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Midterm
CSE 131
Winter 2008

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Subtotal	**_____(100 points)**
Page 6 Extra Credit	**_____ (7 points)**
Total	**_____**

1. Consider the following C-like code:

```
int x = 8;

int f()
{
  print( x );
  return x;
}

int g()
{
  int x = 5;
  print( x );
  return f();
}

int main()
{
  print( g() );
}
```

What does the program output if the compiler implements dynamic scoping? (3 pts)

_____
_____
_____

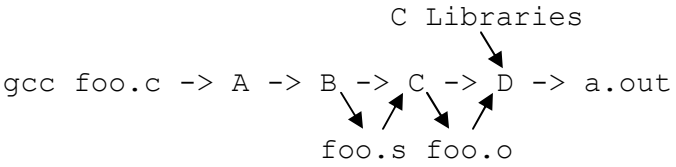
What does the program output if the compiler implements static scoping? (3 pts)

_____
_____
_____

Which kind of scoping (dynamic or static) adds run time overhead compared to the other kind of scoping? (1 pt)

Using the Right-Left rule write the C definition of a variable named `crazy` that is a pointer to an array of 6 elements where each array element is of type pointer to a function which takes one argument, a pointer to a pointer to a float, and returns a pointer to an array of 3 elements where each array element is of type pointer to struct screwball. (9 pts)

Fill in the blanks for each letter with the correct name of the C compilation stage (4 pts)



A. _____ C. _____

B. _____ D. _____

2. Given the following Reduced-C program and following the Project I spec for parameter passing type checking, for each function call determine if a semantic error will occur (and which kind of error). Use the letters below for your answers. (17 pts)

A. No Error
B. Assignability Error
C. Equivalence Error
D. Addressability Error

```
function : void foo0 ( int x ) { /* ... */ }
function : void foo1 ( float x ) { /* ... */ }
function : void foo2 ( float & x ) { /* ... */ }
function : void foo3 ( float[5] & x ) { /* ... */ }
function : void foo4 ( float * x ) { /* ... */ }
function : void foo5 ( float * & x ) { /* ... */ }

function : int main()
{
  int a;
  float b;
  int[5] c;
  float[5] d;

  foo0( a );                _____
  foo0( b );                _____

  foo1( a );                _____
  foo1( b );                _____

  foo2( a );                _____
  foo2( a + b );            _____
  foo2( b );                _____
  foo2( *&b );              _____

  foo3( c );                _____
  foo3( d );                _____

  foo4( c );                _____
  foo4( d );                _____
  foo4( &a );               _____
  foo4( &b );               _____
  foo4( (float *) &a );     _____

  foo5( &b );               _____
  foo5( (float *) &a );     _____
}
```

What four Reduced-C (and C) operators evaluate to a modifiable l-val? (4 pts)

_____ _____ _____ _____

3. The C compiler (unlike the C++ compiler) requires all initialized static data (global and static variables) to be initialized with compile time constant expressions so the compiler can set the initial values for these variables in the Data segment statically at compile time. Non-static data (local variables) only exist at run time, so they do not have this requirement. State which initializations in the C program below will elicit a C compiler error and which initializations will not elicit an error. Use the letters below for your answer. (8 pts)

A. No Compiler Error B. Compiler Error

```
#include <stdlib.h>     /* For function prototype of malloc() */

int foo( int x ) { return x + 5; }

int a0 = 5 + 10;                                  _____

int a1 = foo( a0 );                               _____

int a2 = a0 + 5;                                  _____

int *a4 = (int *) malloc( 5 + 10 );               _____

int main()
{
  int c0 = 5 + 10;                                _____

  int c1 = foo( c0 );                             _____

  int c2 = c0 + 5;                                _____

  int *c4 = (int *) malloc( 5 + 10 );             _____

  return 0;
}
```

Given the following Java statements, characterize the class of error detected. (4 pts)

A. Lexical error detected by the scanner
B. Syntax error detected by the grammar
C. Static semantic error detected by the parser/semantic analyzer
D. Dynamic semantic error detected by the run time environment

```
double[] arr = new double[10];
int n;

/* Read user input (specifically the value 17) into the variable n. */

arr[n] = 42.4012;     _____      /* Array reference out of bounds */

double d0 = 42.4.12;  _____      /* Should be 42.4012; */

int i0 = 42.4012;     _____      /* Should be an int initializer (not 42.4012) */

double d1 + 42.4012;  _____      /* Should be = (not +) */
```

4.

Given the following array definition

```
   /* C */
short x[13][27];
```

write the assembly level address calculation expression <u>taking into account scalar arithmetic</u> to access

```
x[i][j]
```

((x + _____) + _____)

The result is the address of where we can find this array element. (8 pts)

Given the array declaration

C

```
int a[3][2];
```

Mark with an **A** the memory location(s) where we would find

```
a[1][1]
```

a:

low memory high memory

Each box represents a byte in memory. (4 pts)

Using Reduced-C syntax from Project I, define a pointer to an array of 5 ints named `foo` such that (*`foo)[4]` is a valid expression. This will take two lines of code. (4 pts)

Given the following Reduced-C code, state whether the assignment statements are semantically correct or not. (3 pts)

```
structdef REC1 { float a; };
structdef REC2 { float a; };
typedef REC1 REC3;

REC1 r1;
REC2 r2;
REC3 r3;
```

`r1 = r1;` _____ A. Error

`r1 = r2;` _____ B. No Error

`r1 = r3;` _____

5. Reduced-C (like C++) allows variables to be defined anywhere within a code block with that variable's scope ranging from the point of that variable's definition to the end of the code block, possibly hiding a symbol with the same name defined in an outer scope. You dealt with this scoping mechanism in Project I. What gets printed with the following program? (3 pts)

```
function : int main()
{
  int i = 2;
  while ( i == 2 ) {
    i = i - 1;
    int i = 3;
    i = i + 2;
    if ( i > 2 ) {
      i = i - 3;
      int i = 4;
      i = i + 4;
      cout << i;        _____
    }
    cout << i;          _____
  }
  cout << i;            _____
  return 0;
}
```

With regard to the following C array and pointer definitions: (3 pts)

```
double arr[5];
double * ptr = arr;
```

What type is `arr` ? _____

What type is `*&arr[1]` ? _____

If `&arr[0]` is 4000, what is `&arr[2]` ? _____

Write two different statements only using `ptr` (not using `arr`) to assign the value 42.5 to the second array element in the array `arr`. (2 pts)

_____ _____

Write two different statements only using `ptr` (not using `arr`) to assign `ptr` to point to the last array element in `arr`. (2 pts)

_____ _____

Explain the difference between a pure declaration and a definition? (2 pts)

Give an example of a pure variable declaration. (1pt)

Give an example of a variable definition. (1pt)

6. Show the memory layout of the following C struct/record definition taking into consideration the **SPARC** data type memory alignment restrictions discussed in class. Fill bytes in memory with the appropriate struct/record member/field name. For example, if member/field name `p` takes 4 bytes, you will have 4 `p`'s in the appropriate memory locations. If the member/field is an array, use the name followed by the index number. For example, some number of `p[0]`s, `p[1]`s, `p[2]`s, etc. Place an `X` in any bytes of padding. Structs and unions are padded so the total size is evenly divisible by the most strict alignment requirement of its members. (14 pts)

```
struct foo {
   char   a[6];
   double b;
   float  c;
   short  d;
   int    e[3];
};

struct foo fubar;
```

low memory

fubar:

high memory

What is the `offsetof( struct foo, e[1] )`? _____

What is the `sizeof( struct foo )`? _____

If `struct foo` had been defined as `union foo` instead, what would be the `sizeof( union foo )`? _____

If you rearranged the order of the struct members in struct foo to minimize padding, how many bytes of padding would you need? _____

And what would be the size of this modified struct? _____

Does it matter whether you arrange the struct members in struct foo from largest to smallest data type or smallest to largest data type to minimize padding? _____

Extra Credit (7 points)

What gets printed by the following C program?

```
#include <stdio.h>

int
main()
{
  char a[] = "CSE131";
  char *p = a;

  printf( "%c", *p++ );             _______

  printf( "%c", ++*p );             _______

  printf( "%c", *++p + 1 );         _______

  p++;

  printf( "%c", *p = *p + 3);       _______

  printf( "%c", --*p++ );           _______

  printf( "%d", p - a );            _______

  printf( "%s", a );           ________________

  return 0;
}
```

A portion of the Operator Precedence Table

Operator	Associativity
++ postfix increment -- postfix decrement	L to R
* indirection ++ prefix increment -- prefix decrement & address-of	R to L
* multiplication / division % modulus	L to R
+ addition - subtraction	L to R
.	
.	
.	
= assignment	R to L

Scratch Paper