# Examination in
## 78010 /45011 Algorithms and Data Structures
## Monday July 31 2000, 0900-1300

**Contact during the examination**: Arne Halaas, ph. 73 593442.
**Tools**: All types of calculators allowed. All printed and handwritten material allowed.
**Answers**: All answers must be given in the boxes. Do not submit extra pages.
**Remember**: Enter your student number in the heading of each page.

## Problem 1. (20%)

Give your evaluation of the following 10 statements. Explain your reasoning.

(a)   $f(n) = 5 n^2 - 64 n + 256 = \Omega(n^2)$

Let $S_1$, $S_2$, $S_3$ be statements with running times $O(f_i(n))$, $i = 1,2,3$.

The following statements (b)-(j) apply to the compound statement

$$S: \quad \textbf{If } S_1 \textbf{ then } S_2 \textbf{ else } S_3$$

(b)  S is $O(\max(f_1(n), f_2(n), f_3(n)))$

(c)  S is $O(\max(f_1(n)+f_2(n), f_1(n)+f_3(n)))$

(d)  S is $O(\max(f_2(n), f_3(n)))$

(e)  S is $\Omega(f_1(n))$

(f)  S is $\Omega(\max(f_2(n), f_3(n)))$

(g)  S is $\Omega(\min(f_2(n), f_3(n)))$

(h)  S is $\Omega(\min(f_1(n), f_2(n), f_3(n)))$

(i)  S is $\Omega(\min(f_1(n)+f_2(n), f_1(n)+f_3(n)))$

(j)  S is $\Theta(f_2(n))$ if $f_2(n) = f_3(n)$

Answer: (Strike out "Yes" or "No". You must explain your reasoning. Each point counts 2 %)

a) Yes/no          Explanation



b) Yes/no          Explanation:


c) Yes/no          Explanation:


d) Yes/no          Explanation:

e) Yes/no         Explanation:

f) Yes/no         Explanation:

g) Yes/no         Explanation:

h) Yes/no         Explanation:

i) Yes/no         Explanation:

j) Yes/no         Explanation:


## Problem 2. (30%)

Assume that you have analyzed the algorithm A for your program P, and concluded that the worst-case running time for P is $O(f(n))$.
You are uncertain about whether the analysis of A is correct, and you have therefore measured the running time of P, $T(n)$, for several different, steadily increasing values of n.

**(a)** How would you proceed to find out if your worst-case analysis of A was correct?

Answer: (30 %) Explain your method concisely, in steps:

## Problem 3. (20%)

Assume that you are to sort N persons after their age, written on the form dd.mm.yyyy, for instance 31.07.2000, 03.04.1979. The age is part of a big data object associated with each person. The persons are to be sorted in increasing order by their age, and it is vitally important to be able to do this as efficiently as possible.

**(a)** Which method would you suggest? (Discuss your choice if the answer is not simple.)

Answer: 10%

**(b)** Find the time complexity of the method(s) suggested in **(a)**.

Answer: 10% (Explain your reasoning.)

## **Problem 4. (30%)**

A directed graph G=(V,E) is called "unipathic" if, for every pair of nodes u,v $\in$ V there is at most 1 path from u to v. An edge in E can have a positive or negative weight.

**(a)** Construct an efficient algorithm to find the shortest path from a source node s to all the other nodes v $\in$ V for a unipathic graph. The algorithm must detect whether G contains cycles with a negative total weight, and report this.

Answer (20%): Algorithm:

**(b)** Find the most useful O-time complexity of the method suggested in (a).

Answer: 10% (Explain your reasoning.)