

# **CG2271 Real Time Operating Systems**

**2025/26 Semester I**

## **Term Assignment**

### **1. Introduction**

In this course we have looked at how to program bare-metal on the MCXC444, and how to combine this bare-metal programming with FreeRTOS. The objective of this assignment is to give you a feel for developing a FreeRTOS-based system from scratch.

You are to build an IoT system that incorporates sensors, actuators, UART and network access (via an ESP32 module), coordinating everything using FreeRTOS.

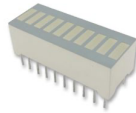
### **2. Project Specification**

You can build anything you'd like for this project, subject to the following conditions:

- i. You should have at least 3 sensors and 2 actuators connected to the FRDM-MCXC444 board. Actuators include buzzers, LEDs, relays, motors, etc. (Note: It is easier to connect some sensors to the ESP32, e.g. the ultrasonic sensor, or the DHT11 digital humidity and temperature sensor. We will count ONE of these amongst the 3 sensors that should be connected to the FRDM-MCXC444 board. The remainder will not be counted).
- ii. At least 1 sensor must be polling and at least 1 must be interrupt driven.
- iii. You must have a minimum of 1 ISR and 2 tasks.
- iv. Ensure good task and ISR design. Review Lab Lecture 7 for principles of good software design using RTOS.
- v. You must use at least one queue and one semaphore. Semaphores include mutexes.
- vi. You must configure your RTOS to support time-slicing and pre-emption, and remove any component you do not require.
- vii. You must connect and use the ESP32 that you are given.
- viii. You must use the ESP32 to connect to OpenAI's API and use GPT4o to perform some reasoning based on the sensor data, and some actuation based on the reasoning. You can purchase up to S\$50 of API credits.

Note that grading is primarily based on meeting these criteria. Some additional actuators that you **might** be able to get from Makers Lab include. Availability is on a first-come-first-served basis.

- i. Motors and motor drivers. You need to learn how connect up and program the motor drivers yourself.
- ii. Buzzers.
- iii. 10-segment LED bar graph like this:



You need to learn how to connect up and program this on your own.

You can add in other devices of your own, but you will not be reimbursed. Again remember that the point is to meet the specifications; coolness is rewarded but secondary.

### 3. Assessment

You will be required to give a demo at your respective lab slots on 11 and 12 November 2025, and submit a report by Saturday 15 November 2025 2359 hours.

### 4. Marking scheme

You are graded based on the following rubrics, totaling 40 marks.

Rubric	Points	Points received
3 sensors, 2 actuators	2	
1 polling sensor	1	
1 interrupt sensor	1	
Proper ISR design	3	
Proper task design	3	
At least 2 tasks	1	
At least 1 semaphore	1	
At least 1 queue	1	
Time-slicing	1	
Pre-emption	1	
Use of ESP32	5	
Use of GPT	5	
Message passing design	5	
Coolness	5	
Report	5	
<b>TOTAL:</b>	<b>40</b>	