

Sample Midterm

CMPSC 465, Fall 2015

- **Do not open this exam booklet** until you are directed to do so. Read all the instructions on this page.
- Write **your name** and info on the front page.
- This exam contains 6 problems for a total of 50 points. You have 50 minutes.
- This exam is **closed book and closed notes**. No calculators, phones, cheat sheets, or programmable devices are permitted.
- Write your solutions in the space provided. If you need more space, use the scratch space at the back of the exam or the back of the pages.
- Do not waste time and paper rederiving facts that we have studied. It is sufficient to cite known results.
- Do not spend too much time on any one problem. Read them all through first, and attack them in the order that allows you to make the most progress.
- Show your work when appropriate, as partial credit may be given.

Good luck!

TO BE FILLED IN BY THE INSTRUCTOR

Problem 1	Problem 2	Problem 3	Problem 4	Problem 5	Problem 6	Total

Problem 1 (Python, 6pt)

Consider the following python program:

```
x= ( (2*2) **2) /4  
y="Bigstring"  
print y[x]
```

What is the output of this program?

Answer =

Problem 2 (Recurrences, 6pt)

Consider the recurrence $T(n) = 4T\left(\frac{n}{4}\right) + 3n$. Use the substitution method to show that $T(n) = O(n \log n)$.

Problem 3 (Master Theorem, 6 pts)

Use the Master Theorem, if possible, to solve each of the recurrences below. Either state that the Master Theorem does not apply or state the solution to $T(n)$.

I. $T(n) = 3T\left(\frac{n}{3}\right) + n^2$

Answer =

II. $T(n) = 8T\left(\frac{n}{2}\right) + n^3$

Answer =

III. $T(n) = 5T\left(\frac{n}{15}\right) + n \log n$

Answer =

Problem 4 (Big-Oh notation, 6pt)

Consider the fact that $7n \in O(n \log n)$. Give a value of c and n_0 that proves the statement.

$c =$

$n_0 =$

Problem 5 (Asymptotic analysis, 10pt)

For each of the rows below, circle exactly one of the options

- a. $f(n) = o(g(n))$
- b. $f(n) = \Theta(g(n))$
- c. $f(n) = \omega(g(n))$

$f(n) = 3$	$g(n) = \log n$	a or b or c
$f(n) = \log^2 n$	$g(n) = \log n$	a or b or c
$f(n) = n^2$	$g(n) = \frac{n^2}{\log n}$	a or b or c
$f(n) = n^2 \log n$	$g(n) = \log(n!^2)$	a or b or c
$f(n) = 3^n$	$g(n) = 2^{\sqrt{n}}$	a or b or c

Problem 6 (Divide and Conquer, 16pt)

[Note for sample midterm: you had this as a homework problem. On the actual exam, you would have a new problem which you have not seen before]

You are given two sorted arrays as input. Each array has n elements. In total, there are $2n$ elements. You can assume that all values in the arrays are distinct. A statistician asks you to find the n^{th} order statistic of these values. The n^{th} order statistic is the n^{th} smallest value. Give the pseudocode for a divide and conquer algorithm to find this value in asymptotic time $\Theta(\log n)$. You can assume that n is a power of two.

Median(A, A_{start}, A_{end}, B, B_{start}, B_{end})

// returns the median of A[Astart::Aend] and B[Bstart::Bend]