

# Computer Science 210 –Computer Organization

## Homework Exercise 4

Due on Github 11:59pm Monday 14 February

All homework should be turned in no later than the due date (no late work accepted). Your turn in will consist of a single file **project4.pdf**.

Jack, a recent W&L grad, is designing a new computer for a local startup. His computer will have a 16-bit word size. Thus, each machine language instruction or each datum will have to fit in 16 bits. His computer will also have a single 16-bit data register, a 16-bit instruction register, and a 12-bit program counter. Jack decides that each machine language instruction will consist of two fields: 4 bits for the opcode and 12 bits for the address of a single operand in memory (the single data register will be used for a second operand, if necessary). You should use this information to complete the following exercises. You may use powers of two in your answers ( $2^{24}$ , for example).

***Caution:*** the format of a machine instruction for Jack's machine is not the same as that of the LC-3. Each of Jack's instructions contains a 4-bit opcode and a 12-bit address of a single operand in memory.

1. What is the largest unsigned integer value (base 10) that can be stored in Jack's computer?
2. Signed integers are represented in twos complement form. What are the largest positive and negative signed integer values (base 10) that can be stored in Jack's computer?
3. Use twos complement notation to write the two largest integers from question 2.
4. How many words of memory (base 10) does Jack's computer have?
5. How many distinct opcodes (base 10) does Jack's computer allow in its instruction set?
6. Jill, who is Jack's supervisor, says that she wants his computer to support up to 32 distinct opcodes. The computer's word size and the number of registers must remain the same. If Jack needs to make changes to his design to accommodate this request, describe what they would be. Include in your answer any consequences that might affect your answers to questions 1-5 above.