University of Cape Town

Department of Computer Science

CSC3003S Class Test

2007

Marks : 20

Time : 45 minutes

Instructions:

- Answer all questions from Section A and 3 questions from Section B.
- Show all calculations where applicable.

Section A [Answer Question ONE – this is compulsory]

Question 1

- a) What is the purpose of the context-sensitive analysis phase of semantic anlysis? [1] *check for errors due to surrounding context e.g., type checking*
- b) Besides context-sensitive analysis, what is the other task carried out by the semantic routines of a compiler? [1]

generate machine code

c) Discuss 1 advantage and 1 disadvantage in using intermediate representations in compilers. [2] *adv: separation of front/back ends, easier to apply optimisations to, etc.*

disad: additional processing, mismatch between IR and real MC, etc.

d) During the process of generating machine code, when should registers be used instead of memory? [1]

as much as possible

Section B [Answer 3 questions ONLY]

Question 1: Symbols and Types

a) What is scope and why is it desirable to have multiple scopes?

where names can be referenced [1]

makes programmers life easier – less context to deal with [1]

b) What is the difference between name and structural type equivalence? Discuss with an example. [3]

name equivalence checks names of types only while structural equivalence checks structure of types irrespective of their names. [1] example: typedef int anint; int x, z; anint y; x and z are name equivalent while x and y are structurally equivalent [2]

[2]

Question 2: Activation Records

a)	What is an activation record?	[1]
	the layout of data to support subprogram invocation	
b)	Write a skeletal program that will result in the following activation record.	[4]



```
main ()
```

```
ł
 int subx (int x, int y)
  {
   int z;
   return ...
 int suby (int a)
  {
   int b;
   subx (1, 1)
   return ...
  }
 suby (10);
}
Minus one mark for each major error
or
Nesting=1, Parameters=1, Locals=1, Subprogram call statements=1
```

Question 3: Code Generation

a) Using the attached IR language, convert the following C-like expression to an unoptimised IR tree. Assume **a** and **b** are stack variables at offsets k_a and k_b respectively from the frame

pointer TEMP(FP). Provide the final tree and do not use the Nx/Cx/Ex expression types/objects. [3]

a = (b + 5) * 10

MOVE(MEM(+(TEMP(FP), CONST(k_a))),
*(CONST(10), +(MEM(+(TEMP(FP), CONST(k_b))), CONST(5))))

Minus one mark for each major error.

b) State the formula used to calculate memory offsets for element A[i, j] of a 2-dimensional array. Assume either row-major or column-major order. [2]

A : array [L1..U1, L2..U2] of type T

[2]

[1]

Offset = [(U2-L2+1) * (i-L1) + (j-L2)] * sizeof(T)

Question 4: Basic Blocks and Traces

a) What is a basic block?

a linear sequence of statements starting with a label and ending with a jump

b) What benefit is there in rearranging basic blocks into traces?

we could possibly eliminate redundant jumps

c) In preparation for instruction selection, what modifications do we need to make to code where a CJUMP is followed by a label other than its true and false labels? Illustrate with an example. [2]

Add in an immediately-following jump to the false label CJUMP (cond, a, b, lt, lf); LABEL lfprime; JUMP (NAME lf)