EE304 Embedded Systems

Final Project Assignment

Due:  
Progress Report – (Updated) 9 **May 2025**  
Final Report – 2 **June 2025**   
(This document might be updated. Please check on it later on)

# Summary

In this project, you are expected to

* apply as much knowledge you learned during the course as possible,  
  Ex: GPIO with different settings (pull up, pull down, push-pull, etc.), multiple sensors in the same SPI bus, etc.
* Find and solve a real life problem,
* Come up with a smart algorithm
* Demonstrate it in Proteus

You are going to submit a progress report explaining your design plan. You are expected to complete at least half of what you are planning to do and demonstrate it. At the end, you are expected to submit a final report. The detailed content of reports and the other required supplementary documents are listed at the end of this document.

**NOTE: You will complete the final project as groups, using the same groups that were assigned for the lab sessions.**

Using each of the following “list of tools and features” counts towards your final score. They are not equally weighted. Highlighted ones **have to** be used in your project:

DO NOT USE ARDUINO CODING!!!

## List of tools and features:

**NOTE: YOUR PROJECT HAS TO BE WORKING. YOUR CODE WILL NOT GET ANY SCORE IF IT IS NOT WORKING.**

**So, start simple. Save each version in case later versions ruin the whole project.**

1. GPIO
   1. Digital input/output,
      1. Pull up/down, open drain,...
2. ADC
3. Interrupt
4. Communication
   1. USART/UART
   2. I2C
   3. SPI
   4. Using multiple devices at the same communication bus
5. Timers
   1. TIM
      1. Periodic interrupt,
      2. Output Compare
      3. PWM
      4. Input Capture
      5. Use it as trigger source (e.g., to initiate DMA)
      6. Using the same timer for multiple tasks
   2. Systick
   3. RTC
6. DMA
7. Sensors,
8. Actuators,
9. Displays  
   Ex: 2x16 LCD display, etc.
10. Something we haven’t covered (E.g., watchdog timer, deep sleep, etc.)
11. Real time OS
12. Smart Algorithm
    1. Could be Data analysis, data filtering etc.   
       Ex: Humidity and temperature readings are recorded for last two days. Next hour’s state is predicted based on that.  
       Ex: Weight readings of each person are recorded separately. Hunger effect is eliminated by using a running average filter. Moreover, the person’s weight in the next month is predicted using linear data regression.
    2. Or you can use what you have learned from other courses such as data sorting, graphs, etc. You do not need to implement those algorithms. You can use other C libraries.
13. IoT application (e.g, displaying data analytics on PC or mobile, controlling your device remotely from mobile phone etc.)

Constraints:

* Do not use polling, busy waiting (i.e., HAL\_Delay) in your code,
* Do not use Arduino codes
* Follow good programming practices
  + Error handling (Check out return values of your functions, etc.)
  + Commenting
  + Human understandable variable names and style

# Your progress and final reports (pdf) should include:

* Clear objective of your project,  
  Ex: smart digital scale which tracks, analyzes each user's fitness and health separately. It helps users to get insight about their weight gain/loss trends by predicting …
* explain your design using visuals.
* Also provide a pricelist of the items you have used and the final product’s cost.
* List Features of your system:  
  Ex: It warns the user if the battery is low.
* Clearly list Which of the elements in the “list of tools and features” used as a table (We will give score to each one of them and sum them up). See the sample table at the end of this document.,
  + This table has to be justified in the report. Each bullet point has to be explained and the related line of the code must be shown in the report (Do not copy paste the whole code. Show only the related lines and line numbers so that TAs can find it in the code if necessary.) For example, if you use ADC, show that you have correctly calibrated it, initialised and called the related functions correctly.
* Explain design steps, the units/modules used,
* Challenges you encountered and how you overcame them.
* Screenshots of your system running
* Do not copy paste your code! You will upload your code separately.
* Teamwork: Who did how many percent of the project? (If this is not included, we will assume that it is equally distributed.) If the project is done by only one person, completing half of it will yield a full score (100).
* In your reports, for each setting give,
  + Why did you choose that setting?  
    Ex: I have chosen 16 cycle as ADC input capture delay because ....
  + What are the things that you had taken into consideration?  
    Ex: We need to wait ADC to stabilaze first. So, first I called ADCstabilize … function..

# Important dates

Date (9**th May**):

* Progress report
  + What is your full design plan,
  + Implement and demonstrate half of it.
* Upload a 5 min (max) video demonstrating the completed half of your project.
* Your current code (Keil MDK)
* and design (Proteus)

Date (**2th June**):

* Final Report
* 3-5 min. demo video
* Your current code (Keil MDK)
* and design (Proteus)

# Help

### Adding new sensors to Proteus

* [Proteus Libraries of Embedded Sensors](https://www.theengineeringprojects.com/2020/07/proteus-libraries-of-embedded-sensors.html)
* [New Proteus Libraries of Digital Sensors](https://www.theengineeringprojects.com/2020/07/new-proteus-libraries-of-digital-sensors.html)

### Past Year Project Ideas:

* [Example Project Reports](https://aguedutr-my.sharepoint.com/:f:/g/personal/abdulkadir_gulsen_agu_edu_tr/EoJ0wXzkqOdLtKDeTUe-YLgBNktmf87sVnph3w8tIqRIMg?e=G4e1KV)
* [Example Project Videos](https://aguedutr-my.sharepoint.com/:f:/g/personal/abdulkadir_gulsen_agu_edu_tr/Ep5QkbCPNZlJv0Rt042mNN4BAEizezNZ1f7dEgBkv2t9yQ?e=Wbp0Wy)

# Summary Table to be filled by each team

|  |  |  |
| --- | --- | --- |
| Module/Feature | Some of the possible types | We used these types: <Delete this comment. The following is an example> |
| GPIO | * ⭐Digital Output * ⭐Digital Input * ⭐Other | * ⭐Digital Output   + Push/Pull x2 * ⭐Digital Input   + Open drain x1   + Pull up x1 |
| Communication | * UART ⭐, * SPI ⭐⭐, * I2C⭐⭐, * CAN⭐⭐⭐, Others * Using multiple devices at the same communication bus ⭐⭐⭐ | * UART ⭐,   + Polling * SPI ⭐⭐,   + Interrupt,   + DMA * Other   + Bluetooth HC-06 (Single wire communication) |
| Watchdog timer | ⭐ |  |
| Interactivity (Leds, buttons, switches, touch etc.) | ⭐⭐ | * Leds x5 * 16x2 Display * Buzzer * Knob switch |
| Using sensors | Single ⭐, few ⭐⭐, many or advanced one ⭐⭐⭐⭐ | * Sensor x5 types   + Sonar distance     - SPI   + Water level     - (Analog)   + DH11 Temp Humidity Sens     - We implemented the communication protocol. |
| Actuators | * Motors, * .. |  |
| Timers | Systick⭐, Advanced-basic Timers ⭐⭐, RTC alarm ⭐⭐ | * TIM1   + PWM * TIM2   + Periodical interrupt generation * Systick timer |
| Usage of polling | ❌❌❌ | We have only used two polling:   * ADC\_rea… * DH11\_read\_value… |
| Usage of Interrupts | No interrupt ❌❌❌, Single ⭐, few ⭐⭐, many with different priorities ⭐⭐⭐ | * ADC1\_rea..\_IT * … |
| Error handling | No error handling ❌ , few ⭐⭐, full ⭐⭐⭐ | * In five places:   + …   + .. |
| Analog-digital Converter | ADC ⭐⭐, DAC⭐⭐ | * ADC1, ADC2 * DAC   + Sound generation |
|  |  |  |
| Advanced Things that no code is provided during the course such as DAC, CAN etc. | extra ⭐⭐⭐ |  |
| Power saving | Sleep - standby - wakeup ⭐⭐⭐ |  |
| DMA | ⭐⭐⭐ |  |
| Ethernet-internet-wifi | ⭐⭐⭐ |  |
| Writing own driver library for a peripheral | ⭐⭐⭐⭐⭐ |  |
| bluetooth | ⭐⭐⭐⭐ |  |
| PCB | External electronics design ⭐⭐, using a different board ⭐⭐⭐, using MCU unit on your own design without the development board ⭐⭐⭐⭐⭐ |  |
| Usage of advanced tools e.g., Matlab, CubeAI etc. (Matlab code should run on MCU) | ⭐⭐⭐⭐⭐ |  |
| Real time OS | ⭐⭐⭐⭐⭐ |  |

**Table 1** Summary of the features and modules used in our project. This table has to be justified in the report. Each bullet point has to be explained and the related line of the code must be shown in the report (Do not copy paste the whole code. Show only the related lines and line numbers so that TAs can find it in the code if necessary.).

# Grading

* Teamwork (Pass / Fail)
  + The team members who haven’t contributed to the project more than (pairs contribution% - 10%) will fail.
* 10% Bonus for impressive achievements (E.g, Writing a driver for a peripheral on your own, Integrating it with a PC game, etc.)

**General Rubrics**

| **Criteria** | **Pts** |
| --- | --- |
| **Documentation (20%):**   * Clear and organized documentation of the project, including system requirements, specifications, and design decisions. * Detailed description of hardware components and connections, including diagrams where applicable. * Well-documented software code, with comments explaining the functionality of different sections. | 20 pts |
| **Implementation and Testing (30%)**   * Effective integration of hardware and software components and successfully implementing all necessary features and functionalities. * Proper utilization of programming techniques and best practices. * Efficient and optimized code execution, minimizing delays and maximizing system responsiveness. * Adequate error handling and fault tolerance mechanisms. * Clear presentation of test results and discussion of any limitations or issues encountered. * Effective use of sensors, actuators, and other hardware components to achieve the desired system behaviour. * Topics covered in the summary table above. | 30 pts |
| **Idea Originality, Creativity, and Design Quality (30%)**   * Demonstrates creative and innovative thinking in the design of the embedded system. * Demonstrates a well-thought-out and effective overall system design. * Efficient utilization of system resources (e.g., memory, processing power) without any unnecessary overhead. * Consideration of factors such as power consumption, modularity, scalability, and robustness. | 30 pts |
| **Project Demonstration (20%):**   * Clear and concise oral or written presentation of the project, explaining the design choices, implementation details, and results. * Professionalism, clarity, and confidence in delivering the presentation. | 20 pts |