Sec: 1 2 (circle) ECE-1021 Spring 2004 Exam #1 19 February 2004

NAME:_____ Score:_____/100

Unless specified otherwise, assume that:

- The variables i, j, k, l, m, and n are declared as int
- The variables u, v, w, x, y, and z are declared as doubles.
- Any reference to a "floating point" value is to be taken as a type double.
- Any reference to an "integer" value is to be taken as a type int.

IEEE-574 Single-precision floating point standard: 32 bits total including an 8-bit exponent.
IEEE-574 Double-precision floating point standard: 64 bits total including an 11-bit exponent.

Multiple Choice (2 points each).

1) Which of the following are complementary pairs of operators?
   a) (= = , !=), (>=,<), (>, <=)
   b) (= = , !=), (>,<), (>=, <=)
   c) (= = , !=), (>,<), (>=, =<)
   d) (= = , !=), (>,>=), (<=, <=)

2) Which of the following statements is false?
   a) A logical operator will always return a value of 0 or 1.
   b) A value is a logical FALSE if it is equal to 0.
   c) Negative values cannot be interpreted as logical values.
   d) A value is a logical TRUE if it is equal to –1.

3) Modulo division of m by n (m%n) is used to return

   a) The result of an integer division.
   b) A value of 1 if m can be evenly divided by n.
   c) The result of a floating point division even if the operands are integers.
   d) The same value that would be returned by m – n*(m/n).

4) Which of the following assignments produces a value of zero?

   a) result = 9%3 – 1;
   b) result = 8%3 – 1;
   c) result = 2 – 8%3;
   d) result = 2 – 6%3;

5) Consider the following statement: int i = 100, j = 0; Which of the following statements is true?

   a) i < 3
   b) (i>0) || (j>50)
   c) !(j<1)
   d) (j<1) && (i<=10)

6) What must be true of an else statement?

a) It must contain a logical test.
b) It is associated with the closest if() statement above it.
c) It must be properly indented for the compiler to determine which if() statement is controlling it.
d) It must appear immediately after an if() statement in the program structure.

7) What is the value of the following expression?

```
!( (4 - 4%3) < 3 || (6/4 > 1) )
```

a) true.
b) false.
c) invalid.
d) none of the above.

8) Why does C offer three different looping structures?

a) Because no one looping structure can implement all of the different types of loop logic that might be needed by a program.
b) Because the for() loop is only capable of executing a finite and predetermined number of times and the while() loop is not guaranteed to execute the loop code at least once.
c) For compatibility with other languages.
d) Because each structure lends itself to a certain type of looping logic and program readability and maintainability are enhanced if the structure used matches the logic implemented.

9) What is the purpose of indenting various lines of code different amounts?

a) It is a requirement of the language – the amount of indenting is used by the compiler to determine code structure.
b) It is purely for aesthetic value and is completely arbitrary. There is no significant advantage to indented code versus non-indented code.
c) The indenting of certain functions, such as loops and if()...else structures, are mandatory and the rest is just to make the appearance of the code more consistent.
d) It is purely to aid the programmer in determining code structure quickly and accurately – the compiler ignores all indenting.

10) What are the three basic building-block structures of a structured program?

a) Sequences, selections and repetitions.
b) Input statements, output statements, computation statements.
c) Goto's, loops, I/O.
d) Looping structures, switching statements, computed goto statements.

11) What are the two common text-based ways of indicating that a number is written in base-16?

a) Prefixing the number with "0x" or placing an "H" as a suffix.
b) Suffixing the number with "x" or placing an "H" as a prefix.
c) Placing "/16" after the number or placing "(16x)" before the number.
d) Placing "base-16" to the left of the number or, alternately, to the right of the number.

12) If j = 0, k = 2 and m = 15, what value is stored in n?

```
n = 8*(k && m) + 16*(j < k/m) + 32*(j || (!m)) + (m/k);
```

a) 8.
b) 15.
c) 15.5.
d) 31.5.

13) In the base-5 number 323.041, what is the weighting of the digit '4'?

a) 0.04
b) 1/20
c) 5e-1
d) 5e-3

14) If it takes N digits to represent the integer value V in a positional number system using base B, which of the following relations will be true?

a) V = B^N
b) (B^N < V) AND (V <= B^(N+1))
c) (B^(N-1) <= V) AND (V < B^N)
d) V^N = B

15) What is required for a (nonzero) number to be in a normalized exponential format?

a) The mantissa has exactly one non-zero digit to the left of the radix point.
b) The exponent is the smallest possible value it can be.
c) The mantissa is an integer.
d) The exponent is the largest possible value it can be.

16) What is the defining relationship for the concept of a negative number?

a) A positive number with a minus sign in front.
b) A number and its negative will sum to zero.
c) A number and its negative have the same absolute value.
d) The negative of a number is less than zero with the same absolute value as the number itself.

17) What is the hexadecimal digit used to represent the decimal value 13?

a) A = 10
b) B = 11
c) C = 12
d) D = 13

18) Repeated division by the number base is primarily useful for what purpose?

a) Converting a number from base-10 to another base.
b) Converting a number between two non-decimal number bases.
c) Converting a number from another base to base-10.
d) Determining how many decimal digits a number has.

19) Repeated multiplication by the number base is primarily useful for what purpose?

a) Converting a number from base-10 to another base.
b) Converting a number between two non-decimal number bases.
c) Converting a number from another base to base-10.
d) Determining how many decimal digits a number has.

20) Why are octal and hexadecimal so prevalent in computer science?

a) Because binary bit strings can be converted to and from octal and hexadecimal very quickly.
b) Because the first programmers set the standard and we are stuck with it.
c) Because arithmetic is easier in either of these two bases than it is in decimal.
d) Because learning hexadecimal serves as a "right of passage" for would be programmers.

21) What is the most likely reason that a "nibble" is the size that it is?

a) Because that is exactly half a byte.
b) Because the first processor has a data bus that was this size.
c) Because anything larger would require the use of a number base that is too difficult for humans to work with.
d) Because that is the smallest number of bits that can be used to represent all of the decimal digits.

22) Which of the following is not one of the common ways of representing a negative integer?

a) Signed binary.
b) Offset binary.
c) One's complement.
d) Two's complement

23) What property does two's compliment exploit?

a) The inverting all of the bits in a value produces a one's compliment value.
b) That subtraction is equivalent to adding the negative of a number.
c) The fact that, in a fixed-width binary value consisting of N bits, that 2^N is indistinguishable from zero.
d) That addition and subtraction use the same hardware in a computer.

24) How is zero represented in a IEEE standard floating point representation?

a) As a pattern of all zeroes.
b) Zero cannot be exactly represented because of the implied leading one in the mantissa.
c) As a pattern with a one as the second bit from the left.
d) As a pattern of all zeroes except for a leading one.

25) What is the order of the information, left to right, in an IEEE standard floating point representation.

a) mantissa, exponent
b) sign, exponent, mantissa magnitude
c) sign, mantissa magnitude, exponent
d) exponent, sign, mantissa magnitude

26) Why does an exponent consisting of all zeroes and an exponent consisting of all zeroes except for a trailing one represent the same exponent value?

a) To avoid a gap as the representation moves from a normalized to a non-normalized interpretation.
b) To increase the static range of the representation.
c) So that zero may be exactly represented.
d) It doesn't.

27) Given a bit pattern representing a floating point value in the standard IEEE format, how can the negative of that value be represented?

a) By taking the two's complement of the mantissa.
b) By inverting the sign bit and all bits of the mantissa.
c) By treating the entire pattern as though it were an integer and taking the two's complement of it.
d) By inverting the sign bit.

28) Given a four byte integer at address 0x3CF0 that uses the Little Endian convention, at what address is the most significant byte stored?

0x3CF0 +1 +2 +3
LSB msB

a) 0x3CED
b) 0x3CF0
c) 0x3CF3
d) 0x3CF4

29) How is the end of a string of characters indicated in many programming languages, including C?

a) By following the string with an additional byte that is set to all zeroes - the NUL character.
b) By interpreting the first byte in the string as an integer that indicates how many characters are in the string.
c) By passing the length of the string as a separate argument to any function needing that information.
d) By repeating the last character in the string eight times.

30) The speed of light (in a vacuum) is exactly 299,792,458 meters/second. How many digits are required to express this in base 5?

$5^N = C =$

ASIDE: $5000 = 10^{3.7}$ 4 digits
so ROUND UP

$N = \frac{\log(c)}{\log(5)} = 12.1 \Rightarrow 13$ digits

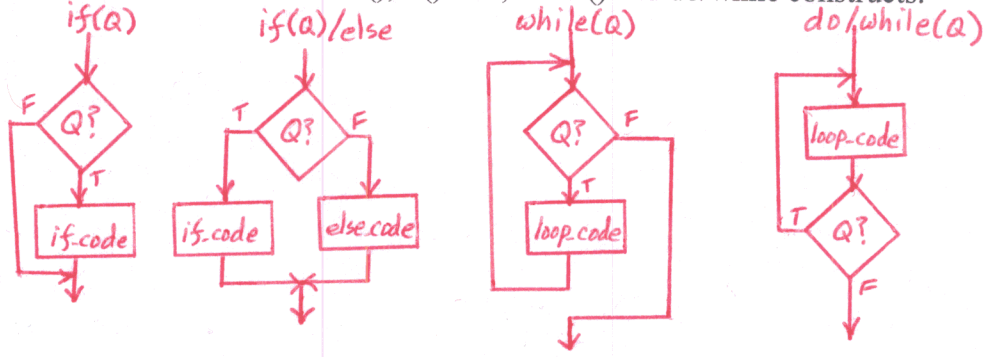
a) 12
b) 13
c) 14
d) 15

Short Answer

31) (2 pts) The string, "Time 2 Go!" is stored at memory location 0xC340. Indicate the values (using the actual numbers - in hex) that are stored in each of the relevant memory locations.

0xC340	0	1	2	3	4	5	6	7	8	9	A	B
	'T'	'i'	'm'	'e'	SP	'2'	SP	'G'	'o'	'!'	NUL	
	54	69	6D	65	20	32	20	47	6F	21	0	

32) (4 pts) Draw the flow charts for an if(), if()/else, while() and do/while constructs.



33) (2 pts) What value is stored in k?

```
k = 25/10*10;
```

2

20

34) (2 pts) If a (non-global) variable is not initialized, what value will it have by default?

whatever value is already in that memory location

35) (2 pts) The following values are stored in memory starting with Card #10: 44, 14, 89, 27, 10, 12. Identify that card(s) that are written to as a result of the following instruction and indicated the new value(s) that is/are stored. (in decimal mode): ADD **11, *13, **15 ?

CARD	10	11	12	13	14	15
VAL	44	14	89	27	10	12

CARD #1 GETS 1
CARD #10 GETS 16

ADD **11, *13, **15
*14 27 *12
10 89

ADD 10, 27, 89
116

36) (4 pts) Briefly summarize the key elements of the top-down algorithm development strategy.

DIVIDE AND CONQUER

BREAK PROBLEM INTO SET OF SMALLER, SIMPLER PROBLEMS

CONTINUE PROCESS UNTIL INDIVIDUAL PROBLEMS ARE SOLVABLE

BUILD TOTAL SOLUTION USING SOLUTIONS TO THE SMALLER PROBLEMS.

Longer Answer

37) (6 pts) A particular number is represented using two bytes in signed binary, offset binary, and two's compliment format. In no particular order, the three representations yield values of 0x7C03, 0x83FD, and 0xFC03. What is the original base-10 number?

SIGN BIT: REPRESENTATION	value pos	value neg
SIGNED	0	1
OFFSET	1	0
2's COMP	0	1

	SIGN BIT
0x7C03	0
0x83FD	1
0xFC03	1

value is negative & 7C03 IS OFFSET BINARY

IN A TWO-BYTE OFFSET BINARY SYSTEM, ZERO IS REPRESENTED BY 0x8000.
0x7C03 IS LESS THAN THIS BY:

```
  7FF,
0x 8000
  -7C03
 0x03FD
```

(((3x16)+15)x16)+13 = 1021

-1021

```
  16
   3
  48
 +15
  63
 x16
 378
  63
1008
 +13
1021
```

38) (6 pts) Given two two-byte binary bit strings A and B, what is the practical net effect of executing the following three statements:

A = A^B
B = A^B
A = A^B

Note that '^' indicates bitwise XOR and that these instructions are neither ACME-1021 nor C code. This is a general question regarding the impact of performing three successive XOR operations on the same variables as shown above.

SINCE IT IS A BITWISE OPERATION, EACH BIT IS INDEPENDENT.
FOUR POSSIBILITIES FOR EACH BIT POSITION

		LINE #1	LINE #2	
A_R	B_R	A_n	B_n	A_n
0	0	0	0	0
0	1	1	0	1
1	0	1	1	0
1	1	0	1	1
		VALUES FOR LINE#1	VALUES FOR LINE#2	VALUES FOR LINE#3

B_R FINAL = A_R INITIAL
A_n FINAL = B_R INITIAL

A & B ARE SWAPPED

39) (6 pts) Performing all computations directly in hexadecimal, write the result of 0xFADE divided by 0x2BAD in quotient-remainder form (i.e., the quotient is an integer).

$$2BAD \overline{)\,FADE}\ 5$$

$$DA61$$

$$207D$$

$$3334 \times 5 = DA61$$

$$\frac{F000}{3000} = \frac{F}{3} = 5$$

5 r207D

40) (6 pts) Below is a partial template for an ACME-1021 if() structure. Write the code that would go in the IF_TEST section for each of the relational operators (operating on the values stored on cards A and B). You may assume that all values fit on a single card. Clearly identify which operator is being implemented for each control structure.

```
EQU BORROW (1)
EQU A (14)
EQU B (15)
EQU Q (16)

LABEL IF_TEST
// Control structure goes here

LABEL IF_CODE
// Code to execute if TEST is TRUE

LABEL END_IF
```

A<B

```
SUB Q, *A, *B
SKP BORROW
JMP END_IF
JMP IF_CODE
```

A>B

```
SUB Q, *B, *A
SKP BORROW
JMP END_IF
JMP IF_CODE
```

A≠B

```
SUB Q, *A, *B
SKP Q
JMP END_IF
JMP IF_CODE
```

A≥B

```
SUB Q, *A, *B
SKP BORROW
JMP IF_CODE
JMP END_IF
```

A≤B

```
SUB Q, *B, *A
SKP BORROW
JMP IF_CODE
JMP END_IF
```

A=B

```
SUB Q, *A, *B
SKP Q
JMP IF_CODE
JMP END_IF
```

EXTRA CREDIT – (10 pts) An ACME-1021 program is to be written that computes the sum of the first n non-zero integers. At the time that your program begins execution, the value of n has been stored on Card #2. Your result should be a two-card result (i.e., four digit answer) stored at Card #3 in Little Endian format.

1) Draw a flowchart for this program.
2) Implement this program in ACME-1021 code. You may use the Assembly Language directives (e.g., EQU and LABEL) or not at your discretion.
3) Using the supplied memory map, walk through the execution of your program for n=4.

0	1	2	3	4	5		
~~0~~	0	4	4	0			
~~0~~	0	3	7	0			
	~~0~~	2	9	0			
	0	1	10	0			
	0	0	10	0			
	~~0~~						
	0						
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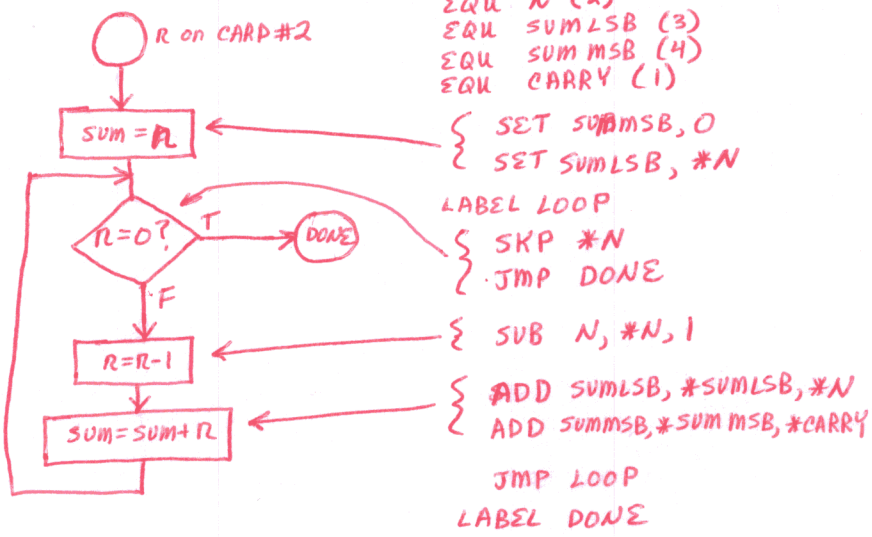

EXTRA CREDIT – (5 pts) The value e (2.718282) is stored as a four-byte IEEE-574 single precision floating point number in Little Endian format. It is then mistakenly read as a four-byte IEEE-574 single precision floating point number in Big Endian format. What is the base-10 value that would be read as a result? Report the answer to seven significant digits.

sign	exponent (E)	mantissa (M)
1	8	23

↑ SIGN = 0

$$\text{value} = 2.718282 = \left(1 + \frac{M}{2^{23}}\right) \cdot 2^{x}$$

$$1.0 \cdot 2^{x} \le \text{value} < 2.0 \cdot 2^{x} = 2^{(x+1)}$$

$$2^{x} \le \text{value}$$

$$x \ln(2) \le \ln(\text{value})$$

$$x \le \frac{\ln(\text{value})}{\ln(2)} = 1.4$$

$x = 1$

$x = E - 127$ (127 = bit pattern for 0)

$E = x + 127 = 128 = 2^{7} = 0x80$

$E = 0x80$

$$\text{value} = \left(1 + \frac{M}{2^{23}}\right) \cdot 2^{1}$$

$$M = \left(\frac{\text{value}}{2} - 1\right) \cdot 2^{23} = 3{,}012{,}693$$

$$\frac{3{,}012{,}693}{16^{5}} = 2.873128$$

13.970048
15.520768
8.332288
5.316608
5.06728

USING METHOD OF SUBTRACTING WHOLE PART AND MULTIPLYING BY 16.

$2.(13)(15)855 \Rightarrow 2DF855$

FINAL PATTERN:

4	0	2
0 100	0000	0 010
8	0	2

DF855

0x402DF855

STORED IN LITTLE ENDIAN:

BASE	+1	+2	+3
55	F8	2D	40

READ IN BIG ENDIAN! 0x55F82D40

0 | 01010111 | 111 1000 0010 1101 0100 0000

A B

0xAB = 160 + 11 = 176

$x = 176 - 127 = 49$

$x = 49$

$M = 7{,}875904$ (by repeated mult)

$$\text{value} = +\left(1 + \frac{7{,}875{,}904}{2^{23}}\right) \cdot 2^{49}$$

$$= 1.9388092 \times 2^{49}$$

$$= \text{value} = 1.0914929 \times 10^{15}$$