**ENGR 260 (Microcontroller Systems)**

**Homework 1**

**Problem 1:**  Microprocessor data and address manipulation

A microprocessor has a 32-bit address bus and a 16-bit data bus, also its data registers are 16-bit registers.

1. What is the size of the address space this microprocessor can address?
   1. This microprocessor has an address space of 2^32 bytes because the address bus can store this many total memory addresses.
2. Would you consider this to be a 16-bit or a 32-bit microprocessor? Please justify your answer.
   1. I would consider this to be a 16-bit microprocessor, because the data bus/data registers are only 16 bit, meaning it can only process 16 bit (2 byte) memory at a time, and therefore the processor’s power is limited by what it can do at once in this way.

**Problem 2:** The TM4C123GH6PM

The memory map for the TM4C123GH6PM is shown on pages 92-94 of the datasheet (Tiva\_C\_Datasheet.pdf).

1. The table has 20 memory ranges that are marked as *reserved*. We know that this microcontroller has 4 GB (232) of addressable memory space, of this 4 GB address space how much space is *reserved*?
   1. The total space reserved in the memory space is 4259807212 bits
2. Provide two possible reasons for reserving these memory ranges.
   1. Peripherals and handling various interrupts.
3. There is an internal 2Kbytes EEPROM. Please provide this memory’s start and end addresses as provided on the memory map.
   1. 0x400A.F000 to 0x400A.FFFF (4KB, EEPROM and Key Locker?)
4. How many bits does this memory hold?
   1. 16384 bits
5. How many 32-bit words does this memory have?
   1. 512 32-bit words
6. Given that 16 words make a block, determine the number of blocks the memory has.
   1. 32 blocks
7. What is the address of bit 31 of word0 i.e. the first word of this memory?
   1. The address location is 0x400A.F0FE (Assuming the EEPROM starts at the beginning of that labeled address block)

**Problem 3:** Memories

1. Is ROM volatile or non-volatile?
   1. Standard ROM is non-volatile
2. List the devices that can drive the address bus during a CPU write cycle
   1. Various registers and the logic unit

**Problem 4:** Major components of a microcontroller

Please explain the function of the following microcontroller components: ROM, RAM, EPROM, EEPROM, I/O Data Registers and Control and Status registers

1. ROM often stores the firmware for the hardware of the MCU
2. RAM stores data currently being used by the CPU, as well as various process sessions
3. EPROM – ROM that can be erased when exposed to UV light, an era before EEPROM, used for debugging programs
4. EEPROM – ROM that can be erased using internal electrical circuits, and it is useful for storing semi-permanent information even when power is cut, while still allowing erasure/replacement if needed

**Problem 5:** On-Chip Flash Memory

From the memory map of page 92, on-chip Flash Memory occupies memory locations 0x0000.0000 to 0x0003.FFFF. What is the size of this on-chip Flash memory? Show your work based on the provided address range.

0x0003.FFFF + 0x1 = 0x0004.0000

0x0004.0000 = 4\*16^4 = 262144 bits of memory