EE 215 Homework #1

(4 problems, 70 pts total)

1. Memory space (15 pts total, 3 pts each)
   What is the largest memory space that can be addressed by processors having the following number of address bits? For this problem, assume that each byte of memory has a unique address.
   a. 4 bits
   b. 16 bits
   c. 22 bits
   d. 25 bits
   e. 32 bits

Answers:

Each bit of a processor can be represented by a binary number in two different cases, so the largest memory space that a processor can address is 2 to the power of N (N is the number of bits of the processor). Therefore:

a. 2^4 = 16 bytes
b. 2^{16} = 65,536 bytes = 64 KB (1024bytes=1KB)
c. 2^{22} = 4,194,304 bytes = 4 MB (1024KB=1MB)
d. 2^{25} = 33,554,432 bytes = 32 MB
e. 2^{32} = 4,294,967,296 bytes = 4 GB (1024MB=1GB)

2. Address bits (15 pts total, 3 pts each)
   What is the number of bits needed for addressing these memories? For this problem, assume that each byte of memory has a unique address (byte addressable).
   a. 2 KB (Arduino's SRAM for runtime data)
   b. 32 KB (the Arduino's Flash memory for bootloader and sketch)
   c. 512 MB (Raspberry Pi RAM)
   d. 4 GB (Motorola 68020)
   e. 32 GB (max memory size for micro SD for Raspberry Pi)

Answers:

a. 2KB=2*1024 byte=$2*2^{10}$ byte=2^{11} byte, requires 11address bits.
b. 32 KB=2 KB*16=$2^{11}*2$ byte=2^{15} byte, requires 15 address bits.
c. 512 MB=512*1024 KB=$2^9*2^{10}*2^{10}$ byte=2^{29} byte, requires 29 address bits.
d. 4 GB=2^2*1024 MB=$2^2*2^{10}*2^{10}*2^{10}$ byte=2^{32} byte, requires 32 address bits.
e. 32 GB=8*4GB=2^3*2^{32} byte=2^{35} byte, requires 35 address bits.

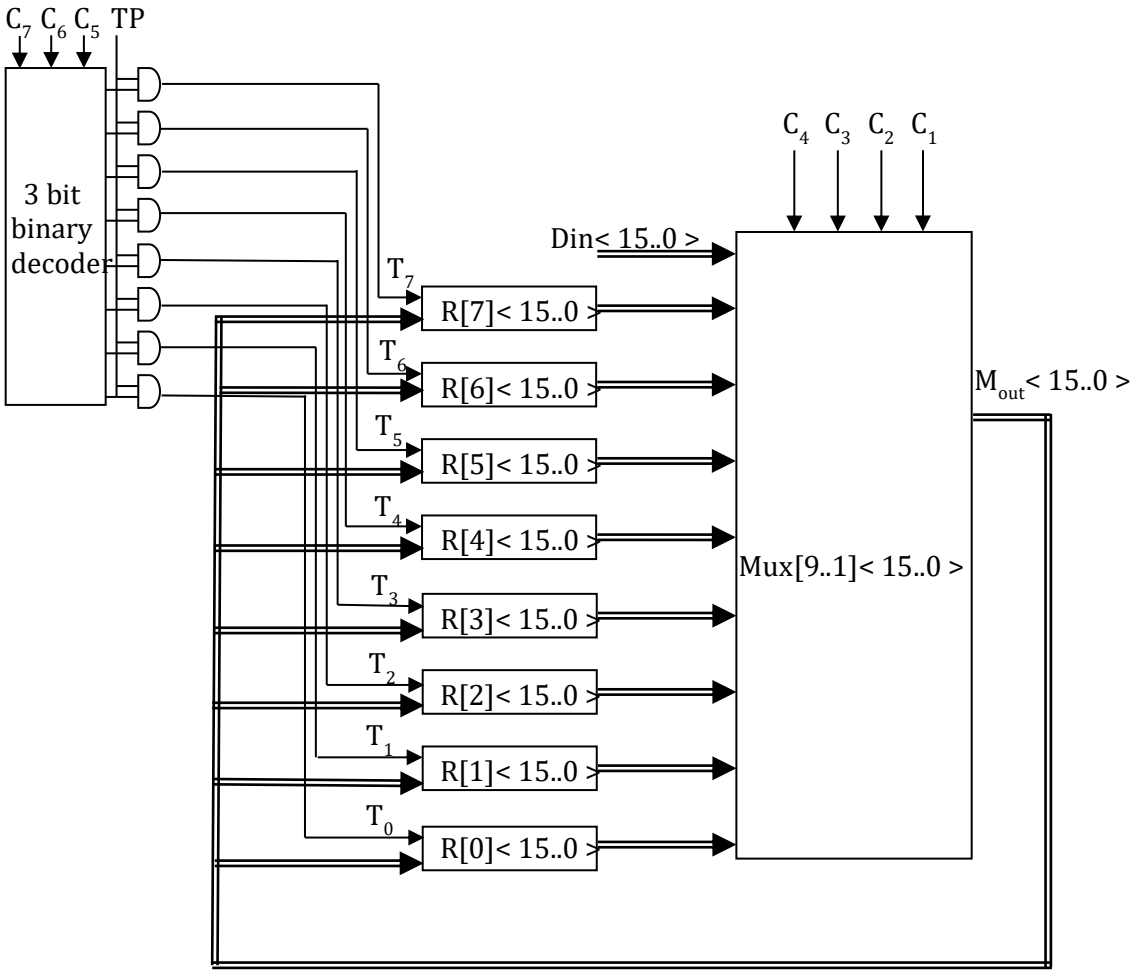
3. Register transfer Vs. control signals (20 pts total, 5 pts each)
   For the following control signals, $C_3C_2C_1$ are used to select source register R[0]-R[7], and C_4 is used for D_{in} selection. If $C_4 = 1$, MUX output is D_{in}. $C_7C_6C_5$ are used for 3 bit binary decoder to select destination register.

1) If $C_7C_6C_5C_4C_3C_2C_1 = 1011100$, describe the corresponding register transfer.

2) If $C_7C_6C_5C_4C_3C_2C_1 = 1110111$, describe the corresponding register transfer.

3) If we want $R[0] \leftarrow R[2]$, what control signals should be used?

4) If we want $R[3] \leftarrow D_{in}$, what control signals should be used?



Answers:

1) R[5]<15..0>←D_{in}<15..2>
2) R[7]<15..0>←R[7]<15..0>
3) $C_7C_6C_5C_4C_3C_2C_1 = 0000010$
4) $C_7C_6C_5C_4C_3C_2C_1 = 0111XXX$

4. New words. (20 pts total, 5 pts each).
Define these words in one or two sentences.

a. register

b. microprocessor

c. microcontroller

d. machine code

Answers:

a. Register:
A small, fast, temporary storage location within a CPU (Central Processing Unit) used to hold data that the CPU is currently processing.

b. Microprocessor:
The central unit of a computer that performs arithmetic and logic operations, controls other hardware components, and executes instructions from memory to carry out tasks.

c. Microcontroller:
A compact integrated circuit that combines a microprocessor with input/output peripherals, often used in embedded systems for dedicated control functions.

d. Machine Code:
The lowest-level programming language consisting of binary instructions that a computer's CPU can directly execute, representing specific operations and data manipulation.