(1) Drawin’ DFAs and NFAs

a) Draw a DFA over $\Sigma = \{C, T, Y\}$ that accepts all strings except CTY. Write a formal description too.

b) Draw an NFA over $\Sigma = \{a, b\}$ that begin or end with ab. If you’re feeling ambitious, draw a DFA too.
(2) The Empty Set and the Empty String are Not the Same!

a) Draw a DFA over $\Sigma = \{0,1\}$ recognizing only the empty string $\epsilon$:

b) Draw a DFA over $\Sigma = \{0,1\}$ recognizing only the empty set $\varnothing$:

(3) Writin’ Up NFAs

a) Give a formal description $(Q, \Sigma, \delta, q_0, F)$ for the following NFA. What is its language?

b) Describe in English the language defined by the regular expression $(00)^*(10 \cup 01)$. Give three strings in this language and three strings not in this language. Draw an NFA that accepts this language.
(4) I’m blanking here…

a) A PDA is an NFA with a ____________________________.

b) Regular languages are recognized by ____________________________.

c) ____________________________ are generated by CFGs.

d) The ____________________________ of an NFA is the set of all strings it accepts.

e) A DFA rejects an input string if the string is ____________________________.
   The DFA does this by ending in a ____________________________.

f) Regular languages are closed under ____________________________.

g) CFLs are closed under ____________________________.

h) The two Pumping Lemmas can be used to show ____________________________
   and ____________________________.

i) The Pumping Lemma is called a “lemma” because ____________________________.

j) A CFG is made up of ____________________________.

k) A PDA is a ____________________________ with a stack.

l) PDAs and CFGs are ____________________________ in power, which means
   ____________________________.
(5) I’ve Got Context For Ya

a) Give two strings that are generated, and two strings that are not generated, by the following context-free grammar. What is the language it describes?

\[ S \rightarrow aSb | \varepsilon \]

b) Give a CFG for the language of all strings of even length with 00 in the middle.

c) Consider the following CFG:

\[ S \rightarrow U | V \\
U \rightarrow TaU | TaT \\
V \rightarrow TbV | TbT \\
T \rightarrow aTb | bTa | \varepsilon \]

What are the variables?
What are the terminals?
What is the start variable?
Give three strings generated by this grammar:
Give three strings not generated by this grammar:
What is the language described by the grammar?
(Really hard; don’t try until you’ve finished all other problems.)

(continued)
(continued)

d) Give a CFG and an English description of a PDA for the language \( \{c^n t^m y^{2n} | n, m \geq 0\} \) over the alphabet \( \{c, t, y\} \).

(6) Pump Me Up!

a) Show \( \{0^n 1^n\} \) is not a regular language.

b) Show \( \{0^n 1^n 2^n 3^n\} \) is not a CFL.