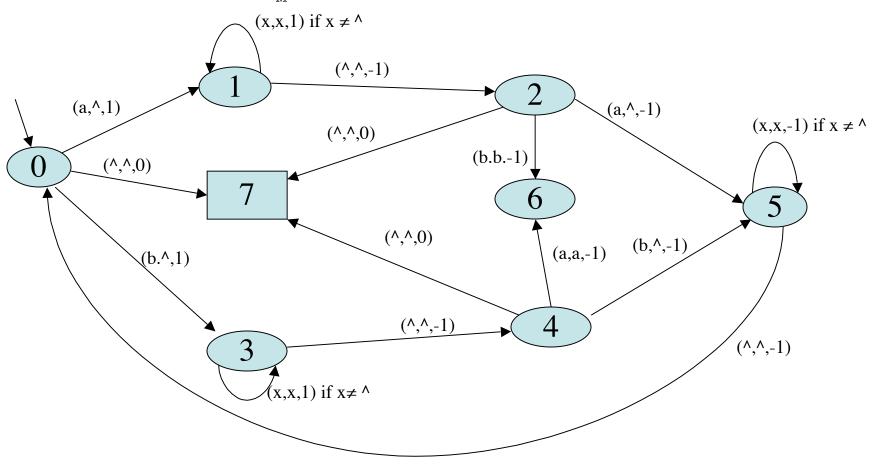**Department of Computing**

C240=MC240 Computability and Complexity
Lecturer: Margaret Cunningham
Tutorial 9 Unassessed
1   (i) What does the Turing Machine M do? (Its input alphabet is {a,b}).
            (ii) How many steps does M take to run on the following inputs:

                       abab   abaa   abba

            (iii) What are the worst case input? Give one of length 4 and one of length 5.
            (iv) Show that $time_{\mathbb{M}}(n) = (n2 + 3n + 2)/2$ for all n

(x,x,1) if x ≠ ^

(^,^,-1)

1

2

(a,^,1)

(a,^,-1)

(x,x,-1) if x ≠ ^

(^,^,0)

0

(^,^,0)

7

(b.b.-1)

6

5

(^,^,0)

(b.^,1)

(a,a,-1)

(b,^,-1)

(^,^,-1)

4

3

(^,^,-1)

(x,x,1) if x≠ ^

2.   Design a (flowchart or pseudo-code) a 2-tape Turing machine M_2, that is equivalent to M above, and runs in linear time (i.e. for some constants a,b, we have time $_{M2}(n) \le a + bn$ for all n).

3   There is a deterministic Turing machine BU, that, given the binary representation of a number as input, outputs the unary representation. Show that BU cannot have polynomial time complexity. [Hint: how long does BU take to output the answer if the input is the binary representation of n?]