CSI 350
Practice Practice Practice

1. Understand the decidability and recognizability of the following languages:

   (a) $A_{\text{DFA}} = \{ < D >, w \mid D \text{ is a DFA and } D \text{ accepts } w\}$
   (b) $A_{\text{CFG}} = \{ < C >, w \mid C \text{ is a CFG and } C \text{ accepts } w\}$
   (c) $E_{\text{DFA}} = \{ < D > \mid D \text{ is a DFA and } L(D) \text{ is empty}\}$
   (d) $E_{\text{CFG}} = \{ < C > \mid C \text{ is a CFG and } L(C) \text{ is empty}\}$

2. Given a Turing Machine (TM) Diagram, show the final tape after a specific input. Determine if the machine accepts, rejects or loops forever for that input. (ex 11.1)

3. Using TMs in general. Including, what is the language of a specific TM (example 11.13, 11.14, 12.13, 12.14,)

4. Give a Turing Machine Diagram that accepts all strings in the form $\{w\#w\#w \mid w \in 0, 1^*\}$ (other examples: 11.2-11.9, 11.15)

5. Describe a TM that accepts $\{w^R\#w\#w^R \mid w \in 0, 1^*\}$ w^R means the string w but in reverse. So if $w = 110$, then $w^R = 011$. (other examples: 11.10, 11.11, 11.12, 11.16, 11.17, 12.15, 12.16, 12.19, 12.20, 12.23, 13.10, 13.14)

6. Draw a TM diagram that erases the input and writes the # to the tape. After, it leave the # on the tape, skips a spot and then writes ##. Next is ####. Continue to do this, forever. (Examples of TMs as transducers: 12.1 - 12.6, 12.12) (This enumerates $\#^{2i}$ - example 13.3, 13.5, 13.6 and 13.9)

7. A TM with multiple (finite) tapes is as powerful as a TM with one tape. Describe a method to take a binary string w on one tape and produce w^R on another tape. (Examples: 12.8-12.10)

8. Describe a TM whose head can begin anywhere on the tape. This TM then searches the tape to see if there are any non-empty cells. Essentially it is trying to find the input. Describe whether this algorithm is decidable, recognizable or not. This is question 12.23.

9. Show that Item #2 is decidable. How about #4? (Example 13.1-13.2, 13.7)

10. Printer-TMs are TMs that print every string in a language. We can use this, or we can just talk about TMs that enumerate all strings (like in #6). Describe a printer TM for the language in #4 and #5. (Examples: 13.5, 13.6, 13.9)

11. Show closure of decidable and recognizable languages under union and intersection by giving a description of closure and then showing how to construct the resulting TMs. (Examples: 13.8)

12. Show that recognizable languages are closed under the * operator. (Example 13.16)
13. Show that decidable languages are closed under *. (Example 13.17)