MODULE DESCRIPTION FORM

Module Information					
Module Title	**Embedded Systems**			**Module Delivery**	
Module Type	**E**			☑ Theory ☑ Lecture ☑ Lab ☑ Tutorial ☑ Practical ☐ Seminar	
Module Code	**AIE 416**				
ECTS Credits	**4**				
SWL (hr/sem)	**100 H/Sem.**				
Module Level	3	**Semester of Delivery**	6		
Administering Department	Artificial Intelligence Eng.	**College**	College of Engineering		
Module Leader	Mithaq Ibrahim Hashim	**e-mail**	-		
Module Leader's Acad. Title	Lecturer	**Module Leader's Qualification**	Ph.D.		
Module Tutor	Bilal Majid	**e-mail**			
Peer Reviewer Name	Hasnaa Mohammad	**e-mail**			
Scientific Committee Approval Date		**Version Number**	1.0		

Relation with other Modules			
Prerequisite module	**NONE**	**Semester**	
Co-requisites module	**NONE**	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents	
Module Objectives	**Embedded System (Controller) Design Process, Embedded Computing Systems, Software Design and Analysis, Hardware Speeds, Embedded Devices, System Analysis and Design, Design Example, Programming Project, ARM Architecture**

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وزارة التعليم العالي والبحث العلمي
جامعة العين العراقية
كلية الهندسة
قسم الذكاء الاصطناعي

Module Learning Outcomes	Knowledge	A1	A1.1 Define the fundamental concepts of Embedded Systems, including the design process of embedded controllers and the characteristics of embedded computing systems. A1.2 Explain key principles of Software Design and Analysis, and their role in developing efficient and reliable embedded applications. A1.3 Analyze hardware performance factors, including device speeds and limitations, and evaluate their impact on embedded system design. A1.4 Illustrate practical applications of Embedded Devices, including real-world examples and system integration. A1.5 Differentiate between System Analysis and Design methodologies, and apply these concepts to structured embedded system projects. A1.6 Examine design examples to understand the practical challenges in embedded system development and hardware-software co-design. A1.7 Propose and implement programming projects for embedded systems, demonstrating the application of theoretical concepts in practical scenarios. A1.8 Explore ARM architecture, its features, and instruction set, and evaluate its suitability for various embedded system applications.
		A4	A4.1 Recognize common design challenges and practical considerations in embedded systems, including timing, resource constraints, and real-time requirements. A4.2 Identify real-world applications of embedded systems across industries, demonstrating how system requirements influence design choices. A4.3 Apply software and programming techniques specific to embedded devices, including low-level programming and hardware interfacing. A4.4 Compare and evaluate hardware platforms and devices for embedded system deployment, considering speed, energy efficiency, and scalability. A4.5 Create and simulate embedded system designs using structured analysis and design principles. A4.6 Develop strategies to optimize system performance, reliability, and efficiency in embedded applications. A4.7 Select appropriate embedded architectures, hardware components, and programming approaches based on system requirements.

			A4.8 Evaluate integrated embedded system solutions, including ARM-based projects, demonstrating the ability to design, implement, and test complete embedded applications.
	Skills	B1	B.1.1 Function efficiently as an individual B.1.2 Function as a member of multidisciplinary and multicultural teams.
		B3	B.3.1 Acquire and apply new knowledge. B.3.2 Practice the strategies of searching for information in life – long self-learning
	Ethics	C3	C.3.1 Utilize contemporary technologies. C.3.2 Make use of codes of practice and standards, quality guidelines. C.3.3 Utilize health and safety requirements C.3.4 Show environmental issues and risk management principles.
Indicative Contents	Indicative content includes the following. **Unit 1:** Embedded System Design Process, Introduction to Embedded Controllers, System Analysis and Design. **[6 hours]** **Unit 2:** Embedded Computing Systems, Characteristics of Embedded Devices, Hardware Performance Factors including Processor Speeds and I/O Devices. **[8 hours]** **Unit 3:** Software Design and Analysis for Embedded Systems, Programming Techniques, Debugging, and Optimization. **[6 hours]** **Unit 4:** ARM Architecture, Instruction Set, Features, and Practical Applications in Embedded Systems. **[6 hours]** **Unit 5:** Design Example of an Embedded System, Integration of Hardware and Software, Embedded System Project, Case Studies and Practical Applications. **[6 hours]**		

Learning and Teaching Strategies

Strategies	• Presentation • Interactive learning • Discussions • Brainstorming • Group Solving Problems • Problem-Based Learning • Self-learning

Student Workload (SWL) for 15 weeks

Structured SWL (h/sem)	63	**Structured SWL (h/w)**	5.2
Unstructured SWL (h/sem)	37	**Unstructured SWL (h/w)**	4.8

Total SWL (h/sem)	100		

Module Evaluation تقييم المادة الدراسية					
		Time/Number	**Weight (Marks)**	**Week Due**	**Relevant Learning Outcome**
Formative assessment	**Quizzes**	2	10% (10)	5 and 10	A1
	Assignments	2	10% (10)	2, 4,6,8,10,12 and 14	A1
	Projects / Lab.	2	10% (10)		A4, B1, B3, C3
	Report	1	10% (10)	13	A1,A4, B1, B3
Summative assessment	**Midterm Exam**	1hr	10% (10)	7	A1, A4
	Final Exam	3hr	50% (50)	15	A1, A4
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus) المنهاج الاسبوعي النظري		
	Material Covered	**Los**
Week 1	Introduction to Embedded Systems, Overview of Embedded Controllers	A1.1
Week 2	Embedded System Design Process, System Analysis and Design Principles	A1.1, A1.2
Week 3	Embedded Computing Systems, Characteristics of Embedded Devices	A1.3, A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 4	Software Design and Development for Embedded Systems	A1.3, A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 5	Programming Techniques for Embedded Systems, Debugging and Optimization	A1.3, A4,1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 6	Hardware Performance Factors: Processor Speeds, Memory, I/O Devices	A1.4, A4.2, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2

Week 7	ARM Architecture: Instruction Set, Features, Advantages	A1.4, A4.3, B1.1, B1.2, B3.1, B3.2, C3.1
Week 8	Mid -term EXAM	A1, A4
Week 9	Embedded Devices Applications in Real-World Systems	A1.5, A4.6, B1.1, B1.2, B3.1, B3.2, C3.1
Week 10	Performance Optimization and Reliability in Embedded Systems	A1.5, A4.4, B1.1, B1.2, B3.1, B3.2, C3.1
Week 11	Case Studies of Real-World Embedded Systems	A1.6, A4,7, B1.1, B1.2, B3.1, B3.2, C3.1
Week 12	Final Project Presentations / Integrated Embedded System Design	A1.7, A4.5, B1.1, B1.2, B3.1, B3.2, C3.1
Week 13	Rubric Exam Preparatory week before the final Exam	A1, A4
Week 14	Preparatory Week for Final Exam	A1, A4

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر		
Weeks	**Material Covered**	**Los**
Week 1	Introduction to Embedded Systems Lab: Overview of Arduino, setup of IDE and boards, basic GPIO operations.	A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 2	Embedded System Design Practice: Implement simple controller programs with LEDs and push buttons.	A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 3	Analog Input/Output: Reading sensors, controlling LEDs via PWM, understanding ADC/DAC.	A4.4, B1.1, B1.2, B3.1, B3.2, C3.1
Week 4	Timers and Delays: Implement timing operations using Arduino timers and millis() function.	A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 5	Interfacing Actuators: Control servo motors, DC motors, and simple devices.	A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2

Week 6	Serial Communication and Debugging: Implement UART communication, print and monitor sensor data.	A4.3, B1.1, B1.2, B3.1, B3.2, C3.1
Week 7	Sensor Integration: Read data from temperature, light, and distance sensors; integrate into small projects.	A4.6, B1.1, B1.2, B3.1, B3.2, C3.1
Week 8	Project Planning: Design mini embedded system integrating multiple sensors and actuators.	A4.4, B1.1, B1.2, B3.1, B3.2, C3.1
Week 9	Mid -term EXAM	A1, A4
Week 10	Software-Hardware Integration: Write and test programs for the integrated mini project.	A4.5, B1.1, B1.2, B3.1, B3.2, C3.1
Week 11	ARM-based Concepts Using Arduino: Explore ARM architecture features if using ARM-based Arduino boards (Arduino Due).	A4, B1.1, B1.2, B3.1, B3.2, C3.1
Week 12	Performance Optimization: Minimize delays, optimize memory usage, and enhance efficiency of embedded programs.	A1, A4,B1, B3, C3
Week 13	Advanced Features Practice: Explore low-power modes, interrupts, and modular programming.	A1, A4,B1, B3, C3
Week 14	Rubric Exam Preparatory week before the final Exam	A1, A4

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	**Shibu K.V.**, *Introduction to Embedded Systems*, 2nd Edition, McGraw-Hill Education, 2017.	YES
Recommended Texts	**Jonathan W. Valvano**, *Embedded Systems: Real-Time Interfacing to Arm® Cortex-M Microcontrollers*, 3rd Edition, CreateSpace, 2016.	NO
Websites	https://eng.alayen.edu.iq//colleges/e/42	

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks (%)**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.