### **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.  $\Sigma = \{0, 1\} : A = \{w \in \{0, 1\} * : w \text{ does not contain the string } 1010 \text{ as a substring} \}$ 

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

aUbU (aUb)\* (aUbb)

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

# **CFL and NonCFL:**

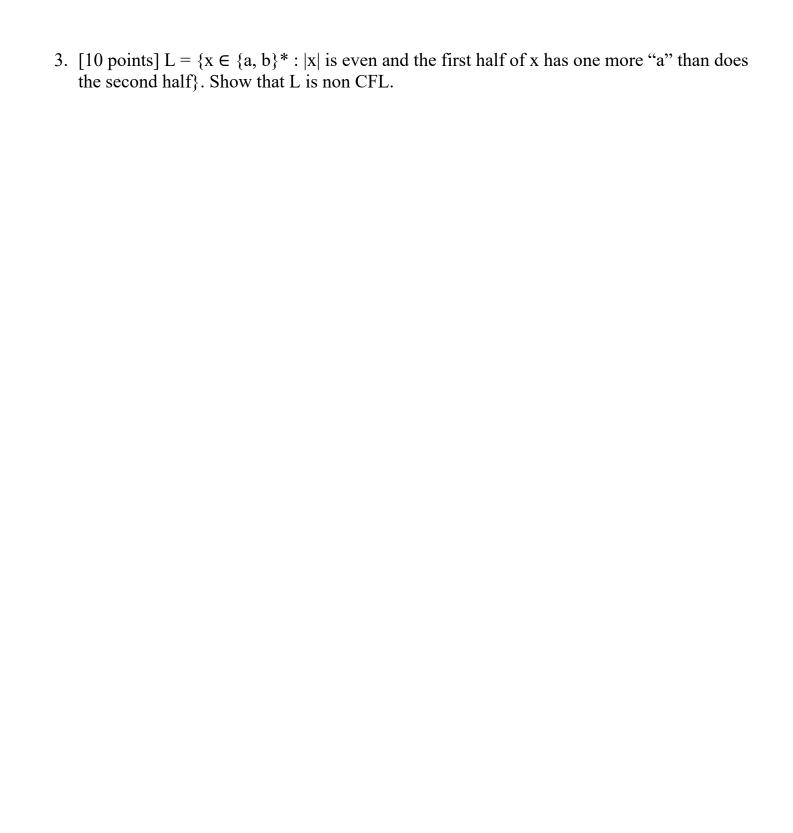
1. [10 points] Design a CFG or PDA for  $L = \{a^{3k+1}b^{3k-1} | k \ge 1\}$ 

2.	[5 points] Consider the following grammar (	<b>ુ</b> ં:
	S-	→1S1 T

 $T\rightarrow 1X1|X$ 

 $X\to 0X0|1$ 

Is G ambiguous?



### **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  $L=\{< M, w, t>: M \text{ is a TM and M runs more than t steps on input } w\}$  is decidable.

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