# CMPS 101
# Summer 2008
# Homework Assignment 4

1. (3 Points)
   Consider the function $T(n)$ defined by the recurrence formula
   $$T(n) = \begin{cases} 6 & 1 \le n < 3 \\ 2T(\lfloor n/3 \rfloor) + n & n \ge 3 \end{cases}$$
   a. (1 Points) Use the iteration method to write a summation formula for $T(n)$.
   b. (1 Points) Use the summation in (a) to show that $T(n) = O(n)$
   c. (1 Points) Use the Master Theorem to show that $T(n) = \Theta(n)$

2. (6 Points)
   Use the Master theorem to find asymptotic solutions to the following recurrences.
   a. (1 Point) $T(n) = 7T(n/4) + n$
   b. (1 Point) $T(n) = 9T(n/3) + n^2$
   c. (1 Point) $T(n) = 6T(n/5) + n^2$
   d. (1 Point) $T(n) = 6T(n/5) + n\log(n)$
   e. (1 Point) $T(n) = 7T(n/2) + n^2$
   f. (1 Point) $S(n) = aS(n/4) + n^2$ (Note: your answer will depend on the parameter $a$.)

3. (10 Point) p.75: 4.3-2
   The recurrence $T(n) = 7T(n/2) + n^2$ describes the running time of an algorithm $A$. A competing algorithm $B$ has a running time of $S(n) = aS(n/4) + n^2$. What is the largest integer value for $a$ such that $B$ is asymptotically faster than $A$ ?

4. (10 Points)
   Let $G$ be an acyclic graph with $n$ vertices, $m$ edges, and $k$ connected components. Show that $m = n - k$. (Hint: use the fact that $|E(T)| = |V(T)| - 1$ for any tree $T$, from the induction handout.)

5. (1 Point) (Appendix B.4 problem 3)
   Show that any connected graph $G$ satisfies $\left|E(G)\right| \ge \left|V(G)\right| - 1$. (Hint: use induction on the number of vertices.)

6. (1 Point) p. 538: 22.2-2
   Show the $d$ and $\pi$ values that result from running breadth-first search on the undirected graph of Figure 22.3, using vertex $u$ as the source.