ITEC201006 - Introduction to Computer Science & Engineering, Jeonghun Park

HW1 – Due date: 3/29

Q1. True or False

Any natural number can be represented by (iteratively) adding 1 to the number 0.

Q2. True or False

Two-thirds is a rational number.

Q3. Proof

Explain the definition of a rational number, and prove that $\sqrt{2}$ is an irrational number.

Q4. Proof

Prove that any square root of a prime number p is an irrational number

Q5. True or False

Product of two rational numbers is also a rational number.

Q5.1. A sub-problem

If the answer of Q4 is true, prove it.

Q6. True or False

Product of a rational number and an irrational number is an irrational number

Q6.1 A sub-problem

If the answer of Q5 is true, prove it.

Q7. True or False

The digits used in base 8 are 1 through 8.

Q8. True of False

Binary numbers are important in a computer system because any number can be converted into them.

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Q9. Short answer

In hexagonal number systems, what is a value of the digit ‘E’?

Note: If not mentioned, a number follows a general base-2 system, not S16.XX.

Q10. Computation

Consider a binary number 101011010. Obtain an octal number for this number.

Q11. Computation

Consider a binary number 101011010. Obtain a hexagonal number for this number.

Q12. Computation

Calculate the summation of the following two binary numbers:

1101010001010 + 1101000100

Q13. Computation

Calculate the summation of the following two binary numbers:

10010110101 + 10000010001

Q14. Computation

Calculate the subtraction of the following two binary numbers:

11000100010011 – 1001010100

Q15. Computation

Calculate the subtraction of the following two binary numbers:

10000010110 - 1100010

Q16. Base conversion

Convert the following decimal numbers to hexagonal number:

A. 1066

B. 1939

C. 998

Q17. Computation

Calculate the following hexagonal additions:

A. 19AB6 + 43

B. AE9 + F

C. 1066 + ABCD

Q18. Explanation

Why are binary numbers important in a computer system?

Q19. S16.XX

How many numbers can be represented with S16.XX format? Is there any duplication among them? Explain it.

Q20. S16.XX

Consider we use S16.10. Obtain the minimum and maximum values (a feasible range) that can be represented with this format

Q21. S16.XX

Consider we use S16.9. Obtain the minimum and maximum values that can be represented with this format

Q22. True or False

An analog signal is more robust to any type of error compared to a digital signal

Q23. Computation

How many dimensions (or symbols) we can have with 16 bits?

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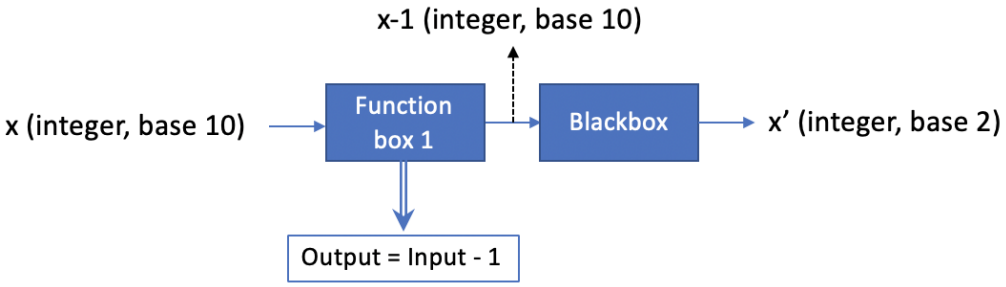
Q24. Computation

How many bits are required if we want to represent 1244 symbols?

Q25. Deep thinking

Assume that we have a black-box whose an input is an integer decimal number and an output is an integer binary number. For details, please see the following:

Let's also assume that we cannot modify the operation of the black-box. What we can do is adding another function box and making a connection to the corresponding block-box. For example, we can do the following:



A function box we added above has an integer decimal number input, and an integer decimal number output. After adding this, what we finally obtain is that the binary number of x-1. Assume that we can make function boxes that operates any mathematical operation we know (e.g., max, min, ceiling or flooring operations, etc.)

Here is a main question:

By adding some function blocks to the black-box, design a system that changes an arbitrary decimal number **(does not have to be an integer !)** to **S16.10** format bits.

Note: Assume that the function blocks can operate a simple mathematical operation that we generally know.

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Q26. Deep thinking

Assume that we a signal vector whose size is 11 as in the following:

---

0 0.4794 0.8415 0.9975 0.9093 0.5985 0.1411 -0.3508 -0.7568 -0.9775 -0.9589

Note that this signal set is generated by using the Sine function in MATLAB:

```
>> x = 0:0.5:5

x =

    0    0.5000    1.0000    1.5000    2.0000    2.5000    3.0000    3.5000    4.0000    4.5000    5.0000

>> sin(x)

ans =

    0    0.4794    0.8415    0.9975    0.9093    0.5985    0.1411   -0.3508   -0.7568   -0.9775   -0.9589
```

Here is a main question:

Assume that we quantize this signal vector with **S16.XX**. Explain which format is the best format (for example, S16.10 is the best) and why.

Q27. Deep thinking

This problem is continued from **Q26**. With the format you selected, obtain the quantized values of the first 4 elements in the signal vector (0 0.4794 0.8415 0.9975). You can answer this either with bits or decimal values.

Q28. Deep thinking

Consider the following bits whose format is **S16.10**:

0001001001001001

Assume that we will change the format to **S16.11.** What will be the corresponding bits? Is there any error after change?

Q29. Knowledge

What is the difference between sampling and quantization?