

Microprocessor Principles and Applications

Final Exam (Hands-on Test)

TM

Fall 2023

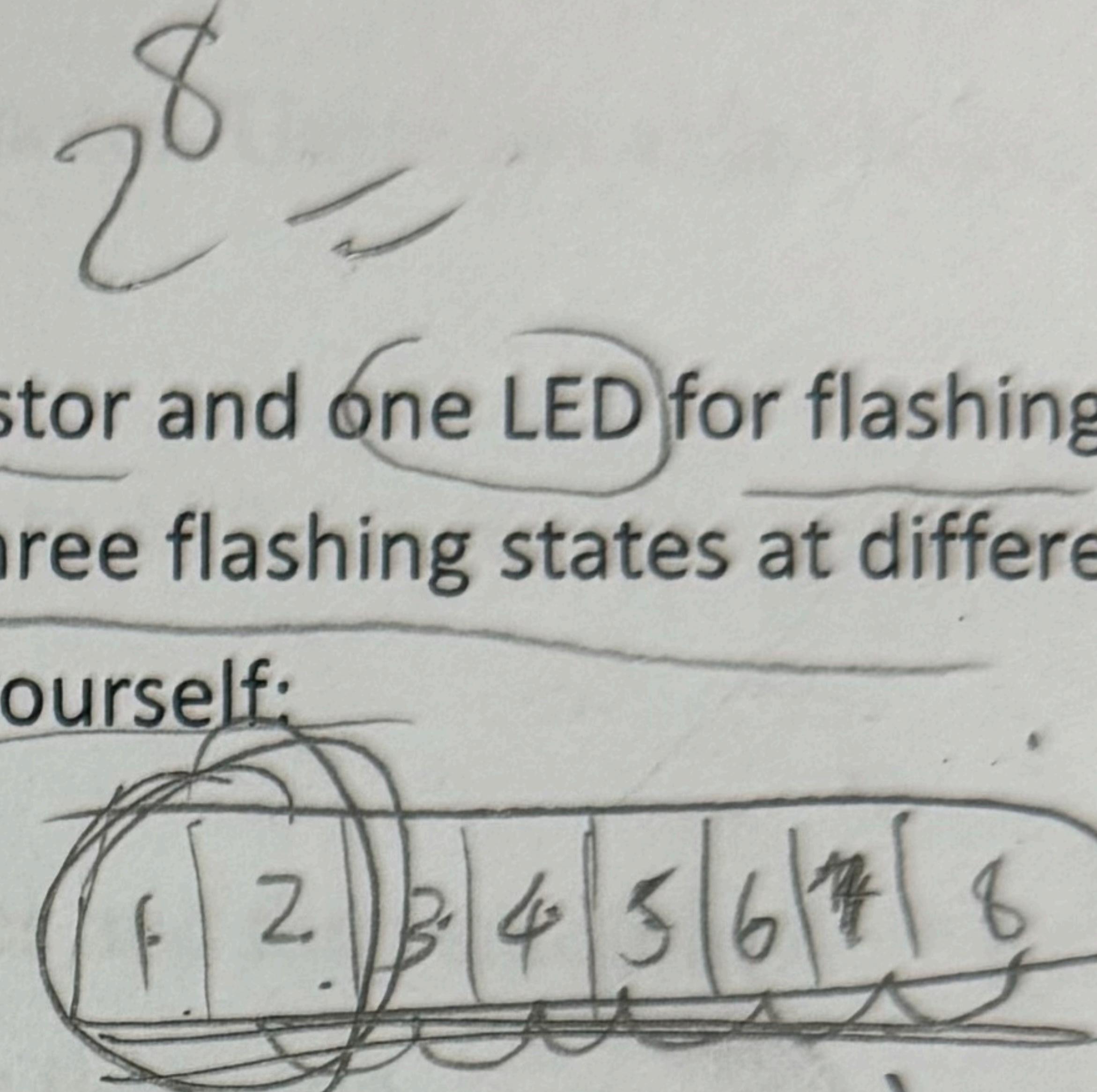
The exam is 180 minutes long. The total score is 100 pts. Please read questions carefully.

Note: We may change testcases when you demonstrate your programs to us.

• Question 1a (20%)

- Description: Design a device that utilizes a variable resistor and one LED for flashing. The user can adjust the timer on the variable resistor, with three flashing states at different frequencies from left to right. Please design the details yourself:

- ◆ State_1: 1s
- ◆ State_2: 0.5s
- ◆ State_3: 0.25s



• Question 1b (15%)

- Description: Design a device using UART and incorporating a variable resistor and one LED for flashing. The user can adjust the timer size on the variable resistor, with three flashing states at different frequencies from left to right:

- ◆ State_1: 1s
- ◆ State_2: 0.5s
- ◆ State_3: 0.25s

While adjusting the variable resistor, please display the current state and the cumulative flash count on Putty at each flashing occurrence, for example:

State_1 count = 1

State_1 count = 2

State_2 count = 3

...

State_X count = n

$$\frac{2400}{500} =$$

$$1450 \mu\text{s} \rightarrow 0^\circ$$

~~500~~ 0

$$240 \mu\text{s} \rightarrow 90^\circ$$

$$F_{osc} = 4 \text{ MHz} \Rightarrow 1 \text{ MHz}$$

$$\Rightarrow T_{osc} = \frac{1}{4} \mu\text{s} = 0.25 \mu\text{s}$$

$$\Rightarrow \text{Instruction cycle} = 1 \mu\text{s}$$

• Question 2a (20%)

- Description: Design a device that utilizes a button and a motor. This device operates in two modes.

Mode 1: The motor rotates from -45 degrees to 45 degrees and then returns to -45 degrees, continuously repeating this cycle until the user initiates a mode change.

125 kHz / 4

Mode 2: The motor rotates from -90 degrees to 90 degrees and then back to -90 degrees in a continuous loop until the user switches modes.

The device initializes in Mode 1, and pressing the button triggers a transition to the alternate mode.

16
9

- Question 2b (15%)

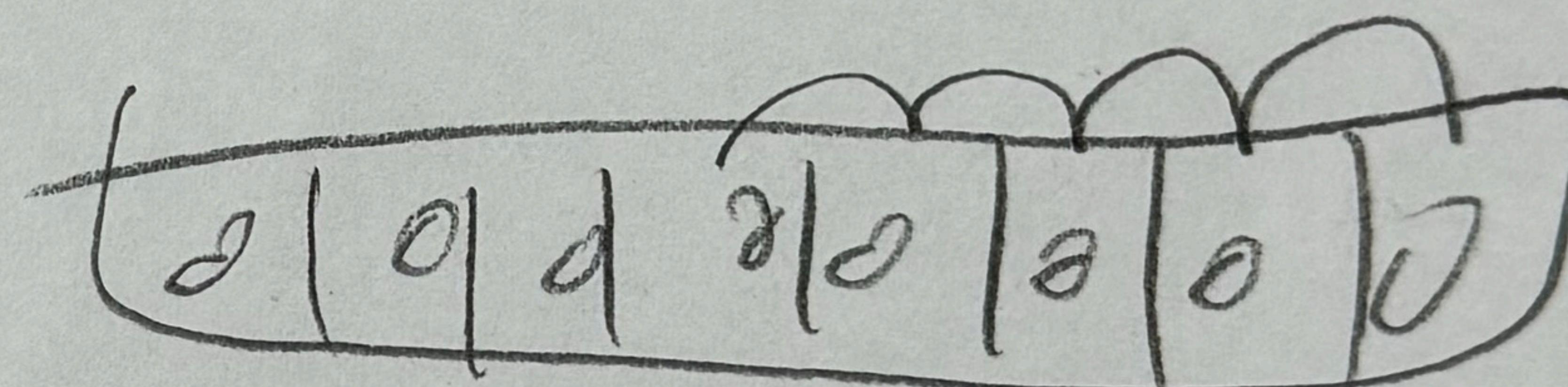
- Description: Design a device that utilizes UART with a motor. Users can input 'mode1' or 'mode2' on Putty to control the motor:

Mode 1: The motor rotates continuously from -90 degrees to +90 degrees and then resets to -90 degrees until users change the mode.

Mode 2: The motor rotates from -90 degrees to +90 degrees and then smoothly decreases back to -90 degrees, repeating this cycle until users change the mode.

- Note: Add a delay during the transition from +90 degrees to -90 degrees in Mode 2, making this movement visibly slower than Mode 1, so it's easy for the teaching assistant to check.

- Question 3a (20%)



- Description: Please use the variable resistor to control the motor. Please use 10-bit resolution and map 0~1023 to the degree 0°~90°. Which 0 map to 0° and 1023 map to 90°. You should deal with each degree, not only 0° and 90°

- Question 3b (10%)

- Description: Using UART with a variable resistor set to 10-bit resolution. An integer x, initially set to 100, can be updated by entering a new number via UART. By rotating the variable resistor or updating the integer x, display the result of dividing the variable ~~resistor~~ value (0~1023) by the integer x (10~600).

$$16 = 2^4 \quad 2^8 = 32$$

(*) FOSC = 125 kHz

T_A

Q 16.

T_{Osc} = 8 μs

16 μs

$$4x * 8 \cancel{\mu s} * 4 = 2400 \cancel{\mu s}$$

$$4x * 8 \cancel{\mu s} * 4 = 500 \cancel{\mu s}$$

11.325

$$x = \frac{2400}{11.325}$$

3.1

18.15