CMPSCI 145 MIDTERM #2

SPRING 2017

April 7, 2017

Professor William T. Verts

NAME	

PROBLEM	SCORE	POINTS
1		15+5
2		25
3		20
4		10
5		18
6		12
GRAND TOTAL		100

CMPSCI 145 – Spring 2017 – In-Class Midterm Exam – Solution Key
Professor William T. Verts

<1> 15 Points – Answer 15 of the following problems (1 point each). Answer more than 15 for extra credit. Scoring will be +1 for each correct answer (+½ for partial credit), -1 for each incorrect answer, and 0 for blank answers. Your score will be the sum, but will not go below zero. (For example 15 correct and 5 incorrect will give a total score of 10.)

137	What is the decimal value of the 8-bit ***unsigned*** binary number **10001001** ?
-9	What is the decimal value of the 8-bit ***sign and magnitude*** binary number **10001001** ?
-118	What is the decimal value of the 8-bit ***one's complement signed*** binary number **10001001** ?
-119	What is the decimal value of the 8-bit ***two's complement signed*** binary number **10001001** ?
89	What is the decimal value of the 2-digit ***BCD*** binary number **10001001** ?
56	What is the decimal value of the 2-digit ***XS3*** binary number **10001001** ?
101000111	What is the binary sum of **10001001** and **10111110**? (You may need more than 8 bits.)
0001 0010 0111	What is the BCD sum of **10001001** and **00111000**? (You may need more than 8 bits.) Show the result in binary.
Denormal	In floating-point, what are numbers called where the biased exponent is equal to zero and the mantissa is non-zero?
NaN/NotANumber	In floating-point, what are numbers called where the biased exponent is all 1-bits and the mantissa is non-zero?
Infinity	In floating-point, what is the number called where the biased exponent is all 1-bits and the mantissa is zero?
Kiss at 1 pt.	Two spheres, each of radius 10 units, have centers 20 units apart. Do they overlap, kiss at one point, or miss each other?
Overlap	Two spheres, each of radius 10 units, have centers 15 units apart. Do they overlap, kiss at one point, or miss each other?
Miss	Two spheres, each of radius 10 units, have centers 25 units apart. Do they overlap, kiss at one point, or miss each other?
Interval Arithmetic	What approach keeps two numbers for each computation, one of which rounds results down and the other rounds results up?
Bézier Curve	What type of cubic curve is tangent at each endpoint to the curve through that endpoint and its corresponding control point?
Ray Tracing	What technique allows us to generate synthetic scenes by passing a line from the eye through each pixel into a 3D model?
Sorted	How must a list of items be configured so that a binary search on that list is possible?
Sequential	One of two traditional methods for accessing a database is called "random access". What is the other method?
Hierarchical	What is the third method of database access, as used in image pyramids?

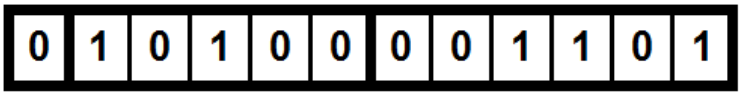
<2> 25 Points – We are going to invent a new floating-point format, called "peculiar-precision" which is exactly twelve bits in length. There is a sign bit, five bits for the biased exponent, and six bits for the mantissa, and all coding rules are the same as single, double, half, and quarter precision.

A. (4 Points) What is the value of the bias for this format? $2^{5-1}-1 = \mathbf{15}$

B. (15 Points) Fill in all the boxes below with 0 and 1 bits to form the indicated values:

	Positive Quiet NaN
	Negative Infinity
	Largest Normalized Positive Value
	Smallest Normalized Positive Value
	-6.75

C. (6 Points) What are the binary scientific, true binary, and decimal values of the following peculiar-precision number?



1.001101×2^5	Binary Scientific (3 points)
100110.1	True Binary (2 points)
38.5	Decimal (2 points)

<3> 20 Points – What are the decimal values of the following 16-bit binary number under each of the listed representations? If the value is illegal under the representation, say so.

0000000111100000

01E0	Hexadecimal
480	Unsigned Binary Integer
1.875 or 1⅞	Unsigned Fixed Point, 8 whole and 8 fraction
1/224	Unsigned Rational, 8 numerator and 8 denominator

<4> 10 Points – Below are a set of replacement rules that you can apply symbolically to an arithmetic expression. DO NOT ADD ANY NEW RULES TO THIS LIST:

#1. Replace X × 1 with X (for any X)
#2. Replace 1 × X with X (for any X)
#3. Replace X × 0 with 0 (for any X)
#4. Replace 0 × X with 0 (for any X)
#5. Replace X + 0 with X (for any X)
#6. Replace 0 + X with X (for any X)
#7. Replace X - 0 with X (for any X)
#8. Replace X - X with 0 (for any X, both X must be the same)

For the following expression, show each step in a ***symbolic optimization*** and indicate in each case which rule applies (the first one has been done for you as an example). Take as many steps as necessary to reduce the expression as far as it can be reduced.

Step 0: **A + (B × (C − (C × 1 − 0))) + (D − D)**

Step 1: **A + (B × (C − (C − 0))) + (D − D)** **Rule #1**

Step 2: **A + (B × (C − C)) + (D − D)** **Rule #7**

Step 3: **A + (B × 0) + (D − D)** **Rule #8**

Step 4: **A + 0 + (D − D)** **Rule #3**

Step 5: **A + (D − D)** **Rule #5**

Step 6: **A + 0** **Rule #8**

Step 7: **A** **Rule #5**

<5> 18 Points – There are two 3D points <4,-3,6> and <9,5,-2>. What are the parametric equations in *x*, *y*, and *z* for the straight line that passes through the first point when *t=0* and through the second point when *t=1*?

A. (12 Points):

x(t) = **5** ***t*** + **4**

y(t) = **8** ***t*** + **-3**

z(t) = **-8** ***t*** + **6**

B. (6 Points):

What are the coordinates of the 3D point when *t=½*? **<6.5, 1, 2>**

<6> 12 Points – Searching lists.

(9 Points) Here is a list of names, in unsorted order. Show the list after each search, using the move-to-front self-organizing list technique (the front of the list is at the left):

	Tom	Fred	Carol	Sam	John	Mary	Bob
A. After searching for John:	**John**	**Tom**	**Fred**	**Carol**	**Sam**	**Mary**	**Bob**
B. After searching for Bob:	**Bob**	**John**	**Tom**	**Fred**	**Carol**	**Sam**	**Mary**
C. After search for John again:	**John**	**Bob**	**Tom**	**Fred**	**Carol**	**Sam**	**Mary**

(3 Points) Suppose I write a function ***f*** so that applying ***f*** to each name gives its index (position) in the list, such as: ***f****(Fred)* = 3, ***f****(Carol)* = 7, ***f****(Bob)* = 4, etc.

D. What is function ***f*** called? **A Hash Function**

E. What is it called if two names generate the same index? **A Hash Collision**

F. Using Big-O notation (O(1), $O(\log_2(N))$, $O(N^2)$, etc.) how fast are most searches using this technique? **O(1)**