

**Only 1 choice is correct for each question and there are at least 5 choices for each question**

- 1: What is the asymptotic upper bound run time of X sort? (5pts)
- 2: Which order of the asymptotic growth rates shown below is correct? (5pts)
- 3: For the functions,  $n^k$  and  $c^n$  which one of the below asymptotic relationships between these functions is correct? (5pts)
- 4: For the functions below, which one of the asymptotic relationship is correct? (5pts)

Four cases of the Master Method are shown below.

The Master Method: Case 1	The Master Method: Case 2 (simple version)
<div>□ Recurrence: <math>T(n) = aT(n/b) + f(n)</math></div> <div> <u>Case 1:</u> <math>\frac{n^{\log_b a}}{f(n)} = \Omega(n^\epsilon)</math> for some constant <math>\epsilon &gt; 0</math> </div> <div> <i>i.e., <math>f(n)</math> grows polynomially slower than <math>n^{\log_b a}</math> (by an <math>n^\epsilon</math> factor).</i> </div> <div> <u>Solution:</u> <math>T(n) = \Theta(n^{\log_b a})</math> </div>	<div>□ Recurrence: <math>T(n) = aT(n/b) + f(n)</math></div> <div> <u>Case 2:</u> <math>\frac{f(n)}{n^{\log_b a}} = \Theta(1)</math> </div> <div> <i>i.e., <math>f(n)</math> and <math>n^{\log_b a}</math> grow at similar rates</i> </div> <div> <u>Solution:</u> <math>T(n) = \Theta(n^{\log_b a} \lg n)</math> </div>

The Master Method: Case 2 (general version)	The Master Method: Case 3
<div>□ Recurrence: <math>T(n) = aT(n/b) + f(n)</math></div> <div> <u>Case 2:</u> <math>\frac{f(n)}{n^{\log_b a}} = \Theta(\lg^k n)</math> for some constant <math>k \geq 0</math> </div> <div> <u>Solution:</u> <math>T(n) = \Theta(n^{\log_b a} \lg^{k+1} n)</math> </div>	<div> <u>Case 3:</u> <math>\frac{f(n)}{n^{\log_b a}} = \Omega(n^\epsilon)</math> for some constant <math>\epsilon &gt; 0</math> </div> <div> <i>i.e., <math>f(n)</math> grows polynomially faster than <math>n^{\log_b a}</math> (by an <math>n^\epsilon</math> factor).</i> </div> <div> <u>and the following regularity condition holds:</u>  <math>a f(n/b) \leq c f(n)</math> for some constant <math>c &lt; 1</math> </div> <div> <u>Solution:</u> <math>T(n) = \Theta(f(n))</math> </div>

Please solve the following four questions according to the Master Method

- 5: What is the asymptotic notation of this function X ? (5pts)
- 6: What is the asymptotic notation of this function X ? (5pts)
- 7: What is the asymptotic notation of this function X ? (5pts)
- 8: What is the asymptotic notation of this function X ? (5pts)
- 9: What would be the running time of below pseudo code shown algorithm? (5pts)

- 10: How X algorithm works at each step (something similar to this) (5pts)
- 11: Why X algorithms are faster than Y algorithms? (5pts)
- 12: Which one of the attributes below is not a characteristic of recursive algorithms? (10pts)
- 13: Which one of the attributes below is not a characteristic of dynamic programming? (10pts)
- 14: Which one of the below components is not one of the component of greedy algorithms? (10pts)
- 15: How many vertices and edges there are in the graph below? (5pts)
- 16: Describe the below directed graph as Vertices and Edges list (5pts)
17. Which one of the below average run time ( $\theta$ ) speed order of the sorting algorithms is correct? (5pts) ( $A > B$  means A is faster than B)