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**School of Electrical and Computer Engineering**

**ECE 5721 - Fall 2022**

**Homework 0**

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**September 5, 2022**

1. Write down the dates for Exam 1, Exam 2, and Final exam. Note these dates in your calendar

Exam 1: Tuesday, October 4, 2022

Exam 2: Thursday, November 3, 2022

Final Exam: Thursday, December 8, 2022

1. Read the objective of the course from the course syllabus. Write at least one objective of the course that you like the most.

I am most excited about the group design project. I deal with embedded software requirements and testing at my job, and I miss the design and implementation aspects of embedded software engineering.

1. Do you know that attendance is taken in every class?

I do now!

1. Do you have any comments on the Course Outline?

Not really. I would really like to know what development board we will be using so I can order it and start tinkering. I know the initial plan was to use the FRDM-KL25Z, but they seem to be out of stock everywhere.

1. Watch the PPT presentation on “Embedded Systems Overview” by Dr. Subra Ganesan, and answer the following questions:
   1. What is an embedded system?

An embedded system is an electronic device that incorporates a computer within its implementation. These computers are typically microprocessors or microcontrollers.

* 1. What are the advantages of microprocessor based embedded systems?

An embedded microprocessor/microcontroller simplifies electronic system design and provides flexibility. It is often much easier to implement/test functionality using a computer and software than it is to do with analog circuitry.

* 1. What possible implications will Embedded Controllers have on personal privacy?

Embedded systems are everywhere and are more and more frequently becoming interconnected with one another, creating an “internet-of-things” (IOT). These embedded systems often include cameras and microphones, which when coupled with insufficient security/encryption mechanisms can present a substantial risk to personal privacy as malicious actors can easily eavesdrop on people’s personal lives.

* 1. What are the typical challenges in Embedded Systems design?

Scalability is one typical challenge of embedded systems design. Developing a scalable system involves selecting (or designing) appropriate hardware (MCU, MPU, DSP, FPGA, etc) that are both easily mass produced and capable of satisfying system requirements. This is especially true in today’s post-pandemic economy in which silicon products are increasingly difficult to source.

* 1. What is the most interesting application of Embedded Systems that you have come across?

The most interesting application of embedded systems that I have encountered might be the “connected car” system my company (Danlaw) is currently developing. This application consists of boxes that will line streets and highways. These boxes are hardwired to the internet and can extend the range of GPS signals into the “concrete canyons” of big cities where devices typically have trouble establishing a link to the satellite network. Additionally, these boxes communicate with modules present in cars to collect, aggregate, interpret, and disseminate real-time driving data.

1. What at this moment is the largest electronic chip, and how does the ARM based Cortex M0+ compare to it? Discuss the fabrication node, transistor count, core count, power consumption, cooling needs, etc.

The largest electronic chip being produced today is the Cerebras Wafer Scale Engine (WSE). Cerebras uses the standard method of photolithography to inscribe electrical circuits onto a silicon wafer. The chip measures 8.5” on each side and contains 2.6 trillion transistors. These transistors constitute 850,000 AI-optimized processing units. It consumes 20kW of power and requires a sophisticated liquid cooling mechanism to help it dissipate heat [1] .

The Arm Cortex M0+ is the most energy-efficient Arm processor available for embedded applications [2]. This line of microprocessors can scale from 12,000 to 30,000 logic gates per chip, which puts the transistor count somewhere in the scale of hundreds of thousands to a few million. That means the Arm Cortex M0+ has a million times less transistors than the Cerebras WSE. The datasheet indicates the typical dynamic power consumption as low as 3.8µW/MHz. This means a chip operating at 16MHz consumes as little as 60.8µW, almost a billion times less than the Cerebras WSE. With power consumption this low, ambient air is a sufficient cooling mechanism for the device. These devices are single core and are produced using the typical photolithography process.

# **References**

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| [1] | D. Spicer, "www.ComputerHistory.org," 03 August 2022. [Online]. Available: https://computerhistory.org/blog/the-biggest-chip-in-the-world/. |
| [2] | Arm Developer, "www.developer.arm.com," 2022. [Online]. Available: https://developer.arm.com/Processors/Cortex-M0-Plus. [Accessed 5 September 2022]. |