Homework 1

CS 540
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1 Consider the following fragment of a high-level program (which counts prime numbers between 2 and n):

```
for i := 2 to n do
   a[i] := true;
count := 0;
for i := 2 to √n do
   if a[i] then
      begin
         count := count + 1;
         for j := 2i to n by i do
            a[j] := false
      end
```

a) Translate the fragment into a three-address program.

b) Construct the flow graph which corresponds to the three-address program.

2 Consider the following three-address program:

(1)	$a := 1$
(2)	$b := 2$
(3)	$c := a + b$
(4)	$d := c - a$
(5)	**if** $c > d$ **goto** (13)
(6)	$d := b * d$
(7)	**if** $a = d$ **goto** (13)
(8)	$d := a + b$
(9)	$e := e + 1$
(10)	**goto** (6)
(11)	$a := 3$
(12)	$b := 4$
(13)	$b := a + b$
(14)	$e := c - a$
(15)	**if** $b \neq e$ **goto** (3)
(16)	$a := b * d$
(17)	$b := a - d$

2 continued,

a) Construct the flow graph which corresponds to the three-address program.

b) For each definition, give (in table form) the blocks which it reaches the beginning of, and the blocks which it reaches the end of.

c) For each variable, identify the points (if any) at which it becomes dead.

3 Consider the following basic block:

$$
\begin{array}{|l|}
\hline
a := 2 \\
b := a * 4 \\
c := a + b \\
d := e[c] \\
b := 3 \\
a := e[c] \\
c := a + b \\
d := e[c] \\
\hline
\end{array}
$$

Apply the four optimizations as defined in class (common subexpression elimination, constant folding, copy propagation, dead-code elimination) until no further applications can be made. The optimizations can be applied in any order. Show the resulting basic block after each application.

4 Prove or disprove the following theorem:

> **Theorem**. For every basic block, if the four optimizations in problem 3 are applied until no more applications can be made, the same block results from any order of application.