Theory Of Computation – Final

Time: 2 hours
Name:

Languages:

1. [5 points] Which of the following are languages over the alphabet {a, b} (select all that apply)

   a) {a}
   b) {b, a}
   c) ab
   d) the empty set
   e) {a, aa, aaa, aaaa}

Regular and Non Regular Languages:

1. [10 points] Draw the state diagram of the DFA that recognizes the language over. $\Sigma = \{0, 1\} : A = \{w \in \{0, 1\}* : w$ does not contain the string 1010 as a substring$\}$

2. [10 points] Convert the below regular expression to NFA.

aUbU (aUb)* (aUbb)

3.[10 points] Prove that the language L = { 0^n | n is a power of 2 } is not regular.

CFL and NonCFL :

1. [10 points] Design a CFG or PDA for $L = \{a^{3k+1}b^{3k-1} \mid k \geq 1\}$

2. [5 points] Consider the following grammar G:

$$S \rightarrow 1S1 \mid T$$

$$T \rightarrow 1X1 \mid X$$

$$X \rightarrow 0X0 \mid 1$$

Is G ambiguous?

3. [10 points] L = {x ∈ {a, b}* : |x| is even and the first half of x has one more “a” than does the second half}. Show that L is non CFL.

Turing Machines:

1. [10 points] Construct a state transition diagram of a Turing Machine that decides the language $L = \{w \in \{a,b\}^*, |w|_a = 1 + |w|_b\}$ where $|w|_a$ denotes the number of occurrences of a in w and $|w|_b$ denotes the number of occurrences of b in w.

Decidability & Undecidability:

1.[10 points] Show that L={< M,w,t > : M is a TM and M runs more than t steps on input w} is decidable.

2. [10 points] Show that the language
   SUB = $\{\langle M_1, M_2\rangle : M_1, M_2$ are TMs and $L(M_1) \subseteq L(M_2)$ is undecidable. You can use the fact that A_{TM} is undecidable.