CS 2333
Assignment 2
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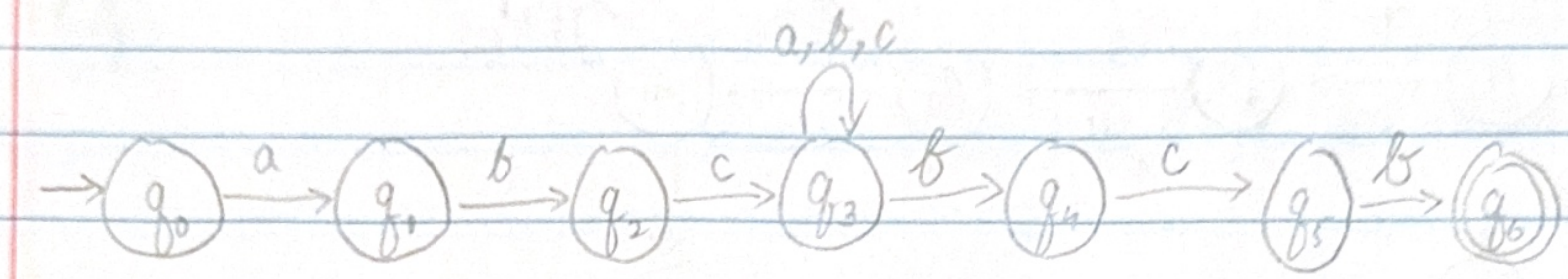
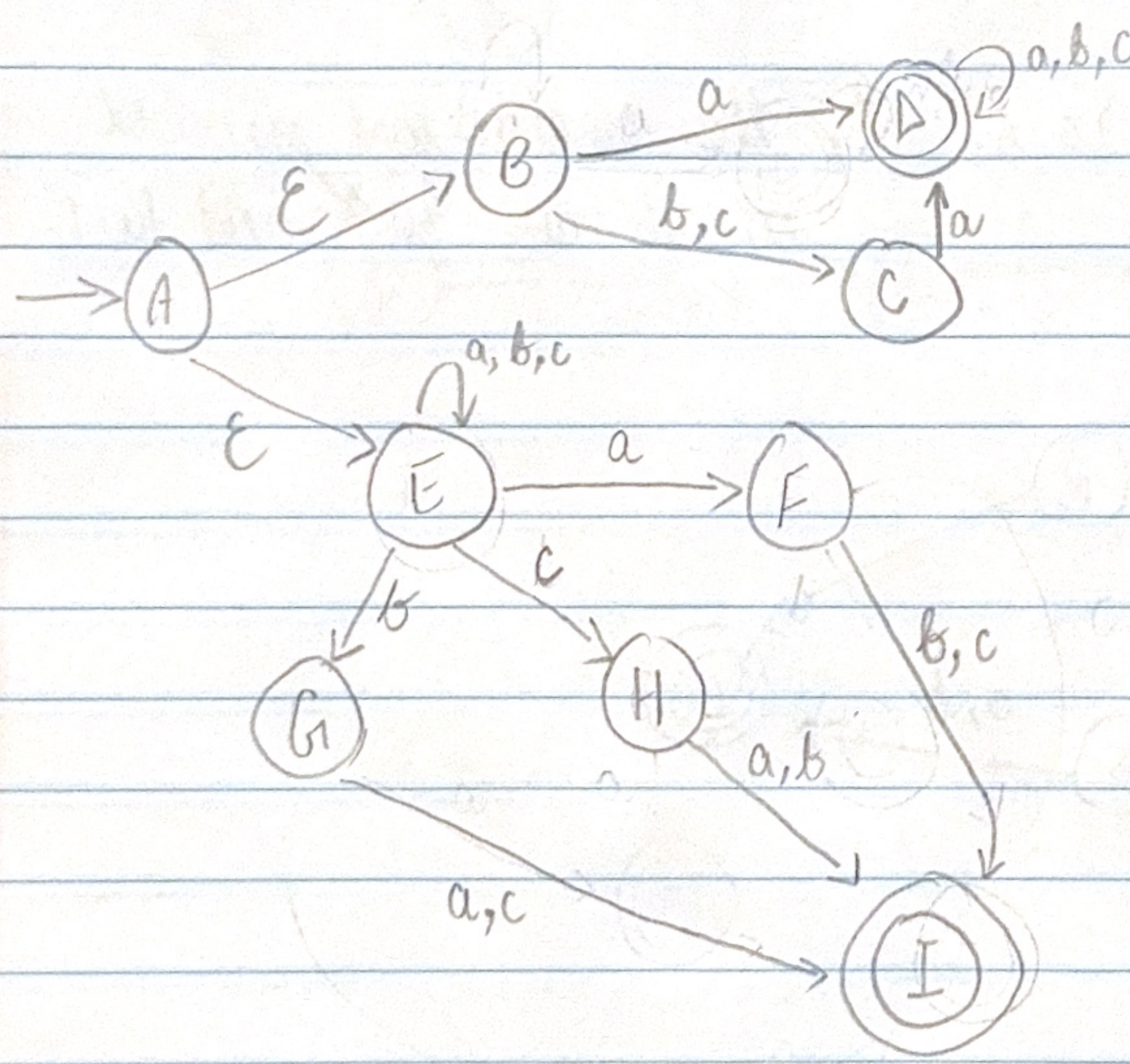
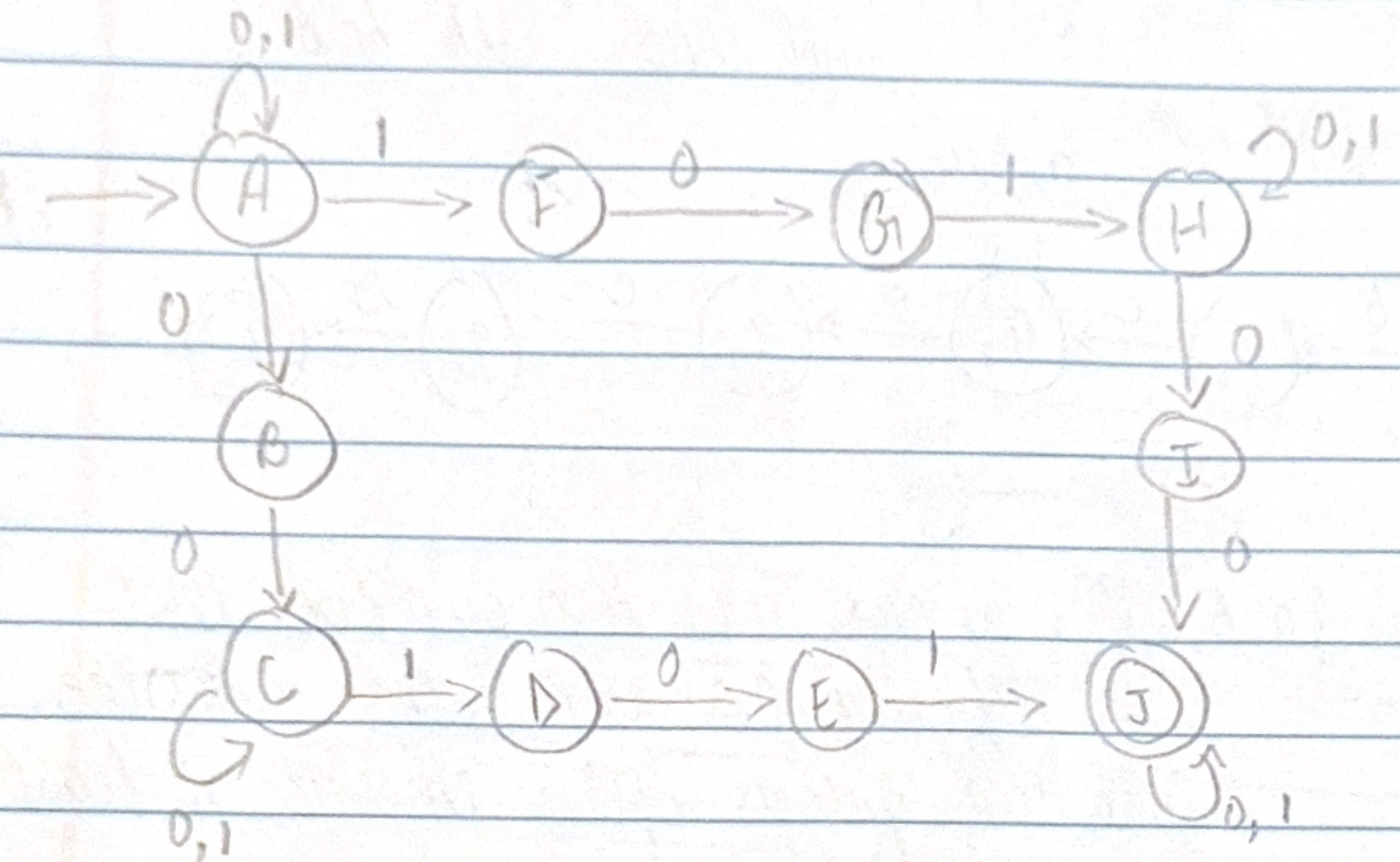
QUESTION 1: a) $L_1 = \{ w \in \{a,b,c\}^* :$ w starts with abc and ends with bcb $\}$



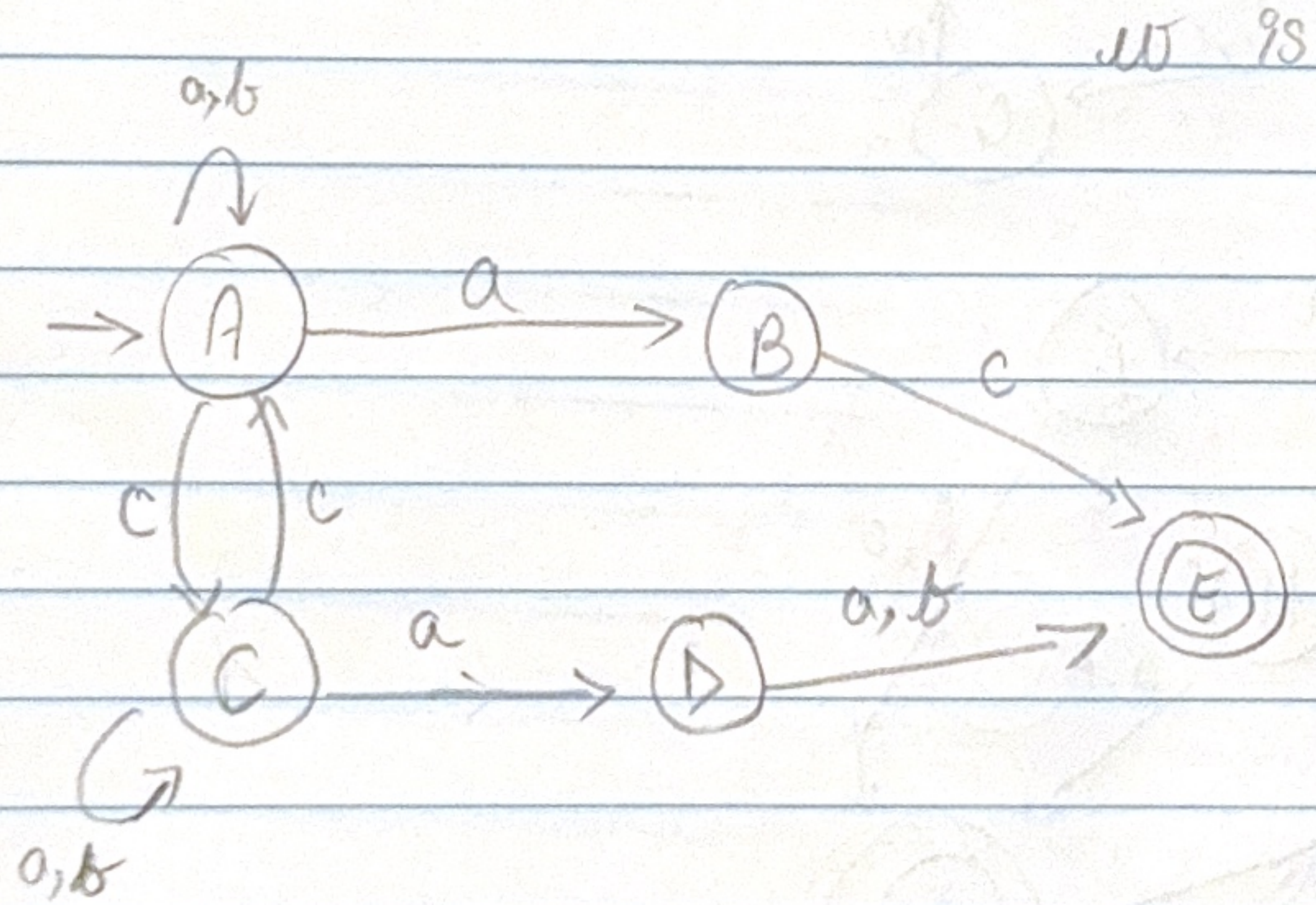
b) $L_2 = \{ w \in \{a,b,c\}^* :$ w ends with two symbols that are different from each other, or the first two symbols of w include at least one 'a' $\}$



c-) $L_3 = \{ w \in \{0,1\}^* :$ w contains both the substring 101 and the substring 00 $\}$



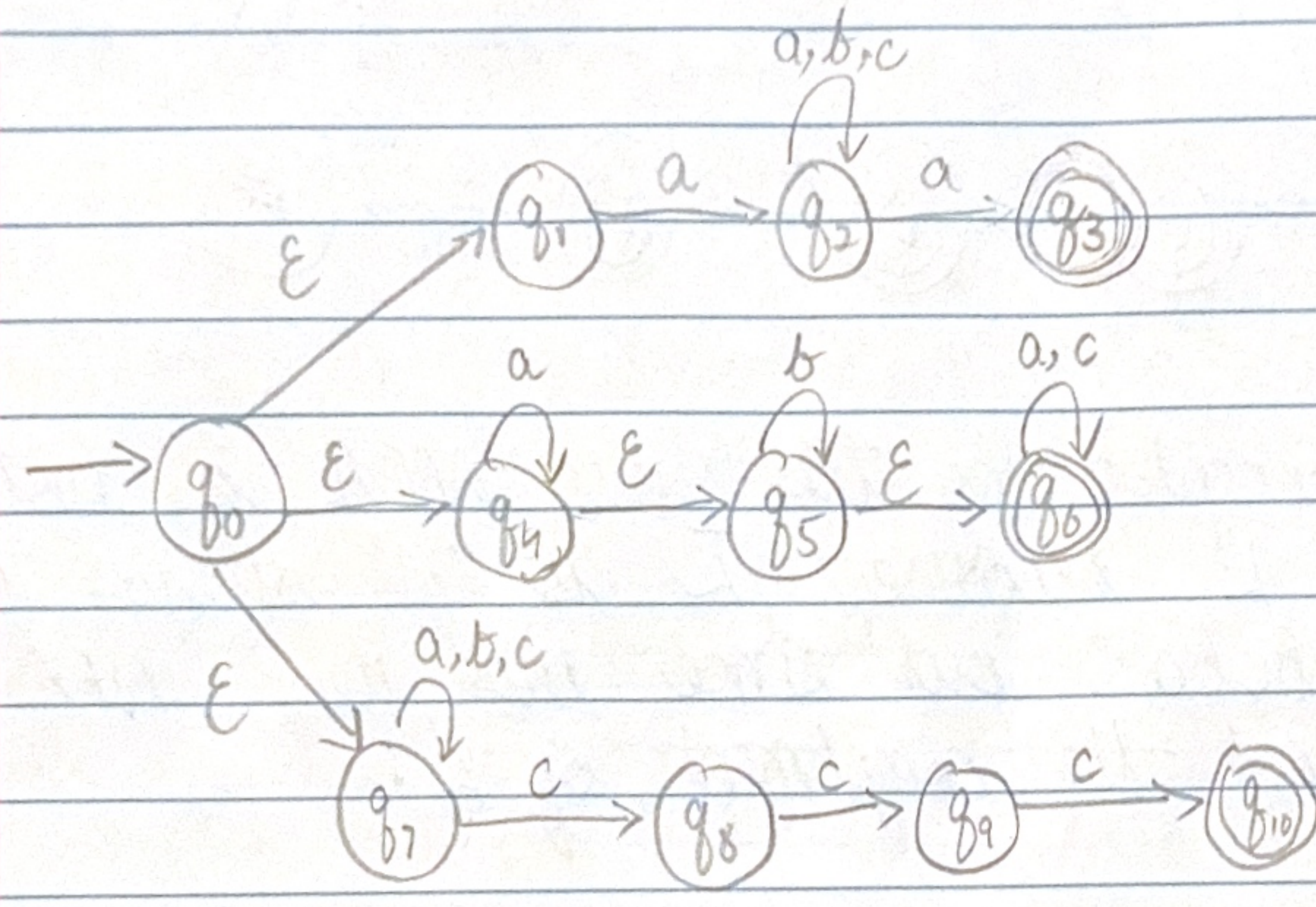
d-) $L_4 = \{ w \in \{a,b,c\}^* :$ the second-last symbol of w is an 'a' and $|w|_c$ is odd $\}$



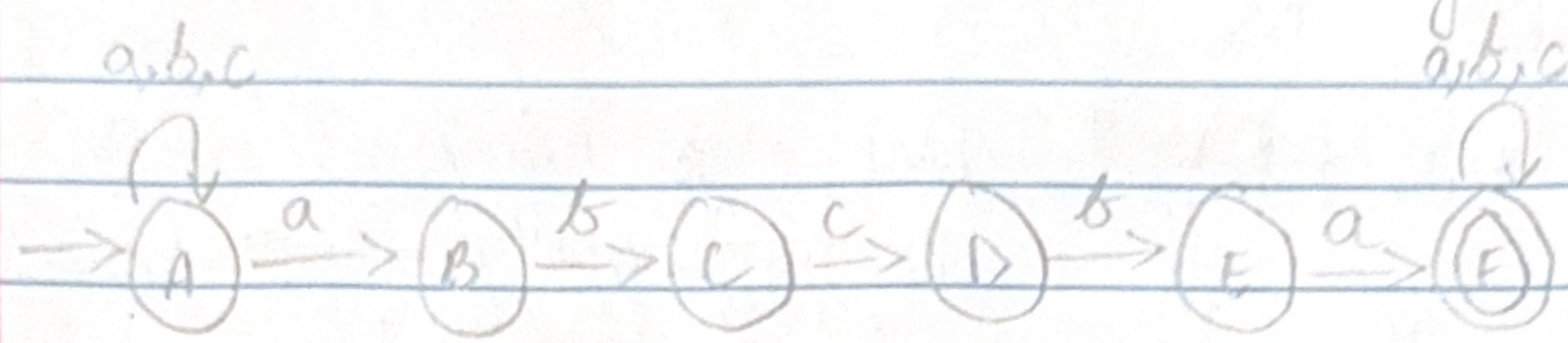
QUESTION 2: a-) $L = \{ a^{2k+1} b^{2m+1} c^{2n} : k, m, n \in \mathbb{Z}_{nonneg} \}$

b-) $L = \{ w \in \{0,1\}^* : |w|_1 = 3k$ for some $k \geq 0$
OR $|w|_0 = 4m$ for some $m \geq 0 \}$

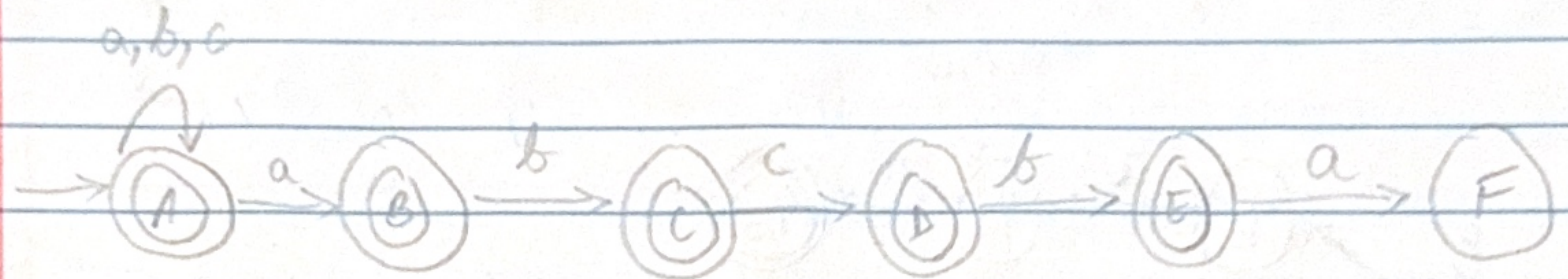
QUESTION 3:



QUESTION 4: $L = \{w \in \{a,b,c\}^* : w$ contains the substring $abcba\}$



New NFA:-



- The language accepted by this new NFA is not the complement of L because $\bar{L}$ is "all strings that don't contain abcba". But since this new NFA accepts all string, its not the complement of L.

QUESTION 5:

a-) $L_1 \cup L_2 = \{b, ba, ab, aab, aaaa\}$

b-) $L_2 \cup L_3 = \{b, ab, aab, aaab, aaaab, aaaa\}$

c-) $L_1 L_2 = \{bab, baab, baaaa, baaab, baaaaa\}$

d-) $L_2 L_1 = \{abb, aabb, aaaab, abba, aabba, aaaaba\}$

e-) $(L_1)^{*}_{length \leq 3} = \{\varepsilon, b, ba, bb, bbb, bba, bab\}$

f-) No, the string is not in $(L_1)^*$ because every string in L_1 either b or ba, so any accepted string is a concatenation of those two pieces and each piece starts with 'b.' Therefore two a's can never appear next to each other, whereas the given string contains it.

Q.5

g-) No, each string of $(L_2)^*$ is ab, aaab or aaaa.
Every string has atleast as many a's as b's never fewer. Adding such strings can never make the total number of b's exceed the total number of a's.

h-) Yes, a single string from L_3 can be just 'b'.
And we can pick the letter b as many times as we like and it belongs to $(L_3)^*$.

QUESTION 6: a-) $L_1 = \{ w \in \{a,b\}^* :$ w starts with bbb and ends with abba $\}$

$$bbb(a \cup b)^* abba$$

b-) $L_2 = \{ w \in \{0,1\}^* : |w|_0 = 4k+1 \text{ for some } k \in \mathbb{Z}^{\text{nonneg}} \}$

$$1^*0(1^*01^*01^*01^*0)1^*$$

c-) $L_3 = \{ w \in \{0,1\}^* : |w| \geq 2$ and the first and last letter of w are the same $\}$

$$0(0 \cup 1)^*0 \cup 1(0 \cup 1)^*1$$

d-) $L_4 = \{ w \in \{a,b,c\}^* :$ every 'a' is followed immediately by at least three consecutive 'b's $\}$

$$(b \cup c \cup abbbb^*)^*$$

QUESTION 7.

a-) $(0 \cup 1 \cup \varepsilon)(0 \cup 1 \cup \varepsilon)(0 \cup 1 \cup \varepsilon)$

$L = \{ w \in \{0,1\}^* : |w| \leq 3 \}$

b-) $(aa)^* (ab \cup ba) (aa)^*$

$L = \{ w \in \{a,b\}^* : |w|_b = 1$ and $|w|_a$ is odd $\}$