**ELMIC**
Embedded Systems

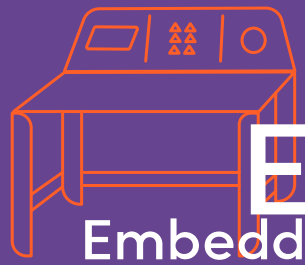
exxer
Skills for the Future

# THE UNION OF EXPERTISE AND SKILLS A NEW LEVEL OF EXCELLENCE IN EDUCATION!

EXXER was born from the merger of two companies passionate **about technology, innovation, and education.**

With the purpose of offering more and more excellence tools to assist in technological education, we believe the union of practical and theoretical learning is what makes the difference in accelerating human and world development!

TECHNOLOGY ● INNOVATION ● EDUCATION



# ELMIC
## Embedded Systems

**Embedded systems are a key technology for the digital world we live in. It is the ability to program embedded micro–electronic devices that enable auto–motive electronics, industrial automation, connectivity, wearables, the Internet of Things (IoT) and cyber–phy–sical systems. Behind every "smart" device there is a programmed embedded system.**

This way, the study of embedded digital systems is a key discipline in the most diverse areas of technology in electronics, automation and control, computing and systems development, renewable energies, telecommu–nications, etc. In addition, of course, the various possibi–lities of development and use of applied electronics itself.

The ELMIC series covers devices embedded in the following technologies:

- Arduino (8–bit microcontroller);
- ARM (32–bit microcontrollers);
- Raspberry Pi (32–bit microprocessor, embedded Linux);
- FPGA (Field Programmable Gate Array, programmable logic device).

Además de eso, esta integración ya validada permite que el estudiante se concentre en el desarrollo del software, no teniendo que preocuparse con montajes y fallas de hardware, aumentando significativamente la eficiencia en el uso del tiempo en laboratorio.

As many of the most modern programmable devices operate at voltages below 5V, the ELMIC kits have regulators and protection circuits and level adjustment for the input and output ports, ensuring their perfect integration with other circuits.

By exploring the main technologies of embedded systems, it is possible to meet curriculum requirements from the most basic to the most advanced ones. Furthermore, the programmable modules are inter–changeable, allowing to study these various technolo–gies on the same platform.

**Software and applications complement the learning solution, ensuring greater effectiveness through more dynamic and modern learning.**

All kits in this series have a comprehensive courseware, focused on teaching by skills and easy to use by instructors.

We have complete solutions for training and updating teachers, ensuring the best use of the kit's resources.

**Ask our experts for more information and the detailed technical features of each equipment in the series.**

# MAIN SKILLS AND COMPETENCIES

## COMPUTER ARCHITECTURE AND ORGANIZATION

- Program in different Programming Languages;
- Implement basic automatic systems;
- Use digital and analog inputs and outputs;
- Apply timers and counters.

## PROGRAMMING LANGUAGES

- Understand the main guiding principles and when to use them;
- Study the basic data types of C structures and how to declare variables;
- Understand how to use the I/O pins of the Arduino microcontroller in practice;
- Simulate different situations with the assignment command;
- Know the *if* and *if–else* decision structures, the *switch* case structure and the conditional ternary operator;
- Use repetition structures and understand the differences between *do–while*, *while* and *for* loops;
- Understand the function library concept and the use of functions;
- Learn and understand code optimization techniques.

## APPLICATIONS

- Program and check the operation of switches and LEDs using C structures;
- Program and check the buzzer operation;
- Program and check the operation of the 7–segment displays in conjunction with the matrix keyboard;
- Program reading of voltage levels and process this information through the program;
- Implement a serial communication between the Arduino and the kit's digital potentiometer;
- Perform a practical application involving external memory and I2C;
- Understand and practice how UART Arduino enables serial communication based on the RS232 and RS485 standard;
- Program and analyze the practical operation of the Oled display.

# TECHNOLOGY HIGHLIGHTS

Arduino Mega is an Arduino platform development board with more memory, speed and I/O ports than the well–known Arduino Uno.

P–NUCLEO–WB55 is a development board from ST equipped with the STM32WB55, dual–core microcontroller of ARM architecture (one ARM Cortex––M4 core and another ARM Cortex–M0 processor) with integrated wireless con–nectivity features compatible with Bluetooth and IEEE 802.15.4.

The Raspberry Pi 3 B+ is a Single–Board Computer (SBC) equipped with a 64–bit quad–core processor and wired and wireless connectivity features.

DE0–Nano is an Field–Programmable Gate Array (FPGA) development board equipped with Cyclone IV EP4CE22F17C6N, programmable in VHDL or Verilog language.


The usability and learning process of each student are extremely important, so we developed educational solutions to provide benefits and differentials for users.

## KEY BENEFITS

- Modular;
- Protected components;
- Easy Storage.

## KEY DIFFERENTIALS

- No tools required;
- Courseware.

# DEVICE CONFIGURATION

| Partnumber | Description | Control unit | Applications |
|---|---|---|---|
| ELMIC2000-L1-001<br>ELMIC2000-L1-002<br>ELMIC2000-L1-003<br>ELMIC2000-L1-004<br>ELMIC2000-L11-005 | Embedded systems kit | Arduino Mega (ATMega 2560 Atmel)<br>FPGA (DE10-Lite MAX10 – 10M50DAF484C7G)<br>Raspberry PI 3 (Broadcom BCM2837B0, Cortex-A53 (ARMv8) SoC de 64-bit @ 1.4GHz)<br>ARM Cortex M4 (STM32WB55RG (P-Nucleo-WB55))<br>Arduino + FPGA + Rasberry + ARM | Tina Design Suite<br>Exxer App |

# FEATURES

With modular configuration, Safety with NR–12, development software included, protection of main components and courseware included.

## ELMIC2000
Embedded Systems Kit


## Settings

- Dock station: compact and suitable for bench and rack module
- Natural anodized aluminum rear closure
- Plastic side closure
- TS–type front plate with indelible identification

| DIMENSIONS | |
|---|---|
| Height | 150mm |
| Width | 350mm |
| Depth | 340mm |
| Weight | 15Kg |

| ELECTRICAL FEATURES | |
|---|---|
| Energy | Bivolt 110/220Vav – 50/60Hz |
| connections | Cables adapted to communication |

# MAIN DEVICES

| | Arduíno Mega 2560 Rev3 | P-NUCLEO-WB55 | Raspberry Pi 3 B+ | DE10-Lite MAX10 FPGA 10M50DAF484C7G |
|---|---|---|---|---|
| Main component | ATmega2560<br>· MCU de 8 bits<br>· Flash: 256kB<br>· RAM: 8kB<br>· EEPROM: 4kB<br>· Clock: 16MHz | STM32WB55<br>. 32 bit MCU<br>. ARM Cortex dual-core<br>. Flash: 1000 kB<br>. RAM: 256 kB<br>. Clock: up to 64MHz<br>. 2 DMA controllers | Broadcom BCM2838B0<br>. 64-bit CPU<br>. ARM Cortex Quad-core<br>. Flash: 1000 kB<br>. RAM: 1 GB<br>. Clock: up to 1.4GHz | Cyclone IV EP4CE22F17C6N<br>. 22,320 Logic Elements (Les)<br>. 594 Kbits internal memory<br>. 66 18x18 bit multipliers<br>. 4 general purpose PLLs<br>. 153 Pins |
| Inputs and outputs | . 54 pins configurable as input or output (15 pins can be used as PWM)<br>. 16 analog inputs<br>. Compatible with other Arduino boards and Shields | . 42 pins configurable as input or output (16 pins can be used as PWM)<br>. 16 analog inputs<br>. Pinout compatible with Arduino boards and Shields | . 40-pin IO connector for general application | . 2 40-pin IO connectors for general application |
| Interfaces | . 4 UARTs (asynchronous serial port)<br>. 1 USB port (Type B connector)<br>. Virtual COM port over USB | . Integrated 2.4 GHz radio (Bluetoo-th v5.0 and IEEE 802.15.4 with bult-in PCI antenna)<br>. 1 USB port (micro-B)<br>. 2 SPI ports<br>. 2 I2C ports<br>. 2 USART ports<br>. Standard Arduino and ST Morpho connections<br>· Virtual COM port over USB | · Wifi dual band (2.4GHz e 5GHz) IEEE 802.11.b/g/n/ac<br>· Bluetooth 4.2, BLE (Bluetooth Low-Energy)<br>· Ethernet port<br>· HDMI<br>· 4 USB 2.0 Ports<br>· MIPI CSI chamber door<br>· MIPI DSI display door<br>· Audio gate<br>· Composite video gate | USB port for programming. |

# MAIN DEVICES

| | Arduíno Mega 2560 Rev3 | P-NUCLEO-WB55 | Raspberry Pi 3 B+ | DE10-Lite MAX10 FPGA 10M50DAF484C7G |
|---|---|---|---|---|
| Other Resources | · Reset button<br>· Communication and user LEDs | · Three user LEDs<br>· Three user buttons<br>· One reset button<br>· USB Dongle for computer communication | . Memory Card | · 50Mhz Oscillator<br>. 3 axis accelerometer (ADI ADXL345)<br>. Serial Programming Memory (EPCS)<br>. 32MB SDRAM<br>. 2kB I2C memory<br>. 8 LEDs<br>. 4 dip switchs<br>. 2 push-buttons |
| Programming | . USB port programming<br>. Programmable through the Arduino IDE<br>. Compatible with other Arduino programming tools | . Programming/debugging via built-in ST-LINK/V2-1 recorder via USB port<br>. Programming through STM32CubeIDE<br>. STM32CubeMX Startup Code Generator | . Raspberry Pi OS operating system, based on Debian Linux<br>. Supports Python, C and many other programming languages | . Onboard USB-Blaster Recorder<br>. Programming by Altera/Intel Quartus II IDE |

# DEVELOPMENT TOOLS

**Our learning solutions are complemented with the development tools and professional software necessary for student training.**

## Arduíno Mega 2560 Rev3

Free Licenses

Arduino IDE!.

- Platform: Windows, Linux, macOS;
- License: freeware, open source.

## P–NUCLEO–WB55

Free Licenses

STM32cubeIDE and STM32cubeMX

- Platform: Windows, Linux, macOS.
- License: freeware

## Raspberry Pi 3 B+

Free Licenses

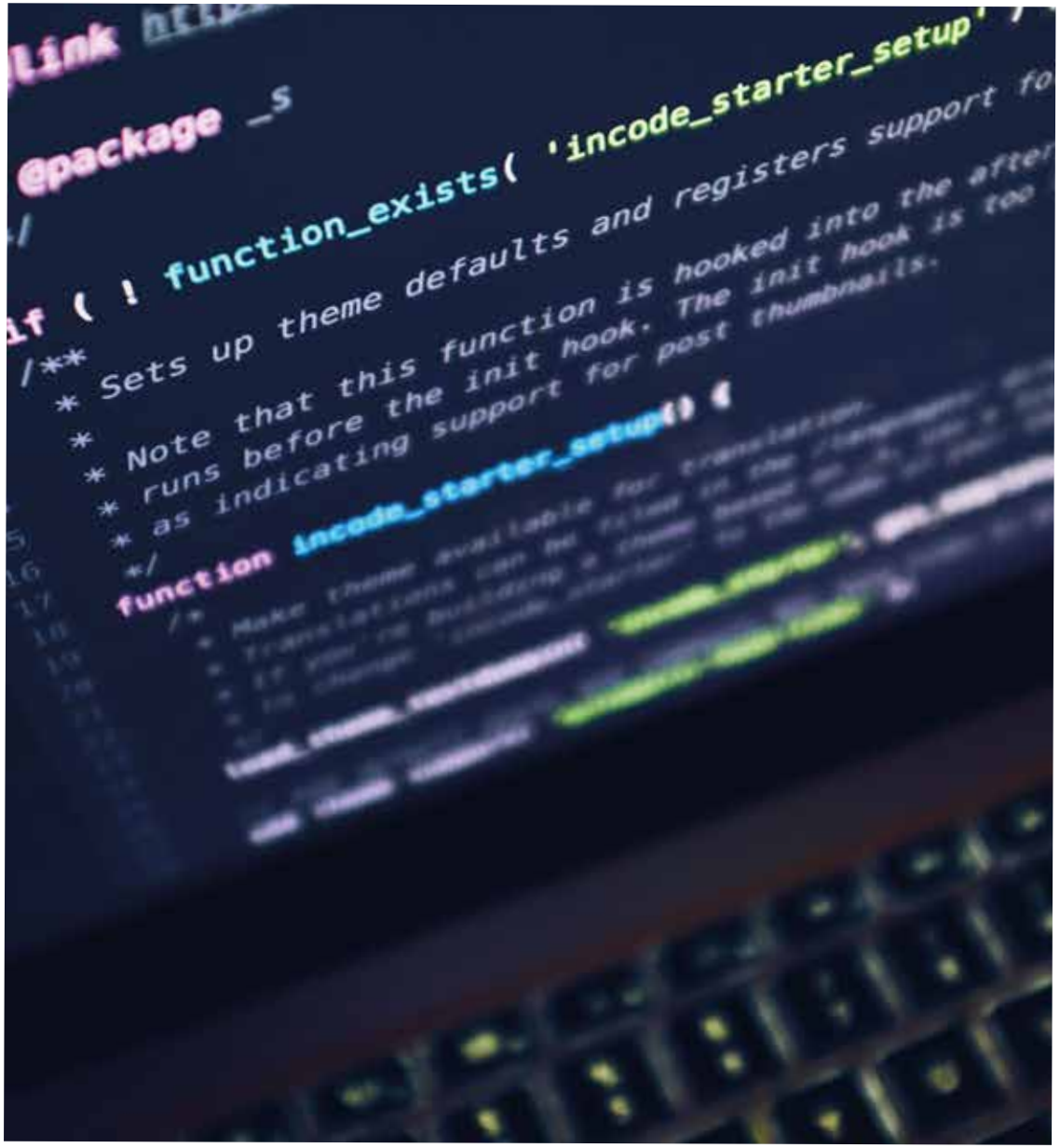
– Programming languages: Python, C/C++, Node–RED

## DE0–Nano

Free Licenses

Quartus II Web Edition

- Platform: Windows
- License: freeware



# USE

**Guidelines on the recommended use of the Kit!**

We suggest this configuration for better use in class. Kits and activities are designed according to the team sizes listed on the side.

The minimum necessary infrastructure is a prerequisite to fully use all functionalities of the training kits.

We recommend the computing and connectivity requirements below for using the software and applications provided with the kit.

## INDUSTRIAL INSTALLATIONS LABORATORY

| PARTNUMBER | DESCRIPTION | TEAM (STUDENT/KIT) | USE |
|---|---|---|---|
| ELMIC2000 | Kit de sistemas embarcados | 1 to 2 | Frequent<br>1 kit per team |

| INFRASTRUCTURE | |
|---|---|
| | ELMIC2000 |
| Elétrica | 1 salida por bancada<br>110 o 220V |

| CONNECTIVITY | |
|---|---|
| ethernet connections by season work | 2 connection points (one for the computer, the other to the plate |
| WiFi | – |
| Internet access | recommended |
| Computer | recommended; according to the minimum requirements of software |

# COURSEWARE

## The training kits have a rich courseware with a pratical focus, containing pratical proposals aimed at training skills and competencies.

In addition to the **User Manual,** wich contains information on operation and maintenance, the **Student Guide** is also provided, with proposals for pratical activities to be carried out using the kit, and the **Facilitator Guide,** with answers to the proposed activities and guidelines to use the kit in a didactic way. In addition, **Video tutorials** are available to help you easily master the development tools and use the kit.

All of this content is available on our website at the **Facilitator Portal.**

# SKILLS AND COMPETENCIES

## Arduino Mega2560

### Computer Architecture and Organization

- Learn and analyze the main computing architectures;
- Distinguish a microcontroller from a microprocessor.

### C Language

- Understand the main guiding principles and when to use them;
- Study the basic data types of C structures and how to declare variables;
- Understand how to use the I/O pins of the Arduino microcontroller in practice;
- Simulate different situations with the assignment command;
- Know the *if* and *if–else* decision structures, the *switch* case structure and the conditional ternary operator;
- Use repetition structures and understand the differences between *do–while*, *while* and *for* loops;
- Understand the function library concept and the use of functions;
- Learn and understand code optimization techniques.

### C Language

- Program and check the operation of switches and LEDs using C structures;
- Program and check the buzzer operation;
- Program and check the operation of the 7–segment displays in conjunction with the matrix keyboard;
- Program reading of voltage levels and process this information through the program;
- Implement a serial communication between the Arduino and the kit's digital potentiometer;
- Perform a practical application involving external memory and I2C;
- Understand and practice how UART Arduino enables serial communication based on the RS232 and RS485 standard;
- Program and analyze the practical operation of the Oled display.

# STM32 Arm Cortex

## Computer Architecture and Organization

- Learn and analyze the main computing architectures;
- Distinguish a microcontroller from a microprocessor.

## Arm Cortex

– Review key features of Arm Cortex–M4;
– Understand how the basic features of the STM32Cube IDE and its debugging mode work;
– Compare and discuss about the different tools available in the IDE.

## C Language

– Understand the main guiding principles and when to use them;
– Study the basic data types of C structures and how to declare variables;
– Understand how to use the I/O pins of the Arduino microcontroller in practice;
– Simulate different situations with the assignment command;
– Know the *if* and *if–else* decision structures, the *switch* case structure and the conditional ternary operator;
– Use repetition structures and understand the differences between *do–while*, *while* and *for* loops;
– Understand the function library concept and the use of functions;
– Learn and understand code optimization techniques.

# Raspberry Pi

## Arquitectura y Organización de Computadoras

– Learn and analyze the main computing architectures;
– Distinguish a microcontroller from a microprocessor.

## Raspberry Pi

– Know the Raspberry Pi operating system;
– Learn how to install the Raspbian operating system;
– Understand how the basic features of Linux work;
– Learn and analyze the Raspberry Pi GPIO;
– Run initial *scripts* in the kit using the Unix system.

## Raspberry Pi Tool

– Learn about the Thonny Python IDE development tool and its main advantages;
– Learn how to simulate with Thonny and how to debug the code step–by–step;
– Practice Thonny operation with the kit's GPIO

## Python

– Study the basic data types of Python and commands;
– Simulate different situations using operators;
– Program and check the operation of decision structures;
– Program and check the operation of repetition structures;
– Distinguish three important instructions to have greater code effectiveness: *break*, *pass* and *continue*;
– Apply and simulate functions;
– Learn how a package should be downloaded and how it should be imported

## Applications with the GPIO

- Program and check the operation of switches and LEDs using Python structures;
- Program and check the buzzer operation;
- Program and check the operation of the 7–segment displays in conjunction with the matrix keyboard;
- Program reading of voltage levels and process this information through the program;
- Implement a serial communication between the Raspberry Pi and the kit's digital potentiometer;
- Perform a practical application involving external memory and I2C;
- Learn (and practice) how the USART of the Raspberry Pi USART allows serial communication based on the RS232 and RS485 standard;
- Learn about the characteristics and operation of the OLED display;
- Program and check the interrupt operation

## IoT – Internet of Things

- Learn about the functions of the TagoIO platform;
- Learn how to create a dashboard in TagoIO;
- Understand the implementation principles of sending a JSON message through a Python IDE.

# MOBILE APPLICATIONS

A current learning solution is not complete without software and applications. Along with the kits of this series, exclusive licenses are provided for applications on computer and mobile devices that complement and enhance the use of the kits.

## Exxer App

### AUGMENTED REALITY KITS

- The solutions can be visualized in 3D through augmented reality, allowing the student to have a first contact with such technology and identify their main characteristics.

### Educational animations

- Augmented reality animations that show the main devices in section, their assembly/disassembly process and the operating principles.

# DESKTOP APPLICATIONS

A current learning solution is not complete without software and applications. Along with the kits of this series, exclusive licenses are provided for applications on computer and mobile devices that complement and enhance the use of the kits.

## Tina Design Suite

– TINA Design Suite is a powerful yet affordable circuit simulator! It comprises circuit design and PCB design software package for analysis, design, and real–time testing of analog, digital, IBIS, HDL, MCU, and mixed electronic circuits and their PCB layouts. You can also analyze SMPS, RF, communication and optoelectronic circuits; generate and debug MCU code using the integrated flowchart tool; and test microcontroller applications in a mixed–circuit

# TRAINING

**As important as teaching resources and tools is teacher training. We have a complete package of solutions for your training and upgrading needs.**

## Quick Start and Tutorials

Quick start is a quick video guide to learn, test and put the product into operation. Tutorials are videos that teach common procedures needed in classes using the kit.

## Technical Delivery

In the technical delivery, our experts present the product, its features, as well as maintenance and safety precautions, and put it into operation together with the customers.

## Operational Training

The purpose of operational training is to teach facilitators on how to use the kit. The kit courseware is presented and some proposed practices are carried out. It also includes all technical delivery activities.

## Technological Training

Technological training is a deeper learning of technology and applied concepts. These courses are not focused on kits but on topics and technical skills to update trainers.

exxer Skills for the Future

**Headquarters:**
Rua José Pinto Vilela, 156
Bairro Centro
Código Postal 37540–000
Santa Rita do Sapucaí — MG
Phone no: (35) 3473–4050

**Branch:**
Av. Rubem Bento Alves, 5167
Bairro Santa Catarina
Código Postal 95030–325
Caxias do Sul — RS
Phone no: (54) 3771–6600

www.exxer.com
exxeroficial
company/exxer
@exxeroficial