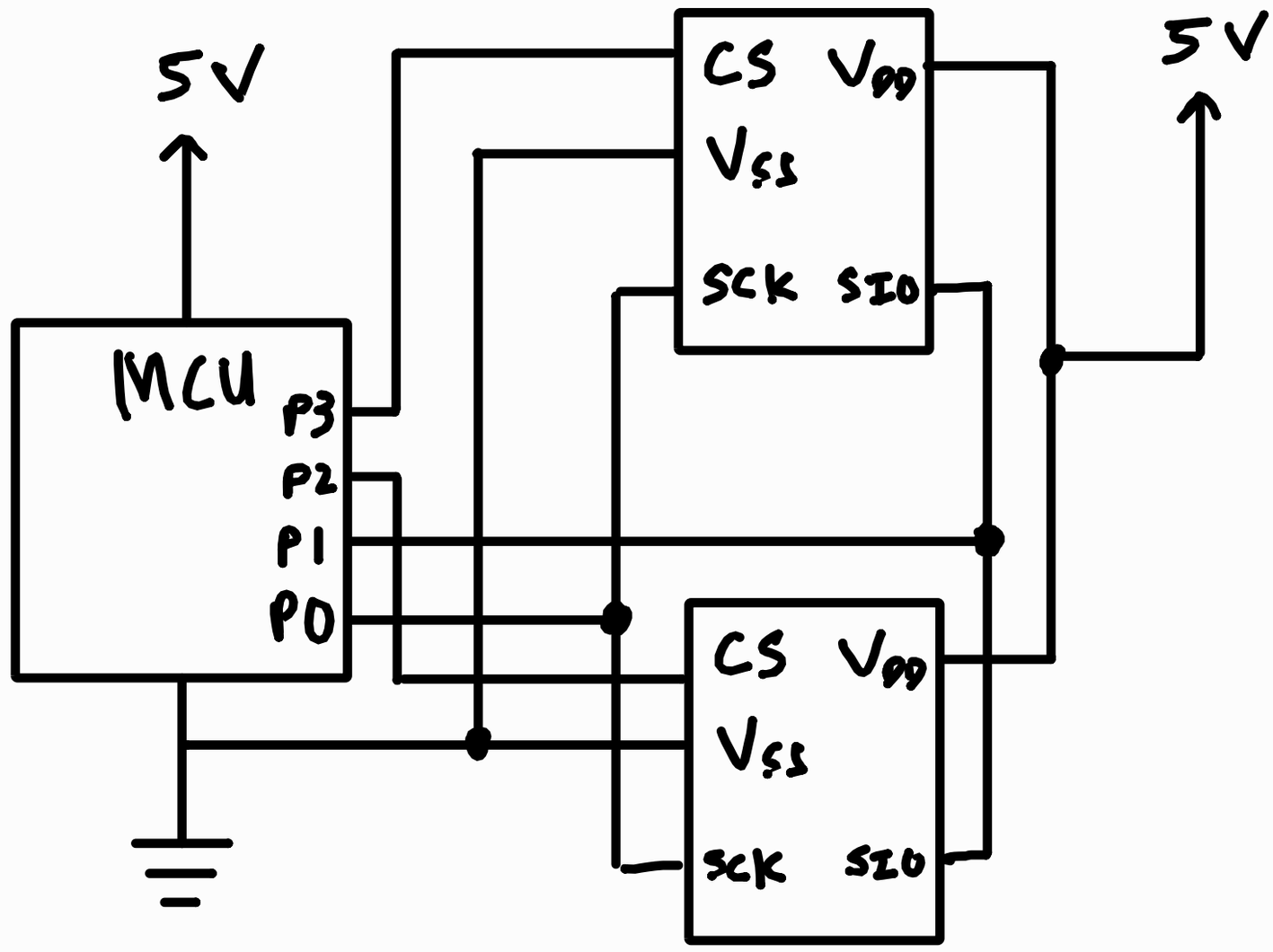
AY15/16

4 a)



b) No.

c) 0.0625°C per bit

d) 2 bytes

e) $\frac{30}{0.0625} = 480$ bits

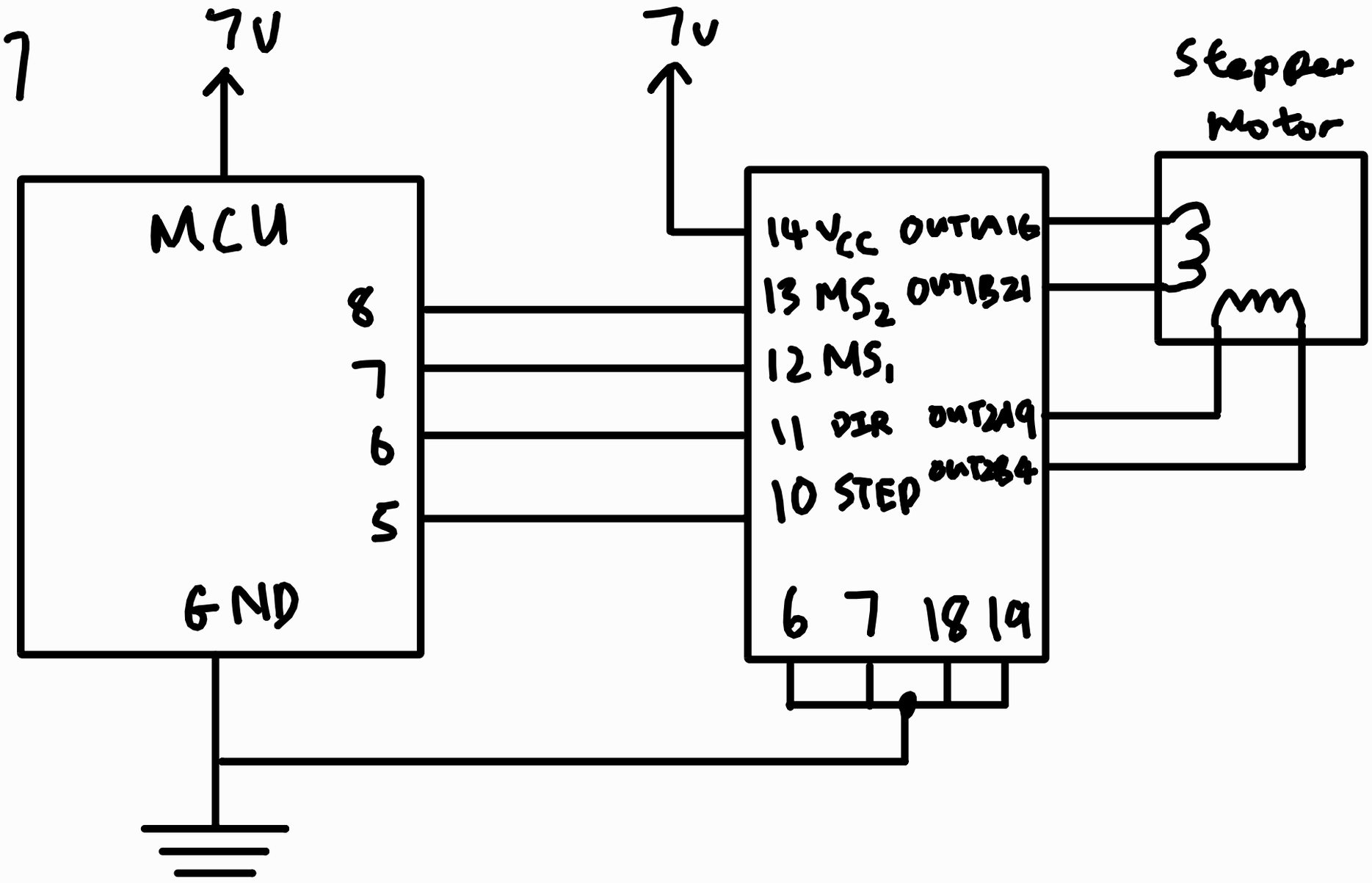
$= 0\ 0001\ 1110\ 0000$

f) Continuous conversion mode as there is no power consumption limitation when the car engine is on.

g) 0x0000

AY16/17

a)



b) Max resolution = $\frac{1}{8}$ step

200 steps = 360°

1 step = 1.8°

$\frac{1}{8}$ step = 0.225°

c) digitalWrite(7, HIGH)

digitalWrite(8, LOW)

di) steps_to_move = 200 x 2

= 400

ii) stepPW = 1 ms

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4 d iii) stepDelay = 2500 ms

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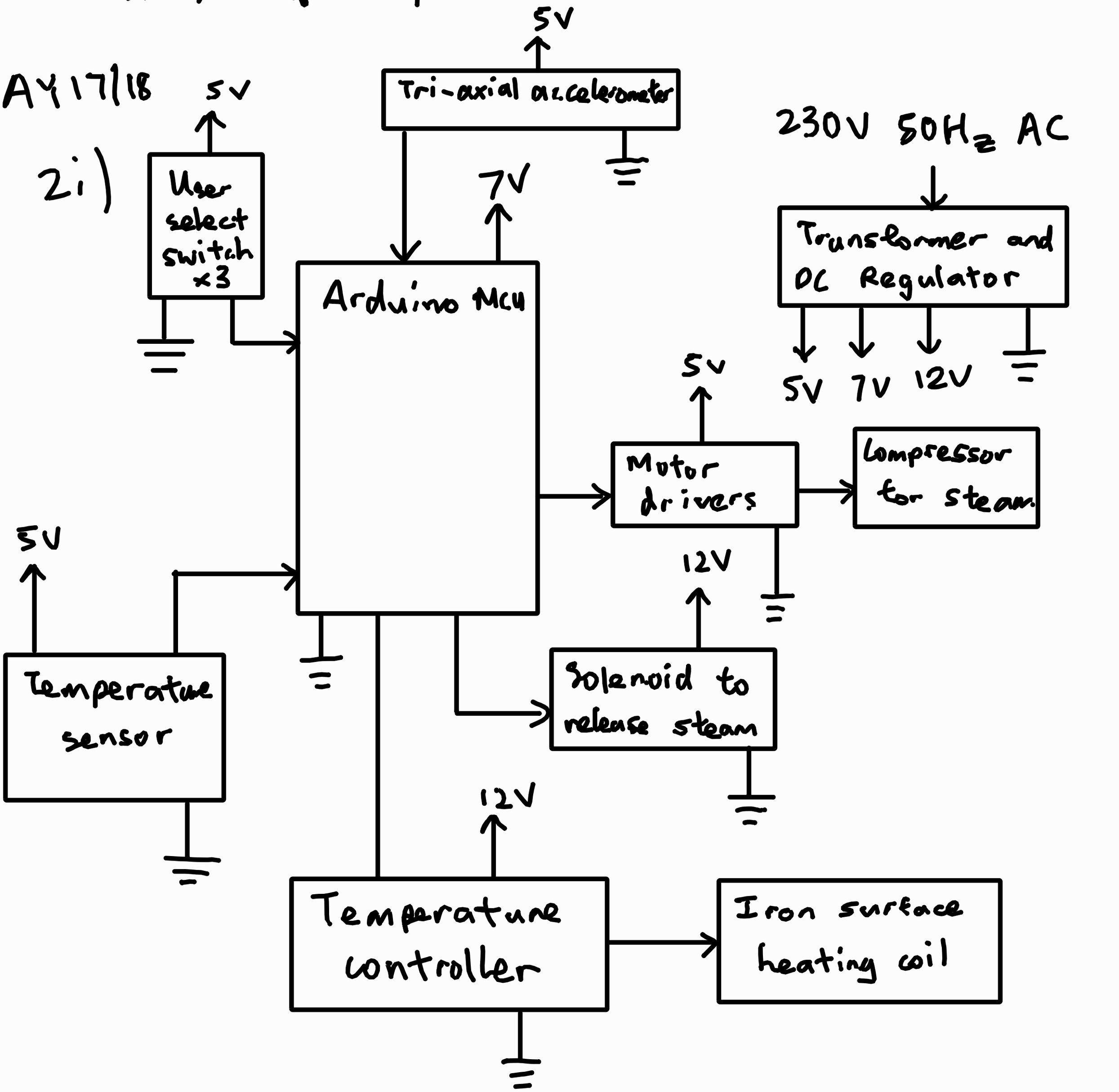

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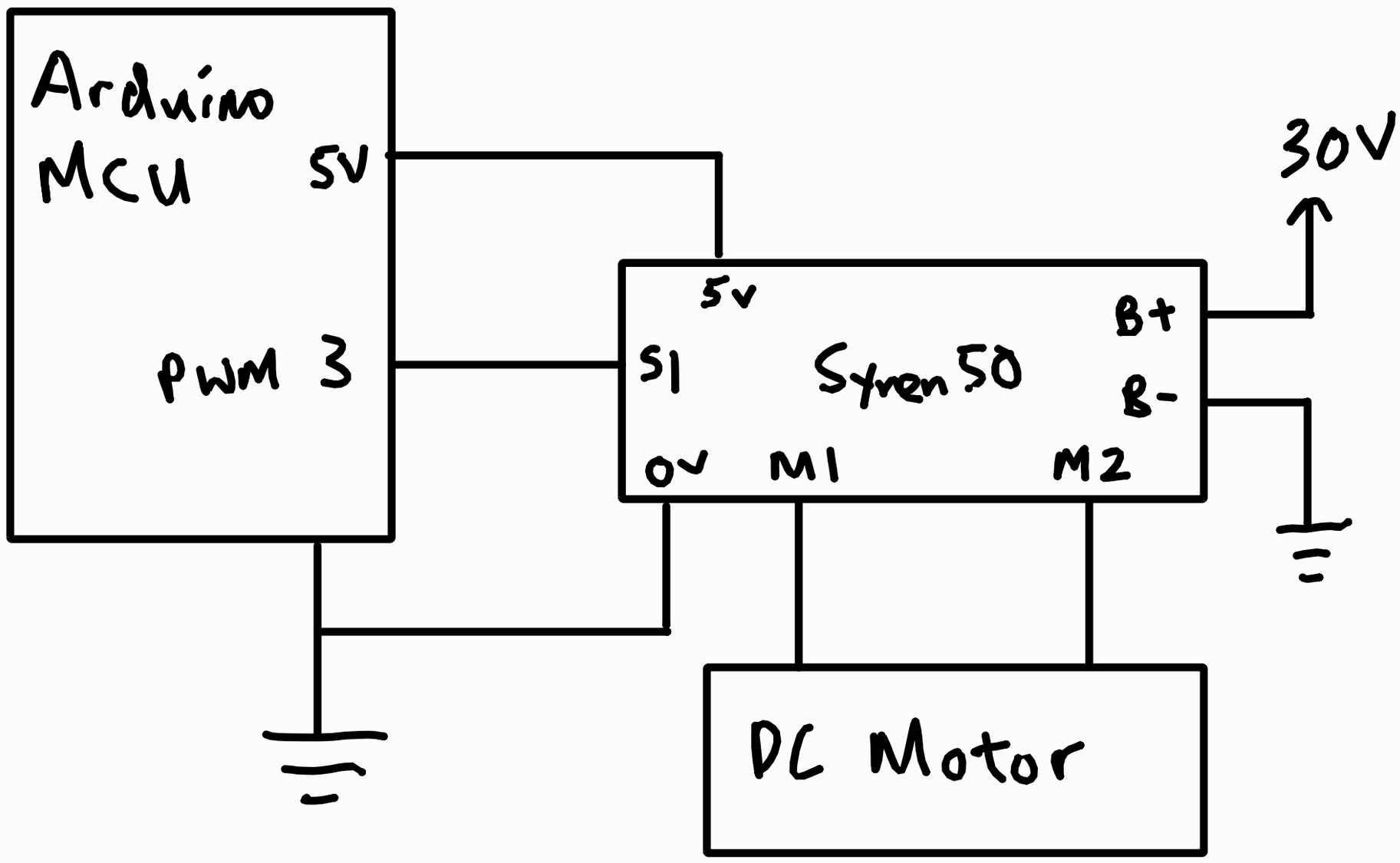
3 a)



b) Switches 1 to 6 are switched on.

ci) 2.5V

ii) 5V

iii) 0V

d) Voltage across S1 and 0V = V_{in}

Voltage across motor = V_{out}

$$V_{in} = k_1 V_{out} + k_2$$

when $V_{in} = 2.5$, $V_{out} = 0$

$$k_2 = 2.5$$

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3d) when $V_{in} = 5$, $V_{out} = 30$

$$5 = k_1(30) + 2.5$$

$$k_1 = \frac{1}{12}$$

$$\therefore V_{in} = \frac{1}{12} V_{out} + 2.5$$

i) when $V_{out} = 10$,

$$V_{in} = \frac{1}{12}(10) + 2.5$$

$$= \frac{10}{3}$$

$$\approx 3.33V$$

The required duty cycle is: $\frac{\frac{10}{3}}{5} \approx 66.7\%$

ii) when $V_{out} = -10$,

$$V_{in} = \frac{1}{12}(-10) + 2.5$$

$$= \frac{5}{3}$$

$$\approx 1.67V$$

The required duty cycle is: $\frac{\frac{5}{3}}{5} \approx 33.3\%$

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3e) Resolution of $V_{out} = \frac{30-(-30)}{2^8-1}$

$= \frac{4}{17}$

$\approx 0.235\,V$

f) low pass filter is required to remove high-frequency noise from the signal

g) No. The Arduino only outputs a maximum of 5V at a very low current, which is insufficient to power the motor.

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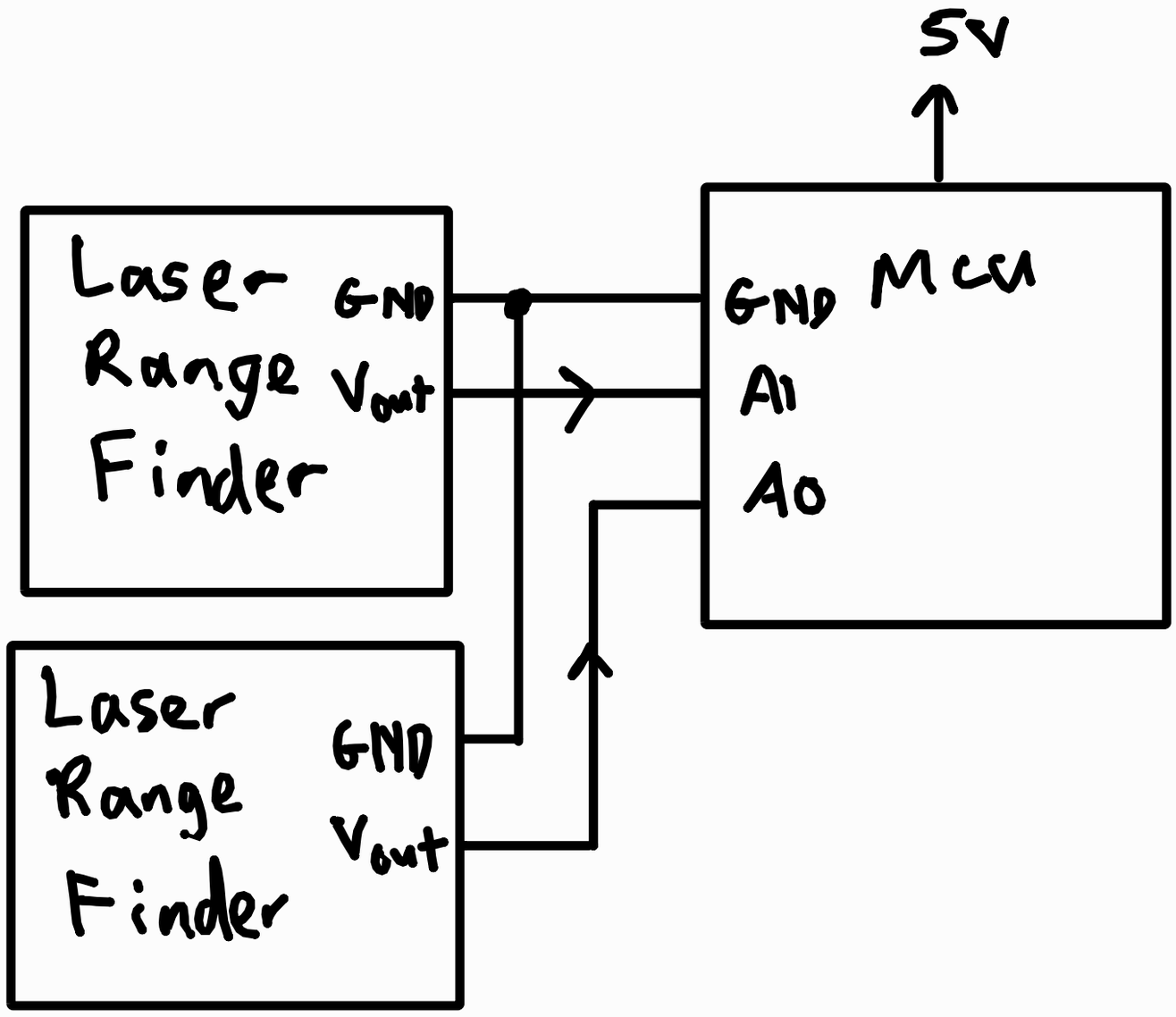
(4a)



bi) $d = \frac{V}{3.3}(DH - DL) + DL$

$d_1 = \frac{2.5}{3.3}(20-0) + 0$

$= \frac{500}{33}$

$\simeq 15.2m$

$d_2 = \frac{1.5}{3.3}(20-0) + 0$

$= \frac{100}{11}$

$\simeq 9.09m$

$\therefore$ The width of the cave $= \frac{500}{33} - \frac{100}{11}$

$= \frac{200}{33}$

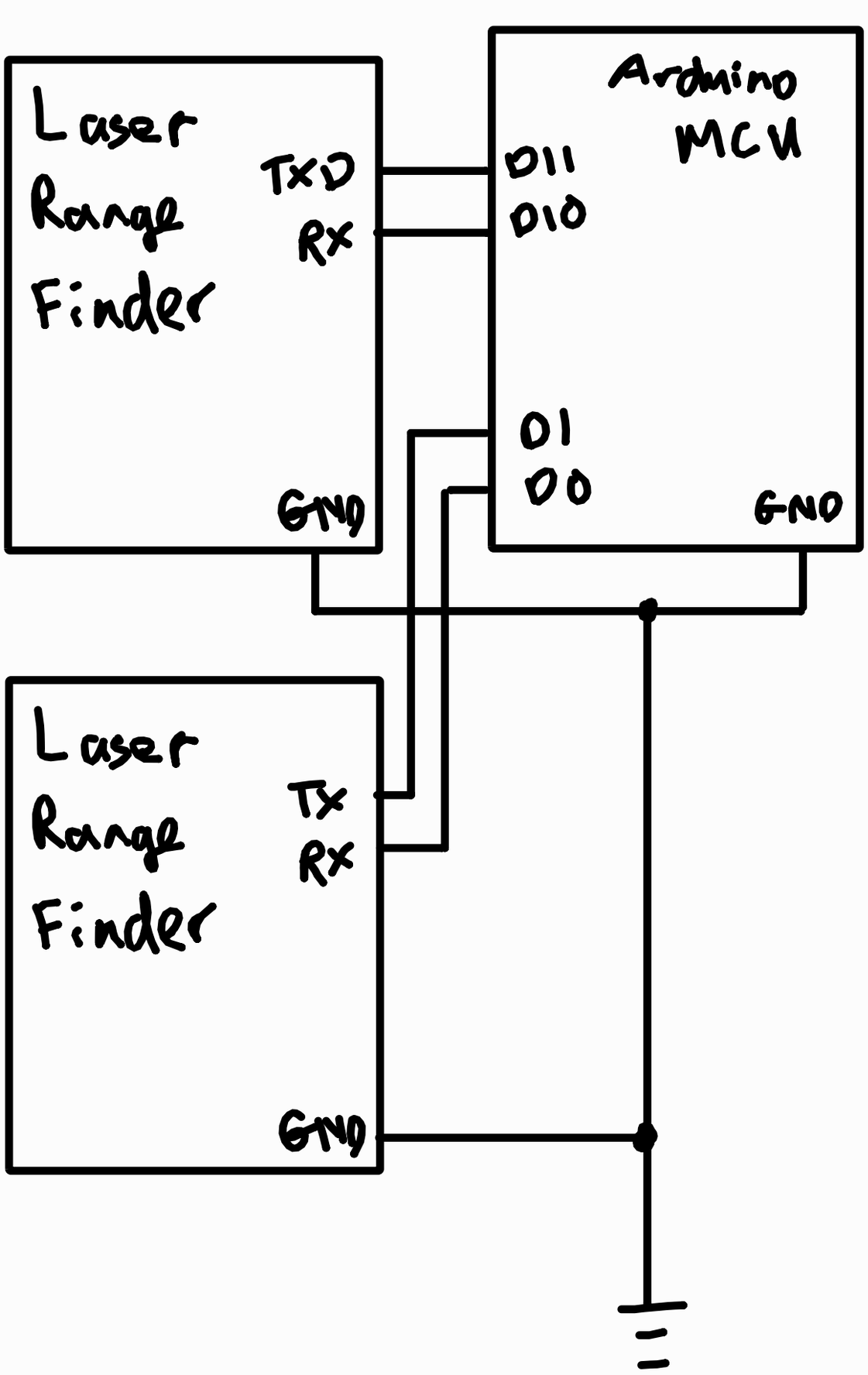
$\simeq 6.06m$

AY 19/20

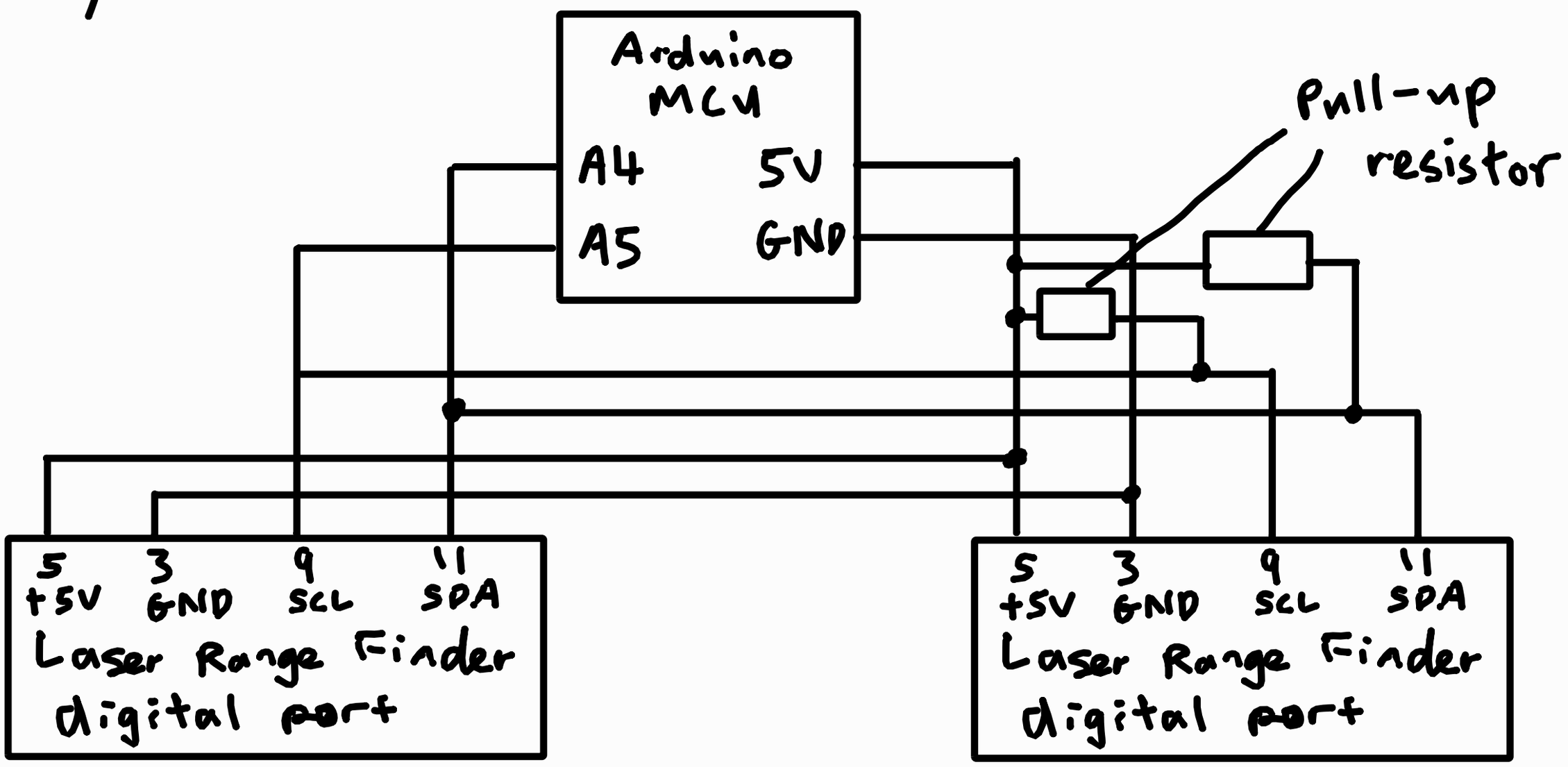
4bii) Max error $\approx 8 \times 2$

$\approx 16cm$

(i)

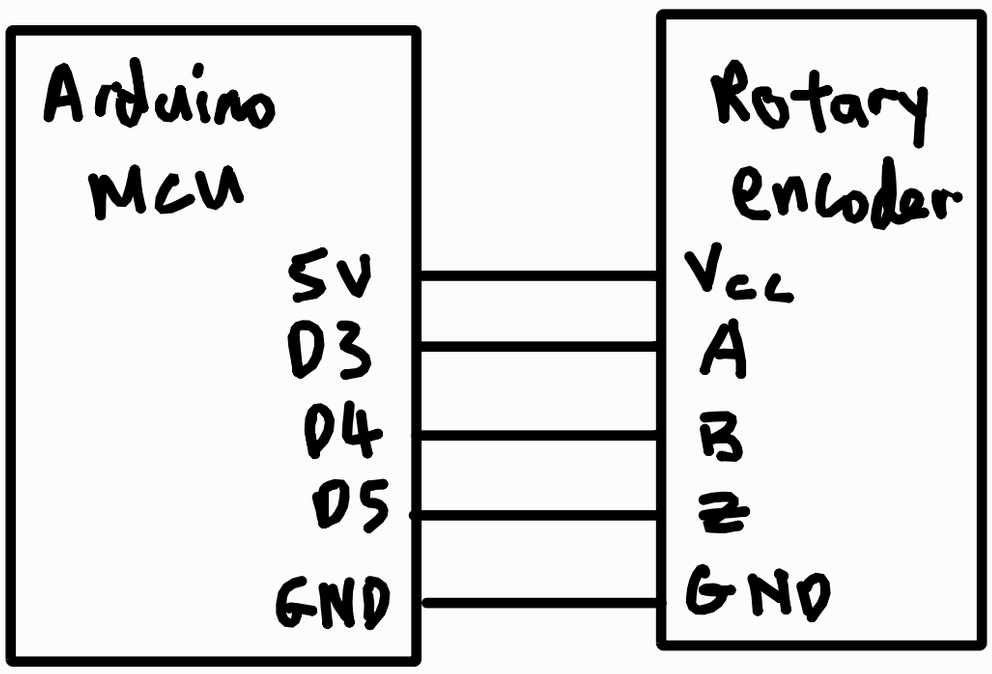


4cii)


Arduino
MCU
A4
A5
5V
GND
Pull-up
resistor
5
+5V
3
GND
9
SCL
11
SDA
Laser Range Finder
digital port
5
+5V
3
GND
9
SCL
11
SDA
Laser Range Finder
digital port

AY 20/21

1a)



bi) An encoder updates frequently, so the polling method may miss a pulse. Using the polling method, the Arduino will be unable to handle other tasks due to constantly checking for a pulse.

ii) attachInterrupt(digitalPinToInterrupt(3), update_position, RISING)

iii)
```
void update_position() {
    if (digitalRead(4) == HIGH) {
        positiontt; //ccw is positive
    } else {
        position--; //cw is negative
    }
}
```

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1c) Measure the time t between each interrupt.

$$\text{Speed} = \frac{1 \text{ encoder step in degrees}}{t}$$

d) Phase Z is used as the reference position for initialisation at power up. All incremental offsets will be taken with reference to this position so the correct prize can be identified.

AY 21/22

3 d) The Shannon sampling theorem suggests that the minimum sampling frequency should be twice the maximum frequency in the signal. Since the fluctuation of chemical consumption is once per shift, he should sample at least twice or more per shift.

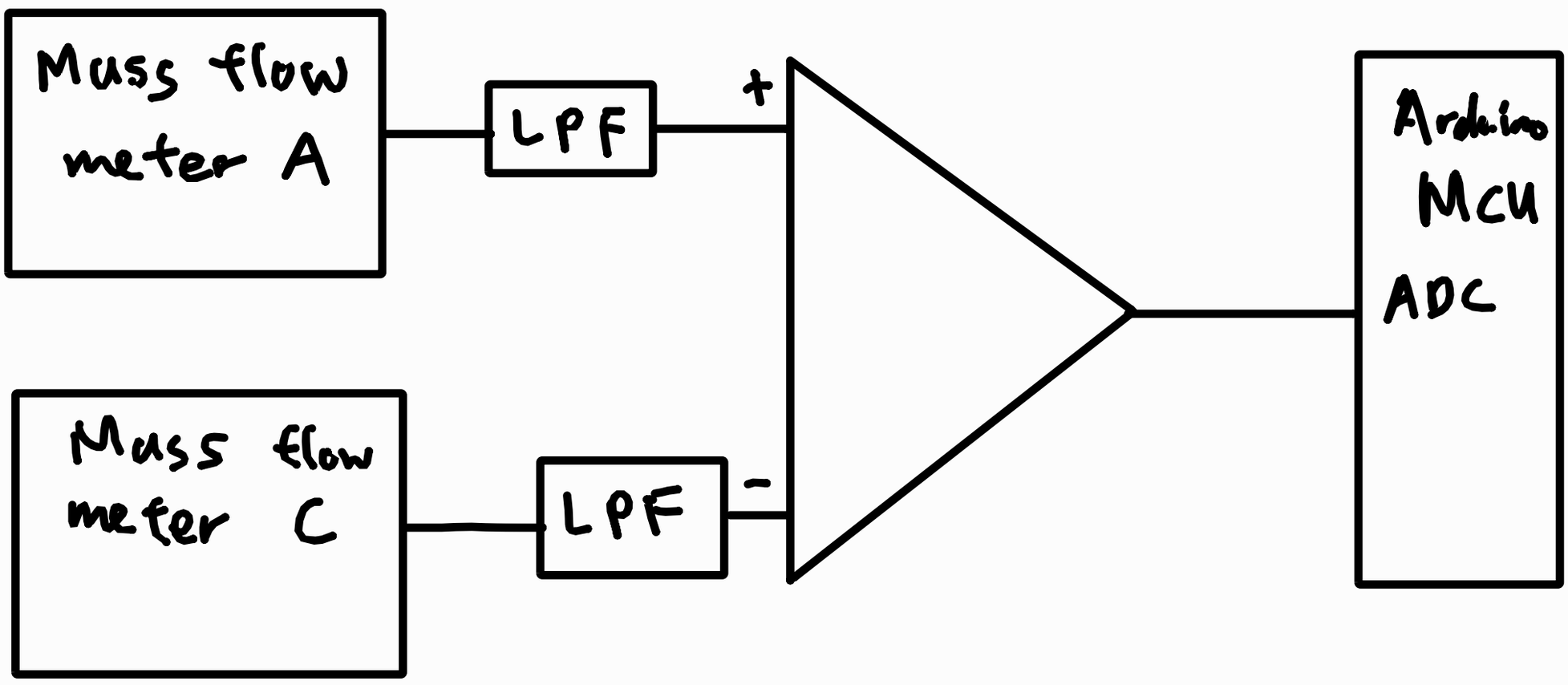
e i) Yes. White noise has uniform intensity over all frequencies.

ii) Software method: Averaging

Hardware method: 1Hz bandpass filter

f i) The buffer tank is refilled every hour, so the measurement at A is not the real time chemical consumption of the new line.

ii)



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3fiii) Advantages:

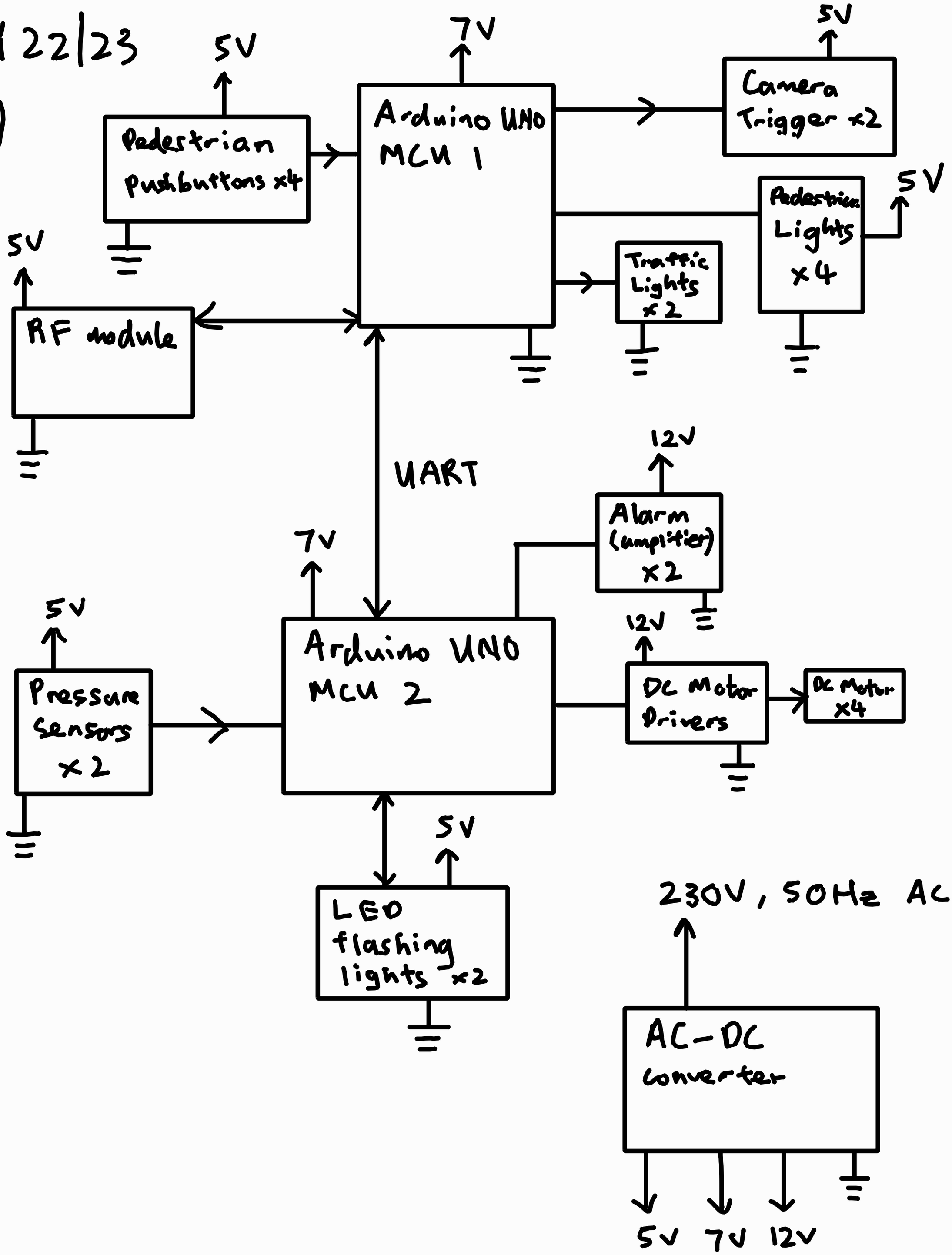
- Flexibility in implementation (can choose different signal processing techniques)
- lower hardware cost
- Simpler circuit

Disadvantages:

- Less clock cycles for the Arduino to perform other tasks
- Input signals have worse signal to noise ratio

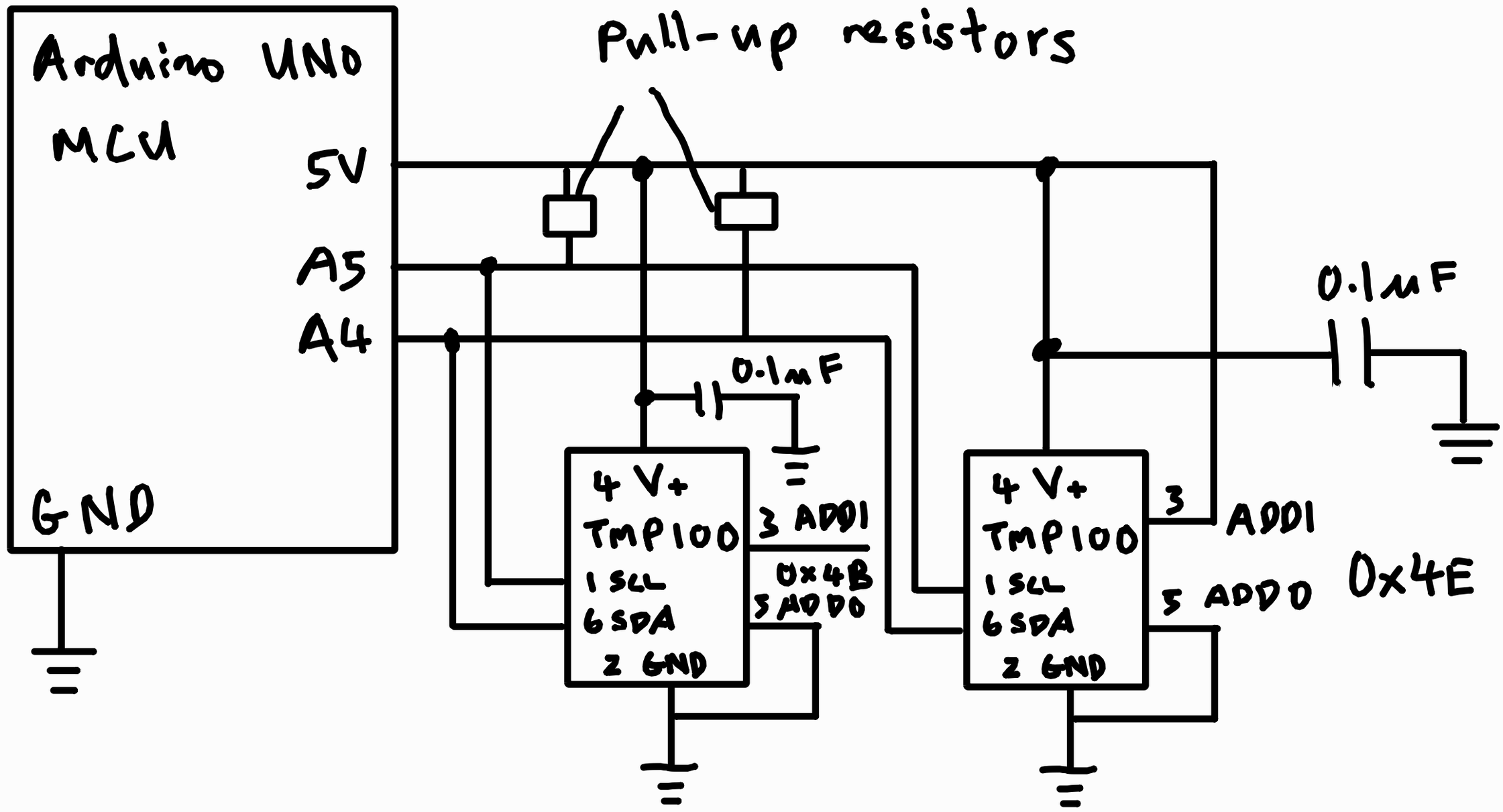
AY22/23

4)


5V
7V
5V
Pedestrian Pushbuttons x4
Arduino UNO MCU 1
Camera Trigger x2
Pedestrian Lights x4
5V
Traffic Lights x2
5V
RF module
UART
12V
Alarm (amplifier) x2
7V
5V
Pressure Sensors x2
Arduino UNO MCU 2
12V
DC Motor Drivers
DC Motor x4
5V
LED flashing lights x2
230V, 50Hz AC
AC-DC converter
5V
7V
12V

AY 23/24

4a)



bi) Cold water tank, 4°C (8 x LSB),
the 9-bit digit equivalent = 0 0000 1000

(first bit is 0
for positive number)

Content of temperature register
= 0000 0100 0000 0000

ii) Hot water tank, 90°C (180 x LSB),
the 9-bit equivalent = 0 1011 0100

Content of temperature register
= 0101 1010 000 000

c) No, there is no need to save power as the water dispenser is plugged into the power mains.

AY 23/24

4d)

D7	D6	D5	D4	D3	D2	D1	D0
OS	R1	R0	F1	F0	P0	TM	SD
X	0	0	0	0	X	X	0