Honors Theory	March 2, 2002
Solutions to Homework Set 4	
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Problem 1

Problem 1(i)

We claim the constant 6 can be sharpened to 5 if $k = 1$.
We follow the notations and outline of proof of theorem 3, chap 2 in professor Yap's book.

We will show in simulation phase, at most 4 moves of N to simulate d steps of M. Then our claim follows. Our proof is based on a simple observation: in M's d steps, the head can NOT visit both cell $j-1$ and $j+1$ (of N). The reason is initially the head is in cell j, which is of length d and each step we can move at most one cell of M.

Our algorithm is: first N moves from cell j to cell $j-1$. If the information gathered by N (of cell j and $j-1$) is enough, then N make one more step from cell $j-1$ to j, to modify these two cells based on the corresponding modifications of M. In this case, M never visits the cell of $j+1$ of N, so N does not need to visit $j+1$. If the information is NOT enough, then N moves two more steps: from cell $j-1$ to j, then to $j+1$. Now N can get information about cell $j+1$ and knows how to modify. Note in this case, cell $j-1$ is not visited by M, so N only need modify j and $j+1$. So only one more step: from $j+1$ to j is needed. Totally $1+2+1=4$ steps in this case. We are done.

Problem 1(ii)

Based on (i) ,we can easily construct a 2-tape Turing machine, which refuses 5 steps of N emulation of d steps of M. Bascially, head1 keeps moving left while head2 keeps moving right.
But I have a question: if we want to say NO (ie. it is impossible to do sth.), we must prove without referencing any specific procedure. Are we required to prove that? i.e. we must prove that no matter which emulation technique we use, we can never emulate d steps of M by 5 ssteps of N.