Embedded Systems Exam (Pitchaya)

Rules:

1. The exam is open books. You may prepared any material and any material you prepared before is a fair game. You may not ask or post questions on the Internet or anyone.
2. During the exam period, you may not any communication devices nor talk to your friends by any mean until both party submit the exam.
3. All answer must be in your own words. No copying from any source.
4. I reserve all the rights to forfeit your exam if I do have any suspicious that you do not honor the rule of the exam.
5. You may answer in Thai or English.
6. You may type in the answer, scan the document, or use your cellphone to capture the answer back.
7. If you have any question regarding a problem in the exam, do you best to state your assumptions and complete the exam.

On your honor as a student, I have neither given nor received aid on this exam.

How many words (including articles) are in the sentence above? _____

Signature _____

Name _____

Start Date - Time: _____

Finish Date - Time: _____

1. Suppose that you are designing a system to regulate water flow. The system has the following property
   - The flow meter returns voltage between 0 to 3V. Where 0 means no flow, and 3V means 10 cm^3/s.
   - The water pump is controlled using voltage from 0-10V. The higher voltage, the higher flow rate.
   - The user can control the flow using a potentiometer. 0 ohm means no flow, 10kOhm means 10cm^3/s

Write a pseudo code for the controlling system above with PID. Make sure you explain any assumption you have on the system

2. Draw a circuit for controlling system in the first problem using opamps.

3. CANbus is typically used in automotive. What are the features that make it suitable for automotive applications?

4. While CAN is popular for an automotive, there is little usage in industrial or IOT applications. Discuss why would you use or not use CAN for an IoT application.

5. Is it possible to have a stable control loop with positive feedback?

6. Explain what is happening to program counter and stacks when an interrupt occur?

7. Suppose that you are building an embedded system for an ATM where there is a high-resolution monitor with high framerate for advertising purpose, but all the user inputs are slow. The system also has a lower power CPU and has a printer to print small receipt and can connect to a network.
   Your task is to design buses architecture and interrupt priority for the system such that it uses as little power as possible during idle time, but also handle the task. State your assumption and details as much as possible.

8. Suppose that you are designing a teleconferencing device that have the following peripheral running together:
    a. Camera sensors data rate of 4Gbps
    b. Display running at 1920x1080 30FPS at 24 bits per pixels
    c. Touch screen input in I2C at 50Hz, 16bits
    d. Audio input running at 48KHz, 16bits
    e. Audio output running at 48KHz, 16bits
    f. Wifi communication at up to 10Mbps

Suppose also that all the peripheral needs to read or write to memory.

a. Calculate total memory bandwidth use if all peripherals are running at the above data rate.

b. Typical System on Chip has an image processing unit. This allows input from camera/imaging sensors to be processed and reduce the size. Design a bus system with DMA for the system assuming that the camera sensor is an input to image processing unit and rescale to the output of the display. Note that display typically needs frame buffers in main memory still.

c. Both Wifi and touch screen inputs require CPU attentions through interrupt. How would you rank the priority of the interrupt?

9. Modern boot loader allows only signed operating system to run. Describe how one would enforced this in a hardware.