CS 321 HW 5

Submit to Canvas a pdf file containing verbal explanations and transition graphs for the Turing machines in problems 1 & 2 and the written answers to problems 3 & 4. Also submit JFLAP .jff files (named youronidnameP1a, youronidnameP1b, etc.) for problems 1 & 2.

1. *(10 pts)* Design single-tape Turing machines that accept the following languages using JFLAP

a) $L_2 = \{ w : n_a(w) = n_b(w) : w \in \{a, b\}^+ \}$.

Test case	Result
abbaba	accept
aaabbb	accept
aaaaaabbbbbb	accept
ba	accept
a	reject
abb	reject
bbaab	reject

b) $L_3 = \{ww : w \in \{a, b\}^+ \}$.

Test case	Result
abaaba	accept
bbbbbb	accept
aabbaabb	accept
a	reject
aabb	reject
bbb	reject

2. *(10 pts)* Design Turing Machines using JFLAP to compute the following functions for x and y positive integers represented in unary. The value $f(x)$ represented in unary should be on the tape surrounded by blanks after the calculation.

a) $f(x) = \begin{cases} x - y, & x > y \\ 0, & \text{otherwise} \end{cases}$

Input	Output	Result
11-1	1	Accept
1-1	0	Accept
111-1	11	Accept
1-1111	0	Accept
1111-11	11	Accept

b) $f(x) = x \ mod \ 5$

Input	Output	Result
1	1	Accept
1111	1111	Accept
11111	0	Accept
1111111	11	Accept
1111111111	0	Accept
11111111111	1	Accept

3. *(5 pts)* The nor of two languages is defined below:

nor(L_1, L_2) = { w: w $\notin L_1$ and w $\notin L_2$}.

Prove that recursive languages are closed under the nor operation.

4. *(5 pts)* Suppose we make the requirement that a Turing machine can only halt in a final state, that is, we require that δ(q,a) be defined for all pairs (q,a) with q $\notin$ F and a $\in \Gamma$. Does this restrict the power of the Turing machine? Prove your answer.