

NAME \_\_\_\_\_

EE573 Final Exam, Fall 98

Points in parentheses indicate the approximate relative effort for answering the questions.

1. (5) Describe the effect that "array privatization" has on  
a) other compiler techniques

b) the performance of the program (be specific)

2. (5) Explain how the GCD test checks the dependence between statement s1 and s2 in the following code:

```
DO i=1,n
s1: a(2*i+3) = b(2*i+3)
s2: a(4*i) = b(3*i+4)
ENDDO
```

3. (5) In the following loop, enforcing the dependences would result in a serial execution.

```
DO i=1,n
  sum = sum + a(i)
ENDDO
```

Explain

a) why this is so (to a non-expert),

b) why we can find parallelism nevertheless. Are there drawbacks?

c) [5 bonus] what architecture features would enable this loop to be run in parallel without program restructuring.

4. a) (8) Write the dataflow equations for the "very busy expression" problem. Very busy expressions are expressions that are certain to be reused later.

b) (2) Indicate if this is a forward/backward flow and an all-path/any-path problem.

5. (5) Consider the production

```
<stmt> ::= WHILE <condition> #start-while DO  
         <stmt-list> ENDDO #final-while
```

explain the semantic actions performed in #start-while and in #final-while

6. (10) Give an example of an LR1 grammar, (which is not LR0 and not LL)

7. a) (5) Write a CFG for an expression containing \*, +, IDs, INTLITERALS and parentheses, so that the usual precedence rules are reversed (+ before \*).

b) (5) Add action symbols to your CFG. Describe the actions performed in each corresponding semantic routine.

8. (5) Determine the register need for the expression  $a*b + (c+d)*(e+f)$ , using the recursive tree algorithm. How many registers would a naive algorithm need? Assume that at most one memory location can be accessed per instruction.

9. (5) What are the major impediments that you see for optimizing compilers to obtain substantial program performance improvements?

10. (10) In Pascal, the expression `12..15` means "range from 12 to 15", whereas `12.15` means the decimal number 12.15. Draw a picture of the character stream as it is processed by a general multicharacter lookahead scanner. Explain how and at which character position the scanner identifies the token "12" in the range expression.

11. (10) Different compiler internal representations are best for applying different compiler techniques. What representation would you choose for the following techniques (give reasons):

- data dependence analysis
  
- peephole optimizations
  
- register allocation
  
- static semantics check
  
- reduction loop parallelization.

12. (5) Give two examples each for architecture dependent and architecture independent compiler techniques. Explain briefly.

13. (10) Transform the following loop nest into parallel form, using OpenMP (exact OpenMP syntax is not important)

```
DO i=1,n
  DO j=1,m
    ind=ind+1
    a(ind) = b(i,j)
  ENDDO
ENDDO
```

14. (5) In EE573 we have used C, Fortran, and occasionally Pascal examples. Give two examples of issues that you think arise when compiling object-oriented languages, such as C++ and Java.