EE 3220 – System-on-Chip Design – 2021/22 Spring

Assignment 1 – Due date: Feb 16, 2022 (Wednesday) – 23:59pm

Submission method – Canvas online assignment collection box

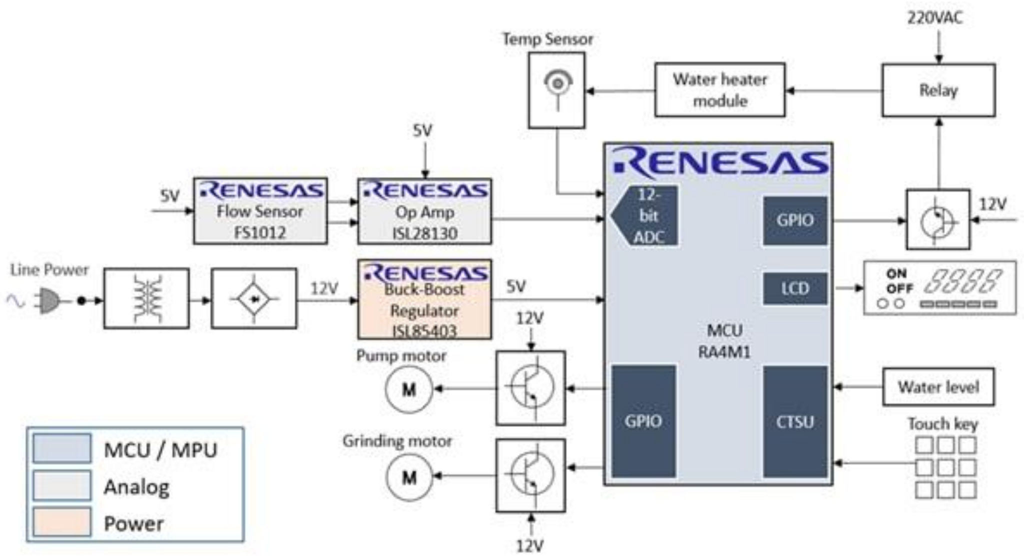
Name: ______________________ **Date:** ____________

Student ID: _________________ **Mark:** ____________

Submission guidelines:

- Please prepare your assignment in "PDF" format. (1%)
- Please rename your file to "EE3220 – assignment 1 – studentID.pdf". (1%)
- For late submission, 10% deduction per day.

Q1: Consider a controller for a smart coffee machine (as shown below) as an embedded computer system.



A. What are the inputs?

B. What are the outputs?

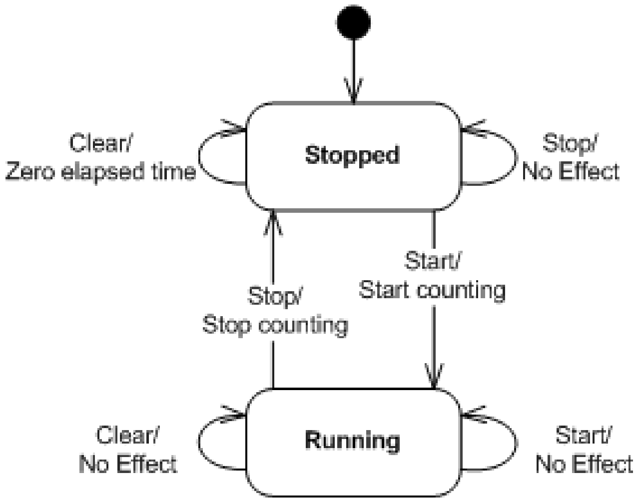
C. Name at least two safety features to include, and specify what hardware and/or software is needed for each.

D. Describe a useful feature which could you add in software without requiring additional hardware.

E. Describe a useful feature which could you add in software if the controller could keep track a user profile setting and add a new I/O component.

F. Describe a useful feature which could you add in software if the coffee machine included an internet connection.

For Q2-Q4, consider a stopwatch as described here. The state machine below presents the desired behavior.



It has the following hardware.

- Buttons for Start, Stop, Lap and Clear functions.
    - Pressing **Start** starts the stopwatch running. If pressed multiple times, stopwatch continues running without resetting elapsed time.
    - Pressing **Stop** stops the stopwatch from counting.
    - Pressing **Clear** zeroes out the elapsed time if the stopwatch is not running. If it is running, the clear button is ignored.
    - Pressing **Lap** records the current time. If pressed multiple times, different laps data are recorded. If it is at the stop state, takes no effect.
- A timer which triggers an interrupt every 1 ms. The timer drives a counter which counts milliseconds since system start-up, and can be read as elapsed_time_counter.
- A display to show elapsed time with 1 ms resolution. The display must be updated 10 times per second.
- A "Lap" button, which records the time for a lap as shown in the above Apple Watch (as an example).

Q2: Design pseudocode for the software using event-triggered scheduling with interrupts. Assume that each button can generate an interrupt.

- Use a variable called state to indicate whether the stopwatch is stopped or running or recording
- Use a variable called **elapsed_time** to track how much time has elapsed since the start button was pressed.
- Use a variable called **display_delay** to track how many milliseconds remain until the display needs to be updated again.
- Use a variable called **lap_time** to record the current lap time.

Q3: Now design pseudocode for the software using a **static scheduler without using any interrupts**. Assume that the timer updates a hardware register called elapsed_time_register every millisecond.

- Use a variable called state to indicate whether the stopwatch is stopped or running
- Use a variable called start_time to record when the start button was pressed.
- Use a variable called stop_time to record when the stop button was pressed.
- Use a variable called lap_time to record when the lap button was pressed.
- Use a variable called next_display_update to indicate when the display needs to be updated next.

Q4: Create a flowchart to represent your solution to the previous question.

Q5: As stated in the lecture, we have introduced the "Qualcomm Snapdragon 8 Gen 1".

- What is the ARM Architecture used in this SoC?
- What kind of new instructions are introduced in this Architecture?
- Please introduce the basic components used in this SoC.
- This SoC can achieve high performance and power saving. In your own words, how this SoC is able to achieve these outstanding features as compared to State-of-the-art products?

Q6: Assume a wafer size of 18 inches, a die size of 2.5cm^2, defect is 1 / cm^2. Alpha is 3. Please use the equations provided in the lecture notes, determine the die yield of this CMOS process.

Q7: A modern desktop processor may contain 1 billion transistors in a chip area of 100 mm^2. If Moore's Law continues to apply, what would be the chip area for those 1 billion transistors after 8 years (assume the cycle is 24 months)? What percentage is that area of the original area?

Q8: Consider a system with the following tasks. We wish to **minimize** the response time for task E. For each type of scheduler, describe the sequence of processing activities which will lead to the minimum and the maximum response times for task E. Assume that each task is ready to run and there are no further task releases.

Task	Duration
A	3
B	1
C	4
D	2
E	5

a. Static, non-preemptive scheduler
b. Dynamic, non-preemptive scheduler
c. Dynamic, preemptive scheduler

Q9: An embedded operating system uses the Shortest Job First scheduling algorithm. Consider the arrival times and execution times for the following processes:

Process	Burst time	Arrival time
P1	20s	0s
P2	30s	15s
P3	15s	30s
P4	10s	45s

Please draw the figure of all the process with burst time and wait time.

Q10: Consider the following table of arrival time and burst time for four processes P0, P1, P2 and P3.

Process	Arrival time	Burst Time
P0	0 ms	9 ms
P1	1 ms	4 ms
P2	2 ms	5 ms
P3	4 ms	3 ms

Now, the Round Robin scheduling algorithm is used, and the quantum is 3ms. Scheduling is carried out only at arrival or completion of processes. What is the average waiting time for the four processes? Please draw the figure of all the process.

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