COS 210 Worksheet 7

- This worksheet consists of **3 questions** for a total of **12 marks**
- Show your working for all calculations and reasoning.

Question 1 ....(4 marks)
   Give a context-free grammar that generates the following language over $\Sigma = \{0, 1\}$.
   You have to give all elements of the 4-tuple $G = (V, \Sigma, R, S)$.

$$L=\{w: w \text{ contains at least three 1's}\}.$$

Question 2 ....(4 marks)
   Give a context-free grammar that generates the following language over $\Sigma = \{a, b\}$.
   You have to give all elements of the 4-tuple $G = (V, \Sigma, R, S)$.

$$L=\{w: \text{the length of } w \text{ is odd and its middle symbol is b}\}.$$

Question 3 ....(4 marks)
   Give a context-free grammar that generates the following language over $\Sigma = \{a, b, (,), \cup, ^*, \emptyset, \epsilon\}$.
   You have to give all elements of the 4-tuple $G = (V, \Sigma, R, S)$.

$$L = \{w : w \text{ is a regular expression}\}$$