Introduction

This assignment is your first group project for `Computer Organization`. It is designed to teach you how group work is to be done in this class. The method for the group work may seem either silly or overly scripted. It is actually drawn from research on brain function and learning theory. I ask that you do your best to follow the plan but feel free to let me know if, for some reason, this method interferes with *your* learning style.

[Based in part on documents found on cspogil.org.]

Note

- By **design**, this assignment includes questions about topics that you have not yet seen in lecture. This encourages *creative* exploration and *constructing* your own mental models.
- Your group is expected to work together on *each* question: the goal is **not** to fill in the "right" answers as quickly as possible but rather to take the time to read, think, and discuss the material **together**.
- Constructing your own model is **short-circuited** by reading or parroting another thinker's answer. This means you should, as much as possible, use *recall* of class material, looking up definitions in *notes* or the *textbook* when necessary, and *avoid* just typing the question into a search engine on the Web. If you want more information, feel free to search **after** the group work is finished.
- Each student in the group has more or less experience with the topics in the assignment. If you have greater familiarity with the topics, *please* hold back a little bit so others can engage with building their own knowledge. You, too, must engage because there is always more to learn.

Assignment Goals

After completing this group assignment, each student is expected to be able to Learning Outcomes

- Name the members of your group.
- Describe the *four* roles in the POGIL method.
- Manipulate decimal numbers using placeholder notation.
- Manipulate binary numbers using placeholder notation and translate binary to decimal values.

Procedure

Get out paper. The group will turn in *one* document. Place the names of all present group members atop the page. This page will also be used by the speaker when answering questions at the end of the class.
Copy each question before the answer. This makes the answer sheet a worthwhile study guide w/o the worksheet. The answers written down should be *discussed* by the group and represent the *consensus* of the group. Sometimes a *picture*, a *graph*, or something similar is the most appropriate way to answer a question.
Assign Roles. Students should take roles they have not held recently (or, perhaps, ever):

Manager Move discussion forward.
Reflector Monitor that everyone gets heard and is caught up. (This is a **group** obligation, really.)
Speaker Asks the facilitator questions and communicates what the team has done.
Recorder Writes the report.

Answer these questions.

1. *Introduce* yourself to your fellow group members, including completions to the following prompts. These are designed to help each of you be more comfortable with being **wrong** in front of one another. **Mistakes** are a major part of learning.
   (a) The *longest* computer program I have ever written was ....
   (b) The most *challenging* computer bug I have ever had to solve was ....

Assume *all* integers in this document are non-negative (also known as *unsigned* integer values).

2. What is the *largest* decimal number you can store in exactly **two** digits? How do you know. What is the *smallest* number.
3. What is the *largest* decimal number you can store in exactly **three** digits? **Four** digits?
4. Consider the number 357_{10}. What does the 3 mean? That is, would 3 mean the same thing if it appeared where the 5 or the 7 appears?
5. If we numbered the digits (with subscripts) in the number as $3_2 5_1 7_0$, write the value of the number in terms of a summation $\sum_{i=0}^{2} \ldots$.
6. Consider $D = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$, the set of *digits* used in **base-10** (or **decimal**) numbers. What is $|D|$? Explain *why* the set has that cardinality.
7. How many *different* decimal numbers are there that use exactly **five** digits.
8. What is the *largest* value you can get when adding two **single-digit** decimal numbers? How many digits does it take to represent?
9. What is the *largest* value you can get when adding two **two-digit** decimal numbers? How many digits does it take to represent? What are the digit values in the two two-digit numbers? Where do they appear in an ordered listing of D?
10. Imagine a decimal number $d_n d_{n-1} d_{n-2} \ldots d_2 d_1 d_0$. Write a summation to calculate the value of the number.

A **binary** number is one written in **base-2**. In base-2, each higher digit position corresponds to a power of 2 (rather than a power of 10 as in decimal representations). For example, 101_2 is $1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$ or 5_{10}.

11. Consider $B = \{\text{the set of binary digits}\}$. B is the set of *bits* used to represent **base-2** numbers. What is $|B|$? What is B, the set of bits, itself?
12. What is the *decimal* value of the *binary* number $1_3 1_2 1_1 1_0$? What about $1_3 1_2 1_1 0_0$? $1_3 0_2 1_1 0_0$? Explain how you are figuring this out.
13. What is the decimal value of the binary number $1_5 0_4 0_3 0_2 0_1 0_0$?
14. Imagine a decimal number $b_n b_{n-1} b_{n-2} \ldots b_2 b_1 b_0$. Write a summation to calculate the *decimal* value of the number.
15. How many **two-bit** binary numbers are there? Write them all out. What are the *decimal* values of each one?
16. What is the *largest* binary number using exactly two bits? What about three bits? Four bits?
17. How many *different* binary numbers are there with exactly **one bit**? **Two bits**? **Three bits**? **Twenty bits**?
18. How do the largest *binary* representations with a fixed number of bits compare to the largest *decimal* representations with a fixed number of digits?
19. What is the *largest* value you can get when adding two **single-bit** binary numbers? How many bits does it take to represent?
20. What is the *largest* value you can get when adding two **two-bit** binary numbers? How many bits does it take to represent? What are the bit values in the two two-bit numbers? Where are they in B?