1. **Course Number and Course Title:**
   COE 411 – Embedded and Cyber Physical Systems

2. **Credit Hours:**
   3 – 3 – 4

3. **Prerequisites and/or Co-Requisites:**
   Prerequisite: COE 241 (Microcontrollers: Programming and Interfacing)
   Co-requisite: ELE 340 (Digital Electronics)

4. **Name and Contact Information of Instructor:**
   Dr. Mohamed Hassan
   Office: ESB-2071
   Email: mhhassan@aus.edu
   Phone: 06-515-2932
   Office Hours: posted on Ilearn

5. **Course Description (Catalog Description):**
   Introduces embedded and cyber physical systems computing platforms, and their building blocks. Covers interfacing and programming sensors and actuators, process-controlled and time-controlled interrupt handling. Explores communication methods. Covers Internet of Things (IoT) applications. Examines embedded and cyber physical systems design requirements and specifications. Reviews embedded and cyber physical systems emerging applications through a class project.

6. **Textbook and other Supplemental Material:**
   - Textbook:
     Jonathan Valvano, "*Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers*", Fourth Edition, ISBN: 978-1463590154
   - Supplemental material:
     Class notes uploaded to iLearn

7. **Course Learning Outcomes:**
   Upon completion of the course, students will be able to:
   1. Demonstrate an understanding of the principal characteristics of embedded and cyber physical systems and edge computing platforms: microcontrollers and microcomputers.
   2. Employ edge computing devices for embedded and cyber physical systems.
   3. Utilize wired and wireless communication protocols for embedded and cyber physical systems.
   4. Design embedded and cyber physical systems using sensors, IoT-based edge computing devices, and actuators.
   5. Analyze the design trade-offs of high-performance embedded systems
   6. Use Modern Real-Time Operating Systems for task scheduling and management
   7. Investigate emerging embedded and cyber physical systems applications.

8. Teaching and Learning Methodologies:

Methods include lectures, labs, quizzes, exams and class discussions.

9. Course Topics and Schedule (Tentative):

Topic	Weeks
Cyber Physical Systems edge computing platforms and their basic building blocks and architecture	Week #1
Digital peripheral interfacing and programming (sensors)	Week #2
Digital peripheral interfacing and programming (actuators)	Week #3
Wired and Wireless communication protocols	Week #4
Analog inputs and outputs peripheral interfacing and programming	Week #5
Process-controlled and time-controlled interrupt handling	Week #6
High-performance embedded systems – CPU	Week #7
High-performance embedded systems – Caches	Week #8
High-performance embedded systems – Memories	Week #9
Real-Time Operating Systems (RTOS) – Task Model and Uniprocessor Scheduling	Week #10
Real-Time Operating Systems (RTOS) – Resource Sharing	Week #11
Real-Time Operating Systems (RTOS) –Multiprocessor Scheduling	Week #12
Timing Analysis and Predictability	Week #13
Project Presentation	Week #14
Group class presentations: Cyber Physical systems and IoT recent applications	Week #15
Final Exam	Week #16

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

Topic	Weeks
Lab 0 – Introduction to the lab equipment and platforms	Week #1
Lab 1 – Digital I/O	Week #2
Lab 2 – Digital peripheral interfacing and programming (sensors)	Week #3
Lab 3 – Digital peripheral interfacing and programming (actuators)	Week #4
Lab 4 – Interrupts	Week #5
Lab 5 – Wired interfacing and programming (LCD and Keypad interfacing)	Week #6
Lab 6 – Analog inputs peripheral interfacing and programming	Week #7
Lab 7 – Analog outputs peripheral interfacing and programming	Week #8
Lab 8 – RTOS (1): Task Creation	Week #9
Lab 9 – RTOS (2): Multi-Task Scheduling	Week #10
Lab 10 – RTOS (3): Synchronization	Week #11
Lab 11 – Wireless applications interfacing and programming	Week #12
Lab 12 – Project System Integration	Week #13
Lab 13 – Project System Testing	Week #14
Lab 14 – project demo: Embedded and Cyber Physical system design and implementation.	Week #15

11. Student Evaluation:

Assessment	Weight	Due Date (tentative)
Quizzes	10%	Weeks #8,#10, #12, #13
Midterm Exam	25%	Week #11

Project	10%	Week #14
Labs	15%	Cf. Section 10
Term Presentations	5%	Week #15
Final Exam	35%	Week #16

12. Assessment Instruments:

Assessment	Course Learning Outcomes
Quizzes	O1 – O7
Midterm Exam	O1 – O5
Project	O2 – O7
Labs	O1 – O7
Term Presentations	O6 - O7
Final Exam	O3 – O7

13. Contribution of Course to Program Outcomes:

BSCoE Program Outcome	Emphasis	CLOs
1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	◑	O1–O7
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.	●	O2–O6
3. Communicate effectively with a range of audiences.	◑	O6, O7
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.	○	O7
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	●	O6, O7
6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	◑	O2–O7
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.	◑	O7

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

14. Letter Grade Policy:

Letter Grade	Total (T)
A	$95 \leq T$
A–	$90 \leq T < 95$
B+	$87 \leq T < 90$
B	$83 \leq T < 87$
B–	$80 \leq T < 83$
C+	$75 \leq T < 80$
C	$67 \leq T < 75$
C–	$60 \leq T < 67$
D	$50 \leq T < 60$
F	$T < 50$