Subjective Questions

Write detailed answers. Adequately explain your assumptions and thought process.

1. [2 points] Draw a NFA for the following Regular Expression : $(((a + b)\ c)^*\ (abb)^*)^*$.
   [CO-1, CO-2]

2. [3 points] Prove that the following language over $\Sigma = \{0, 1\}$ is regular by constructing a DFA for it.

$$L = \{\ w \mid w \equiv 1 \bmod 2 \text{ and } w \not\equiv 0 \bmod 3\ \}$$

Note that the DFA accepts a binary string as input, which corresponds to a natural number. For instance, the number 6 is input as 110. [CO-1, CO-2, CO-3]

3. [3 points] Write down the Context Free Grammar and the corresponding PDA for the language $L = \{0^n 1^{3n} | n \geq 1\}$.
[CO-1, CO-2, CO-3]

$3n$

4. [4 points] Consider the following language

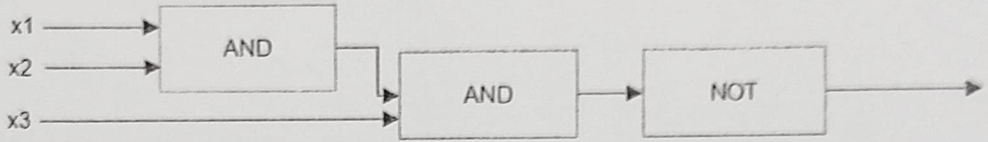
$$F = \{0^i 1^j 2^k \mid i, j, k \geq 0 \text{ and if i} = 1 \text{ then j} = \text{k}\} \quad (1)$$

(a) Does the Pumping Lemma for Regular Languages hold for F? If your answer is yes, demonstrate this. If you answer No, clearly state the property/properties of the Pumping Lemma that F violates.

(b) Is F regular or context-free? Elaborate on your answer with proper justification.

[CO-3, CO-4]

5. [3 points] You are given the following finite circuit. It has 3 boolean values as input and one output value. Convert the circuit into a DFA that takes in a size-3 binary string as input that corresponds to $x_1x_2x_3$ and accepts it if the circuit produces 1 as its output. From this what can you conclude about the power of finite-sized Boolean circuits and regular languages?



$((x_1 \text{ AND } x_2) \text{ AND } x_3)' \to 1$

NB: 'AND', 'OR', 'NOT' correspond to logical AND, logical OR, and logical NOT gates, respectively. [CO-1, CO-2, CO-3, CO-4]