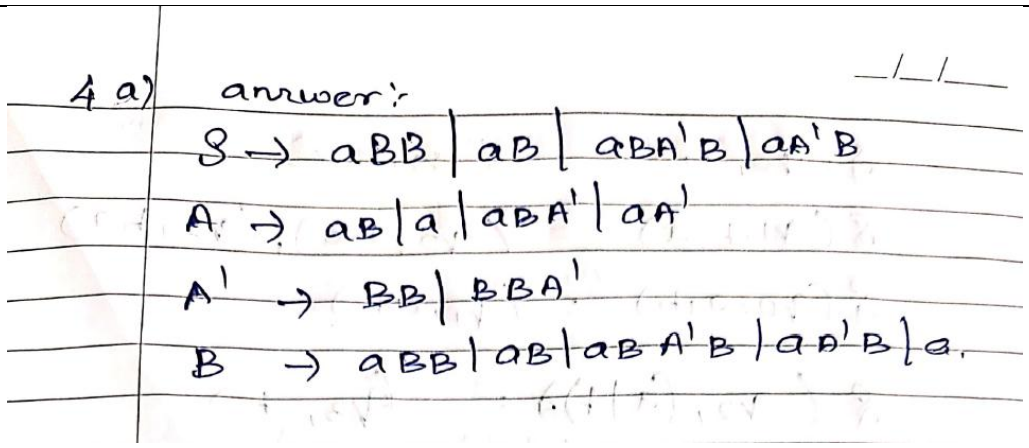
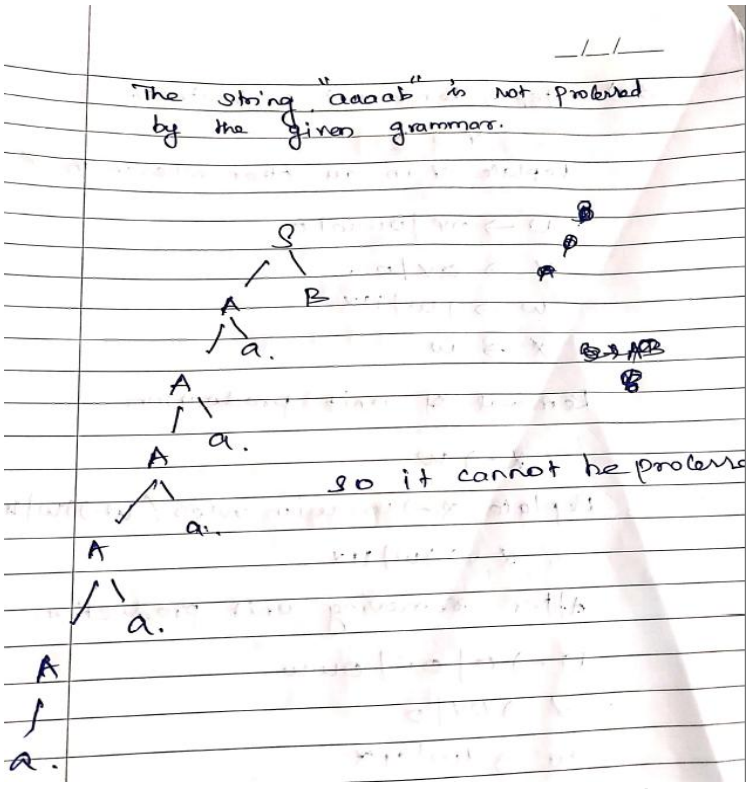


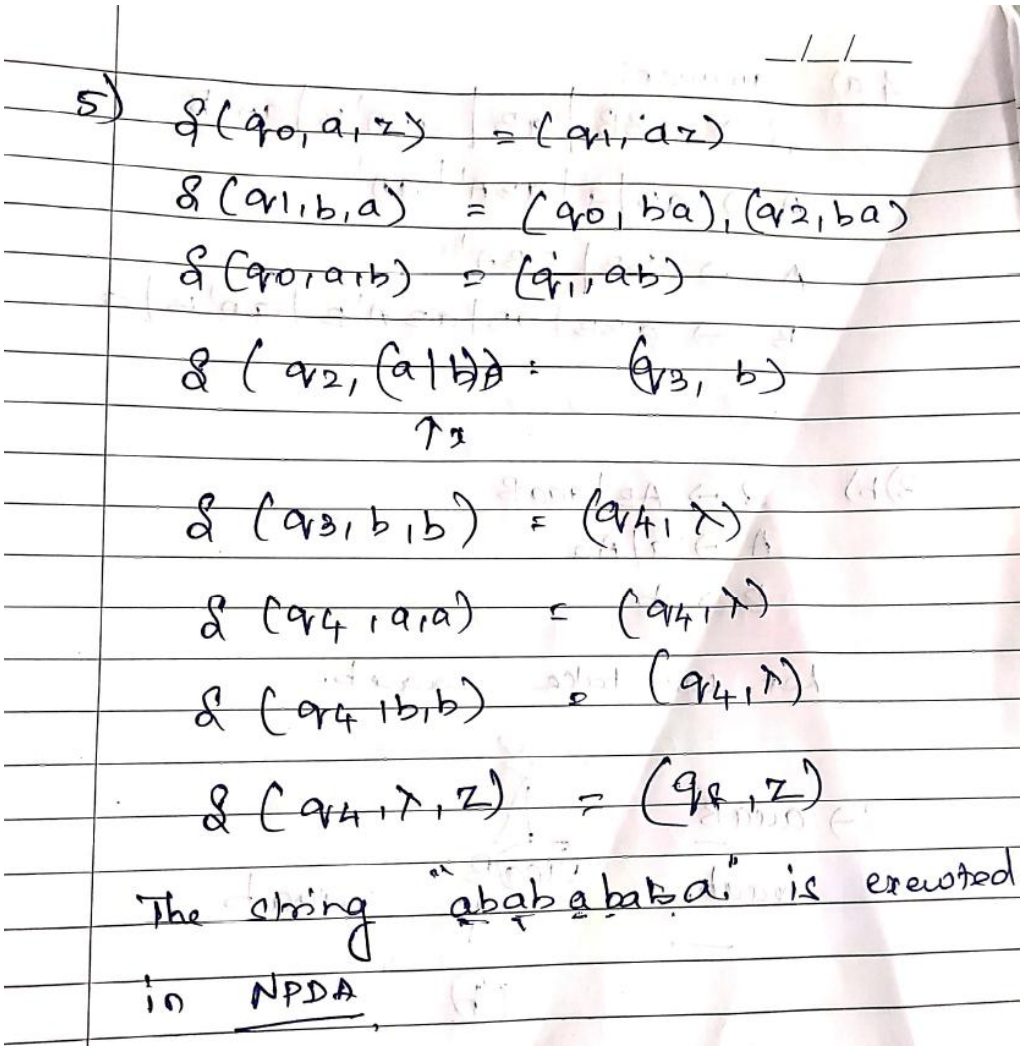


b) Consider the context-free languages L1 = $\{a^{2n}\ b^{k}\ c^{n} \mid n,k \geq 1\}$. L2 = $\{a^{m}\ b^{2p}\ c^{p} \mid m,p \geq 1\}$. What is L1 ⋂L2 ? Is it a context-free language? Justify briefly. (4 Marks)

Answer : L1= $a^{2}b^{+}c$, $a^{4}b^{+}c^{2}$,$a^{6}b^{+}c^{3}$,....
L2= $a^{+}b^{2}c$,$a^{+}b^{4}c^{2}$,$a^{+}b^{6}c$.....
L1 ⋂L2 = $\{a^{2n}b^{2n}c^{n} \mid n \geq 1\}$
No Its not a CFG becauses $a^{2n}b^{2n}$ can be computed in PDA but c^{n} is not computed.

5.	Construct a Non-deterministic push down automata (NPDA) that recognizes the language L = {ab(ab)^{n} x b(ab)^{n} a | n≥0, x={a,b}}. Note that x is a symbol a or b. Describe the idea of your construction of transition rules and provide the	10	CO 4	BL3

transition rules. Show the configurations made by the constructed NPDA for the input string “abababa”.



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