Syrian Arab Republic

Higher Institute for Applied Sciences and Technology

# Course Specification Document

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| **Title** | Microcontrollers and digital signal processors |

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| **Credits** | 6 ECTS |

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| **Aims** | This course aims to provide the student with the necessary knowledge to understand the internal structure of the microcontroller ATmega16, which is considered one of the most commonly used microcontrollers in academic, industrial and other applications, and all the peripherals inside it, as well as the basic concepts for communicating and connecting it with the external environment, which enable the student to design and implement systems that depend on this microcontroller, both hardware and software.<br><br>The course also aims to provide students with the basic concepts related to the Single Board Computer (SBC) and their applications, by introducing the hardware structure of the BBB (BeagleBone Black) board and the software tools necessary to communicate and control it. Additionally, the course clarifies the mechanism of connecting electronic components and circuits to the board correctly, enabling students to design and implement advanced systems based on this type of board. |

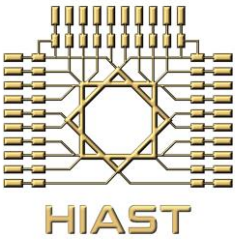
**Intended learning outcomes**

On successful completion of this course, the student will be able to:

- Understand the hardware structure of ATmega16 microcontroller, interrupts, timers and assembly language instructions.
- Understand the USART, I2C, and SPI communication protocols.
- Recognize the structure of Single Board Computers (SBC) and their applications.
- Understand the characteristics of the main components of the hardware structure of the BBB board, as well as the necessary software tools for communication and control.
- Understand the mechanism for connecting elements and electronic circuits to the BBB board
- Use ATMEL STUDIO software environment.
- Use PROGISP environment for programming the microcontroller via an ISP programmer.
- Use the Linux operating system and scripting languages to interact with and program SBC boards.

**Syllabus**

- **The hardware structure of Atmega16:** The description of the microcontroller's pins, the types of internal memories and their addressing modes and how to communicate with them.
- **How the I/O ports work:** I/O ports registers, DDRx control register, PORTx data output register, PINx data input register, I/O ports functions in the ATMEL STUDIO software.




- **Assembler instructions:** Instruction syntax, instructions types, addressing patterns, directives.
- **Interrupts:** Interrupt sources in Atmega16, interrupt priorities, interrupt vector and interrupt service routines.
- **Timers:** Timer0, Timer2, and Timer1 and their operation modes.
- **Analog to Digital Converter:** Fundamentals of sequential approximation method, converter specifications, converter registers, split and converting times, exercises.
- **Asynchronous Serial Transmission Module USART:** RS232 transmission protocol, USART registers and USART functions in ATMEL STUDIO software.
- **$I^2C$ and SPI Transmission Protocols:** Standard protocol terminology and $I^2C$ registers. $I^2C$ functions in ATMEL STUDIO software.
- **Introduction to Single Board processors (SBCs):** SBC characteristics and applications, comparison with other control systems, the main components of SBC boards (e.g. Raspberry Pi and BeagleBone Black).
- **The hardware architecture of the BeagleBone Black board**: **Description** of the board's ports and main components (ARM Cortex A8 processor, memory, power control unit, programmable real-time processing unit PRU, and high-resolution multimedia interface HDMI), **methods** of connecting with the board, instructions for ensuring the safety of the board, examples of some secondary boards and their applications.
- **The software tools for communicating and controlling the BBB board**: Operating systems supported by the board, serial and network communication methods, basic Linux commands for controlling the board, the tools Node.js, Cloud9, BoneScript, programming the board using scripting languages, practical application: controlling the light-emitting diodes (LEDs) on the board.