Lecture 29

I/O

- Connecting devices to a CPU
  - memory is justa device
  - CPU communicates with it
- Memory responds to certain addresses, usually not all
- CPU can talk with other devices
  - using same method: `lw`, `sw`
  - Devices respond to certain addresses
- Memory-mapped I/O
  - Device sits on memory bus, watches for certain addresses and responds like memory for those addresses
  - Memory map of which devices respond to which addresses

Examples

- Suppose I/O Device 1 is assigned to memory address 0x20001000. Write code writing the value 7 to Device 1 then reading the output value from it.

```
li s1, 0x20001000
addi s0, zero, 7
s2 s0, 0(s1)
lw s2, 0(s1) # reads data back from device
```

- Delay loop followed by incrementing a counter on the hex display, input only

```
.global _start
_start:
    li s2, 0xffff0010
    mv s0, zero # pseudo instruction, same as addi s0, zero, 0
    mv s3, zero
    mv s4, zero
    mv a0, s0
    jal HEX_DECODE
    mv s3, a0
    DELAY: li s6, 50000
    LOOP: addi s6, s6, -1
    bnez s6, LOOP
    mv a0, s0
    jal HEX_DECODE
    sb s3, 1(s2)
    sb a0, (s2)
    addi s0, s0, 1
    li s8, 10
    bne s0, s8, DELAY
```

```
addi s4, s4, 1
bne s4, s8, UPDATE
mv s4, zero
UPDATE: mv a0, s4
jal HEX_DECODE
mv s3, a0
mv s0, zero
j DELAY
END: ebreak
HEX_DECODE:
bnez a0, CHECK_1
li a0, 0x3F #0b0111111
j DONE
CHECK_1:
    li t0, 1
    bne a0, t0, CHECK_2
    li a0, 0x06 #0b0000110
    j DONE
CHECK_2:
    li t0, 2
    bne a0, t0, CHECK_3
    li a0, 0x5B #0b1011011
    j DONE
CHECK_3:
    li t0, 3
    bne a0, t0, CHECK_4
    li a0, 0x4F #0b1001111
    j DONE
CHECK_4:
    li t0, 4
    bne a0, t0, CHECK_5
    li a0, 0x66 #0b1100110
    j DONE
CHECK_5:
    li t0, 5
    bne a0, t0, CHECK_6
    li a0, 0x6D #0b1101101
    j DONE
CHECK_6:
    li t0, 6
    bne a0, t0, CHECK_7
    li a0, 0x7D #0b1111101
    j DONE
CHECK_7:
    li t0, 7
    bne a0, t0, CHECK_8
```

```
    li a0, 0x07 #0b0000111
    j DONE
CHECK_8:
    li t0, 8
    bne a0, t0, CHECK_9
    li a0, 0x7F #0b1111111
    j DONE
CHECK_9:
    li t0, 9
    bne a0, t0, DONE
    li a0, 0x6F #0b1101111
DONE: jr ra
```