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Ans 2. (a) Using pumping lemma, we need to prove $L = a^{n+m} b^m c^n$; $m, n \geq 1$ is non regular over the alphabet $\Sigma = \{a, b, c\}$.

We will prove this by using definition of pumping lemma to contradict the above case.

If we consider FA with no. of state as 10, then if language is regular, then using the lemma $w = a^6 b^3 c^3$, $|w| = 12 > N$ must be accepted by the FA ($m = 3$, $n = 3$)

so, $\Rightarrow w \in L; a^6 b^5 c^3 \in L$

$$w = \underbrace{aaaaaa}_{x}\underbrace{abbb}_{y}\underbrace{bccc}_{z} \in L$$

By pumping y two times i.e. $i=2$

$$xy^2z \in L$$

where $x = aaaa$
$y = aabb$
$z = bccc$

$$\therefore xy^2z = \underbrace{aaaa}_{x}\underbrace{aabbaabb}_{y^2}\underbrace{bccc}_{z} \notin L$$

as, this dissatisfies the condition of L.

hence $xy^2z \notin L$.

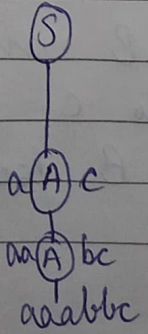
$\therefore \longrightarrow \times$

hence, By pumping lemma, we proved that our assumption is wrong and L is non regular.

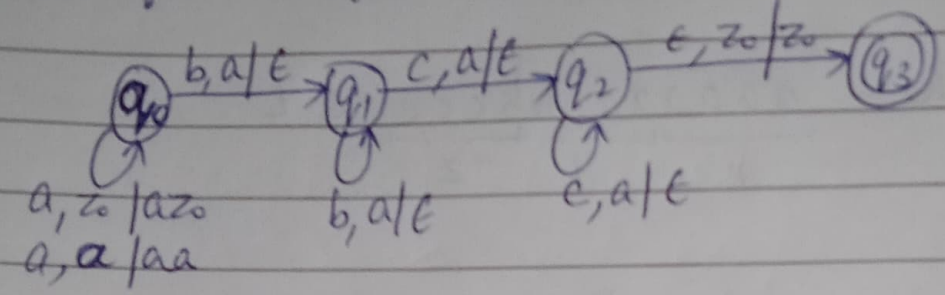
(b) CFG of L, and parse tree of aaabbc.

CFG: $S \longrightarrow aSc \mid aAc \mid aabc$
$A \longrightarrow aAb \mid ab$

parse tree:



PDA for $L : \{a^{n+m} b^m c^n \mid m, n \geq 1\}$



Transitions:

$\delta(q_0, a, z_0) = (q_0, az_0)$
$\delta(q_0, a, a) = (q_0, aa)$
$\delta(q_0, b, a) = (q_1, \epsilon)$
$\delta(q_1, b, a) = (q_1, \epsilon)$
$\delta(q_1, c, a) = (q_2, \epsilon)$
$\delta(q_2, c, a) = (q_2, \epsilon)$
$\delta(q_2, \epsilon, z_0) = (q_3, z_0)$