1. **Course Number and Course Title:**

   COE 241 – Microcontrollers: Programming and Interfacing

2. **Credit Hours:**

   3 – 3 – 4

3. **Prerequisites and/or Co-Requisites:**

   Prerequisite: CMP 120 Programming I or MCE226L Computer Applications in Mechanical Engineering I, COE 221 Digital Systems, and ELE 211 Electric Circuits I or ELE 225 Electrical Circuits and Devices

4. **Name and Contact Information of Instructor:**

   Name: Dr. Waleed Dweik
   Email: wdweik@aus.edu
   Office: ESB 2146
   Phone: 06 515 4899
   Office Hours: Posted on office door and iLearn; also by appointment

5. **Course Description (Catalog Description):**

   Examines the basic hardware building blocks, addressing modes and instruction sets of microprocessors and microcontrollers. Introduces selection criteria for microcontrollers. Covers digital and analog input/output, timers, interrupts and serial communications, programming and interfacing.

6. **Textbook and other Supplemental Material:**

   Textbook:
   - Yifeng Zhu, *Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C,* 4th ed., E-Man Press LLC, 2023.

   Other supplemental material:
   - Class notes will be uploaded on iLearn.

7. **Course Learning Outcomes:**

   Upon completion of the course, students will be able to:
   1. Describe the internal architecture and software model of a generic microprocessor and microcontroller.
   2. Develop assembly-based programs using various addressing modes.
   3. Develop microcontroller programs using a high-level language.
   4. Utilize microcontroller digital I/O and analog I/O ports for interfacing applications.
   5. Configure interrupts/timers for interfacing applications.
   6. Implement serial communication protocols using a microcontroller.
   7. Program a microcontroller for controlling and operating a real-time process.

8. **Teaching and Learning Methodologies:**

   Methods include lectures, problem-based learning, class discussions, and laboratory sessions. Students learning is assessed via quizzes, exams, and laboratory assignments.

9. Course Topics and Schedule:

Topic/Activity	Weeks
Microprocessor and microcontroller hardware architecture and software models	Week #1
Data representation and types, ARM instruction set architecture, and addressing modes	Week #2
ARM Assembly instructions (arithmetic, logic, and data movement)	Week #3
ARM Assembly instructions (branch and conditional execution)	Week #4
ARM Assembly instructions (Subroutines and stack)	Week #5
Programming and interfacing the Digital I/O ports of STM32L4 microcontrollers using Assembly and C	Week #6
Interfacing STM32L4 with an LCD using C – Midterm I Exam	Week #7
Basics of Analog to Digital conversion	Week #8
Programming and Interfacing the ADC modules of STM32L4	Week #9
Timers programming and interfacing of STM32L4 (General purpose timers)	Week #10
Timers programming and interfacing of STM32L4 (Output Compare)	Week #11
Timers programming and interfacing of STM32L4 (PWM) – Midterm II Exam	Week #12
Timers programming and interfacing of STM32L4 (Input Capture)	Week #13
Serial communication protocols – UART	Week #14
Serial communication protocols – I^2C	Week #15
Final Exam	Week #16

10. Schedule of Laboratory and other Non-Lecture Sessions:

Assignment	Due Date (tentative)
Lab 0 – Lab introduction and orientation	Week #2
Lab 1 – Introduction to STM32L4 microcontroller and STM32CubeIDE	Week #3
Lab 2 – ARM assembly programming – Arithmetic and logic	Week #4
Lab 3 – ARM assembly programming – Data movement	Week #5
Lab 4 – ARM assembly programming – Control flow	Week #6
Lab 5 – Digital I/O programming and interfacing of STM32L4 using ARM assembly	Week #7
Lab 6 – Digital I/O programming and interfacing of STM32L4 using C	Week #8
Lab 7 – Interfacing STM32L4 microcontroller with LCD using C	Week #9
Lab 8 – ADC – Part I – Interfacing with a potentiometer	Week #10
Lab 9 – ADC – Part II – Interfacing with a temperature sensor	Week #11
Lab 10 – Timers – Part I – Output Compare and PWM	Week #12
Lab 11 – Timers – Part II – Input Capture	Week #13
Lab 12 – Serial communication protocols – UART	Week #14

Project: none in this course.

11. Student Evaluation:

Assessment	Weight	Due Date (tentative)
In-class Quizzes	11 %	Week #4, Week #9, and Week #13
Laboratory Assignments	12 %	cf. section 10
Midterm I Exam	21 %	Week #7
Midterm II Exam	21 %	Week #12
Final Exam	35 %	Week #16

12. Assessment Instruments:

Assessment	Course Learning Outcomes
In-class Quizzes	O1 – O5
Laboratory Assignments	O2 – O7
Midterm I Exam	O1 – O2
Midterm II Exam	O3 – O4
Final Exam	O2 – O7

13. Contribution of Course to Program Outcomes:

BSCoE Program Outcomes	Emphasis in this course	Course Learning Outcomes
(1) Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	◑	O1 – O2
(2) Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	○	O7
(3) Communicate effectively with a range of audiences		
(4) Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts		
(5) Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives		
(6) Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	◑	O3 – O7
(7) Acquire and apply new knowledge as needed, using appropriate learning strategies		

Emphasis: ● High; ◑ Medium; ○ Low; Blank – Nothing Specific Expected

14. Letter Grade Policy:

Total (T)	Letter Grade
$95 \leq T$	A
$90 \leq T < 95$	A-
$85 \leq T < 90$	B+
$80 \leq T < 85$	B
$75 \leq T < 80$	B-
$70 \leq T < 75$	C+
$65 \leq T < 70$	C
$60 \leq T < 65$	C-
$55 \leq T < 60$	D
$T < 55$	F