复旦大学计算机科学技术学院
2020-2021 学年第一学期期中考试试卷

课程名称： 计算机系统基础 **课程代码：** COMP130156.01/COMP130143.02
开课院系： 计算机科学技术学院 **考试形式：** 开卷
姓名： _____ **学号：** _____ **专业：** _____

提示：请同学们秉持诚实守信宗旨，谨守考试纪律，摒弃考试作弊。学生如有违反学校考试纪律的行为，学校将按《复旦大学学生纪律处分条例》规定予以严肃处理。

题号	1	2	3	4	5	6	7	8	总分
得分									

1. (16 分)

Assume we are running code on a 6-bit machine using two's complement arithmetic for signed integers. A "short" integer is encoded using 3 bits. Fill in the empty boxes in the table below. The following definitions are used in the table:

```
short sy = -3;
int y = sy;
int x = -17;
unsigned ux = x;
```

Note: You need not fill in entries marked with "–".

Expression	Decimal Representation	Binary Representation
Zero	0	
–	-6	
–		01 0010
ux		
y		
x>>1		

TMax		
-TMin		
TMin+TMin		

2. (18 分)

Consider the following 8-bit floating point representation based on the IEEE floating point format:

- There is a sign bit in the most significant bit.
- The next 3 bits are the exponent. The exponent bias is $2^{3-1} - 1 = 3$.
- The last 4 bits are the fraction.
- The representation encodes numbers of the form: $V = (-1)^s * M * 2^E$, where M is the significand and E is the biased exponent.

The rules are like those in the IEEE standard (normalized, denormalized, representation of 0, infinity, and NAN). FILL in the table below. Here are the instructions for each field:

- **Binary:** The 8 bit binary representation.
- **M:** The value of the significand. This should be a number of the form x or x/y, where x is an integer, and y is an integral power of 2. Examples include 0, 3/4.
- **E:** The integer value of the exponent.
- **Value:** The numeric value represented.

Note: you need not fill in entries marked with "—".

Description	Binary	M	E	Value
Minus zero				-0.0
—	0 100 0101			
Smallest denormalized (negative)				
Largest normalized (positive)				
One				1.0
—				5.5
Positive infinity		—	—	$+\infty$

3. (6 分)

Consider the following C functions and assembly code:

```
int fun7(int a)
{
    return a * 30;
}

int fun8(int a)
{
    return a * 34;
}

int fun9(int a)
{
    return a * 18;
}
```

```
pushl %ebp
movl %esp,%ebp
movl 8(%ebp),%eax
sall $4,%eax
addl 8(%ebp),%eax
addl %eax,%eax
movl %ebp,%esp
popl %ebp
ret
```

Which of the functions compiled into the assembly code shown?

4. (6 分)

Consider the following C functions and assembly code:

```
int fun4(int *ap, int *bp)
{
    int a = *ap;
    int b = *bp;
    return a+b;
}

int fun5(int *ap, int *bp)
{
    int b = *bp;
    *bp += *ap;
    return b;
}

int fun6(int *ap, int *bp)
{
    int a = *ap;
    *bp += *ap;
    return a;
}
```

```
pushl %ebp
movl %esp,%ebp
movl 8(%ebp),%edx
movl 12(%ebp),%eax
movl %ebp,%esp
movl (%edx),%edx
addl %edx,(%eax)
movl %edx,%eax
popl %ebp
ret
```

Which of the functions compiled into the assembly code shown?

5. (10 分)

Consider the source code below, where M and N are constants declared with `#define`.

```
int array1[M][N];
int array2[N][M];

int copy(int i, int j)
{
    array1[i][j] = array2[j][i];
}
```

Suppose the above code generates the following assembly code:

```
copy:
  pushl %ebp
  movl %esp,%ebp
  pushl %ebx
  movl 8(%ebp),%ecx
  movl 12(%ebp),%ebx
  leal (%ecx,%ecx,8),%edx
  sall $2,%edx
  movl %ebx,%eax
  sall $4,%eax
  subl %ebx,%eax
  sall $2,%eax
  movl array2(%eax,%ecx,4),%eax
  movl %eax,array1(%edx,%ebx,4)
  popl %ebx
  movl %ebp,%esp
  popl %ebp
  ret
```

What are the values of M and N?

M =

N =

6. (10 分)

Consider the following assembly representation of a function `foo` containing a `for` loop:

```
foo:
   pushl %ebp
   movl %esp,%ebp
   pushl %ebx
   movl 8(%ebp),%ebx
   leal 2(%ebx),%edx
   xorl %ecx,%ecx
   cmpl %ebx,%ecx
   jge .L4
.L6:
   leal 5(%ecx,%edx),%edx
   leal 3(%ecx),%eax
   imull %eax,%edx
   incl %ecx
   cmpl %ebx,%ecx
   jl .L6
.L4:
   movl %edx,%eax
   popl %ebx
   movl %ebp,%esp
   popl %ebp
   ret
```

Fill in the blanks to provide the functionality of the loop:

```
int foo(int a)
{

    int i;
    int result = _____________;

    for( ________; ________; i++ ) {

        ___________________;

        ___________________;
    }


    return result;
}
```


7. (16 分)

Consider the following C declarations:

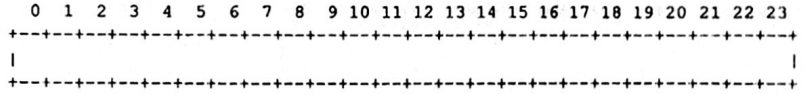
```
typedef struct {
    short code;
    int start;
    char raw[3];
    double data;
    } OldSensorData;

typedef struct {
    short code;
    short start;
    char raw[5];
    short sense;
    short ext;
    double data;
    } NewSensorData;
```

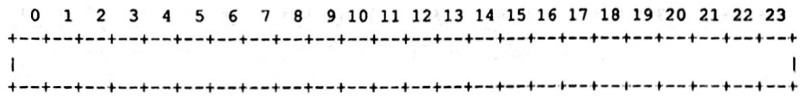
A. Using the templates below (allowing a maximum of 24 bytes), indicate the allocation of data for structs of type `OldSensorDataNewSensorData`. Mark off and label the areas for each individual element (arrays may be labeled as a single element). **Cross hatch the parts that are allocated, but not used (to satisfy alignment).**

Assume the Linux alignment rules discussed in class. **Clearly indicate the right hand boundary of the data structure with a vertical line.**

`OldSensorData:`



`NewSensorData:`



B. Now consider the following C code fragment:

```
void foo(OldSensorData *oldData)
{
    NewSensorData *newData;

    /* this zeros out all the space allocated for oldData */
    bzero((void *)oldData, sizeof(oldData));

    oldData->code = 0x104f;
    oldData->start = 0x80501ab8;
    oldData->raw[0] = 0xe1;
    oldData->raw[1] = 0xe2;
    oldData->raw[2] = 0x8f;
    oldData->raw[-5] = 0xff;
    oldData->data = 1.5;

    newData = (NewSensorData *) oldData;

    ...
```

Once this code has run, we begin to access the elements of newData. Below, give the value of each element of `newData` that is listed. Assume that this code is run on a Little-Endian machine such as a Linux/x86 machine. You must give your answer in hexadecimal format. **Be careful about byte ordering!**.

(a) `newData->start = 0x`_____

(b) `newData->raw[0] = 0x`_____

(c) `newData->raw[2] = 0x`_____

(d) `newData->raw[4] = 0x`_____

(e) `newData->sense = 0x`_____

Problem 8. (18 分):

The problem concerns the following C code. This program reads a string on standard input and prints an integer in hexadecimal format based on the input string it read.

```
#include <stdio.h>

/* Read a string from stdin into buf */
int evil_read_string()
{
    int buf[2];
    scanf("%s",buf);
    return buf[1];
}

int main()
{
    printf("0x%x\n", evil_read_string());
}
```

Here is the corresponding machine code on a Linux/x86 machine:

```
08048414 <evil_read_string>:
8048414:   55                  push  %ebp
8048415:   89 e5               mov   %esp,%ebp
8048417:   83 ec 14            sub   $0x14,%esp
804841a:   53                  push  %ebx
804841b:   83 c4 f8            add   $0xfffffff8,%esp
804841e:   8d 5d f8            lea   0xfffffff8(%ebp),%ebx
8048421:   53                  push  %ebx                  address arg for scanf
8048422:   68 b8 84 04 08      push  $0x80484b8            format string for scanf
8048427:   e8 e0 fe ff ff      call  804830c <_init+0x50> call scanf
804842c:   8b 43 04            mov   0x4(%ebx),%eax
804842f:   8b 5d e8            mov   0xffffffe8(%ebp),%ebx
8048432:   89 ec               mov   %ebp,%esp
8048434:   5d                  pop   %ebp
8048435:   c3                  ret

08048438 <main>:
8048438: 55                    push  %ebp
8048439: 89 e5                 mov   %esp,%ebp
804843b: 83 ec 08              sub   $0x8,%esp
804843e: 83 c4 f8              add   $0xfffffff8,%esp
8048441: e8 ce ff ff ff        call  8048414 <evil_read_string>
8048446: 50                    push  %eax                    integer arg for printf
8048447: 68 bb 84 04 08        push  $0x80484bb              format string for printf
804844c: e8 eb fe ff ff        call   804833c <_init+0x80> call printf
8048451: 89 ec                 mov   %ebp,%esp
8048453: 5d                    pop   %ebp
8048454: c3                    ret
```

This problem tests your understanding of the stack discipline and byte ordering. Here are some notes to help you work the problem:

- scanf("%s", buf) reads an input string from the standard input stream (stdin) and stores it at address buf (including the terminating '\0' character). It does not check the size of the destination buffer.
- printf("0x%x", i) prints the integer i in hexadecimal format preceded by "0x".
- Recall that Linux/x86 machines are Little Endian.
- You will need to know the hex values of the following characters:

Character	Hex value	Character	Hex value
'd'	0x64	'v'	0x76
'r'	0x72	'i'	0x69
'.'	0x2e	'l'	0x6c
'e'	0x65	'\0'	0x00
		's'	0x73

A. Suppose we run this program on a Linux/x86 machine, and give it the string "`dr.evil`" as input on stdin.

Here is a template for the stack, showing the locations of `buf[0]` and `buf[1]`. Fill in the value of `buf[1]` (in hexadecimal) and indicate where `ebp` points just **after** `scanf` returns to `evilreadstring`.

```
                |<- buf[0]->|<-buf[1] ->|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

What is the 4-byte integer (in hex) printed by the `printf` inside main?

0x_____

B. Suppose now we give it the input "`dr.evil.lives`" (again on a Linux/x86 machine).

(a) List the contents of the following memory locations just **after** `scanf` returns to `evilreadstring`. Each answer should be an unsigned 4-byte integer expressed as 8 hex digits.

`buf[0]` = 0x_____

`buf[3]` = 0x_____

(b) Immediately **before** the `ret` instruction at address `0x08048435` **executes, what is the value of the** frame pointer register `%ebp`?

`%ebp` = 0x_____

You can use the following template of the stack as *scratch space. Note:* this does **not have to be filled out to receive full credit.**

```
                <- buf[0] -><- buf[1] ->
--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--
  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--
```