Part A Introduction

Program: Under Graduate Course	II year	Session: 2022-23

Course Code	**V2-ELE-ELXT**
Course Title	**Introduction to Physical Computing**
Course Type	**Vocational**
Pre-requisite (if any)	**Certificate course**
Course Learning outcomes (CLO)	**After completion of course, students will be able to** • Understand the evolution of the CPU from microprocessor to microcontroller and embedded computers from a historical perspective • Operate basic electronic components and analog and digital electronics building blocks including power supply and batteries. • Use basic laboratory equipment for measurement and instrumentation. • Understand the Arduino ecosystem and to write simple Arduino programs (sketches) • Understand sensor characteristics and how to select a suitable sensor for various applications. • Read digital and analog data and produce digital and analog outputs from an embedded computer. • Understand how to interface an embedded computer to the physical environment. • Visualize the needs of a standalone embedded computer and implement a simple system using Arduino.
Expected Job Role / career opportunities	• Interface an embedded computer to the physical environment. • Implement a simple systems using Arduino.
Credit Value	**2 (Theory) + 2 (Practical) = 04**

Part B- Content of the Course

Total No. of Lectures + Practical (in hours per week): **L-1 Hr / P-1 Lab Hr (=2 Hrs)**

Total No. of Lectures/ Practical: **L-30 /P-30 (60 Hrs)**

Module	Topics	No. of lectures (Total 30)
I	Brief overview of a computer. Evolution from CPU to Microprocessor to microcontroller. Introduction to Arduino. Overview of basic electronic components (R, L, C, diode, BJT, MOSFET etc.) and circuits, 555 timer, logic gates, logic function ICs, power supply and batteries.	04
II	Capturing schematic diagrams. Using free software such as Eagle CAD. Using basic lab instruments – DMM, oscilloscope, signal generator etc.	06
III	Understanding Arduino programming. Downloading and installing Arduino IDE.	11

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	Writing an Arduino sketch. Programming fundamentals: program initialization, conditional statements, loops, functions, global variables. Digital Input and Output. Measuring time and events. Pulse Width Modulation.	
IV	Analog Input and Output. Physical Interface: sensors and actuators. Communication with the outside world. System Integration and debugging.	09

	Practical	No. of lectures
	1. Hello LED: Connect a LED to a digital output pin and turn it on and off. 2. Hello Switch: Read a switch a toggle an LED when the switch is pressed and released. 3. Hello ADC: Connect a potentiometer to an ADC input and print the analog voltage on the serial monitor. 4. Hello Blink: Read a switch and changing the LED blink rate every time the switch is pressed and released. 5. Hello PWM: Write a Pulse Width Modulation code in software and vary the LED intensity. 6. Hello Random: Read a switch and every time the switch is pressed and released, generate and print a random number on the serial monitor. 7. Hello Random2: Connect a Seven Segment Display (SSD) and print the random number on this display each time a switch is pressed and released. Collect large data sample and plot relative frequency of occurrence of each 'random' number 8. Hello LCD: Connect a (16X2) LCD to an Arduino and print 'Hello World'. 9. Hello LCD2: Connect a temperature sensor to an ADC input and print the temperature on the LCD 10. Hello PWM2: Connect a RGB LED and 3 switches. Use hardware PWM feature of the Arduino and change the relative intensity of each of the LEDs of the RGB LED and generate large number of colors. **Suggested Mini Projects:** 1. Connect 2 SSDs and every time a switch is pressed and released, print 2 random numbers on the two SSDs 2. Connect a switch and 4 RGB LEDs in a 'Y' configuration. Change the LED lighting patterns each time a switch is pressed and released (total 4095 patterns possible). 3. Arrange acrylic mirrors in a triangle and make a LED kaleidoscope using the RGB LEDs as the light source. 4. Connect a photo-gate mechanism to a bar pendulum. Verify that the period of oscillation is independent of the amplitude for small amplitudes. What happens when the amplitude is large? 5. Connect 8 switches and a small speaker and an audio amplifier and make a piano. 6. Connect 2 sets of 3 switches for two players. Connect LCD and implement a 'rock-paper scissors' game.	30 (02 Hours each) Extra time as per the project

Project/ Field trip:

Part C-Learning Resources

Text Books, Reference Books, Other resources

1. Learn Electronics with Arduino: An Illustrated Beginner's Guide to Physical Computing. Jody Culkin and Eric Hagan. Shroff Publishers. ISBN: 9789352136704.
2. Programming Arduino: Getting Started with Sketches, Second Edition. Simon Monk. McGraw-Hill Education. ISBN-10: 1259641635.
3. Physical Computing: Sensing and Controlling the Physical World with Computers, 1st Edition. Thomson. ISBN-10: 159200346X.

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4. The Art of Electronics. Paul Horowitz and Winfield Hill. Cambridge University Press. 2 nd Edition. ISBN-13: 978-0521689175
5. Designing Embedded Hardware. John Catsoulis. Shroff Publishers. 2nd Edition. ISBN: 9788184042597

Suggested equivalent online courses: e-reading:

1. https://www.arduino.cc/
2. https://learn.sparkfun.com/tutorials/what-is-an-arduino/
3. https://opensource.com/resources/what-arduino
4. https://www.youtube.com/c/Arduino/videos

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