MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering
Department of Mechatronics Engineering
Course Hand-out
Arduino, IoT Fab Lab | MC1030 | 1 Credits | 0 0 2 1

Session: Aug 23 – Dec 23 | Faculty coordinator: Dr. Krishna Kant Pandey | Class: Laboratory

A. Introduction:

The students know about modern-day technologies (learning and hand on) and tools employed in STEAM (Science, Technology, Engineering, Arts and Mathematics) education such us robotics, 3D printing and mobile technologies using Arduino and RPi applications. It provides a platform to access the environment, the skills, the materials, and the advanced technology to allow anyone anywhere to make anything.

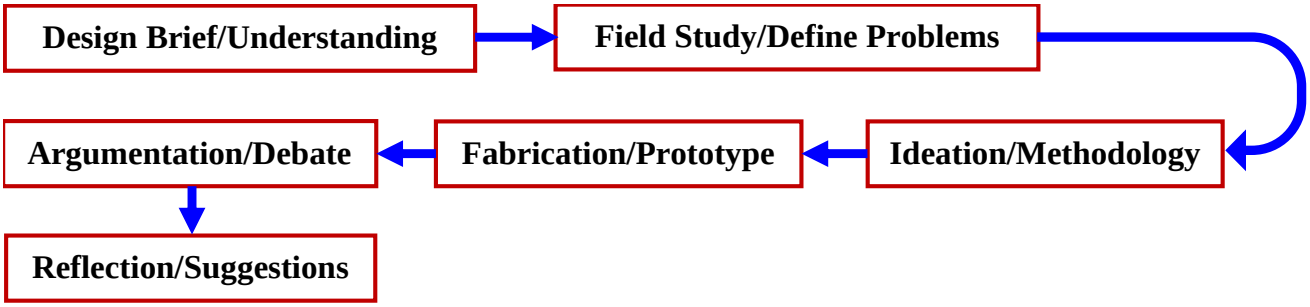

Figure. 1: Process flow - An Arduino, IoT Fab Lab.

B. Course Outcomes: At the end of the course, students will be able to:

[MC1030.1]. Identify the modern era of technical education.

[MC1030.2]. Understanding the impact of iterative and experimental design thinking.

[MC1030.3]. Recall the significance of practical and problem-based learning.

[MC1030.4]. Understand systems using a methodical pattern of design and innovation.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

[PO.12]. **Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

[PSO.1]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Plan:

Criteria	Description		Maximum Marks
Internal Assessment (Summative)	Laboratory Sessions	2 Assignments (As additional task any 2)	10
		Lab Record	10
		Experiments Performed	20
		Mini Project	20
End Term Exam (Summative)	Lab Exam Performance	Viva/Quiz Test	10
		End Term Experiment Performance	20
		End Term Experiment Write up Performance	10
Total			**100**
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the Practical End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.		
Make up Assignments. (Formative)	Students who miss a lab session will have to report to the teacher about the absence. The missed experiment can be performed as a makeup experiment in the next lab session or any time before the laboratory exam.		
Laboratory Guidelines	Students are expected to maintain an observation book and a laboratory record notebook. The experimental data should be noted in the observation book on the day of performance and the same should be transferred to the record notebook before the next lab. No students are allowed to enter the lab without the observation book and record book and attendance will be marked absent.		

E. Syllabus

Arduino - Introduction to Arduino and its different modules. Basic programming environment of Arduino. Interfacing of different sensors (IR, Ultrasonic and Temperature sensors) and actuators (Motors, LED/LCD, and Buzzer) with Arduino. Mini project using Arduino.

Raspberry Pi (RPi)- Introduction, Interfacing different elements (Sensors & Actuators) with RPi.

3D Printing - Introduction, (Interfacing of 3D Printer with CAD models), Hands on 3D printing.

F. Reference Books

1. Simon Monk, 2015. *The TAB Book of Arduino Projects,* McGraw-Hill Education.
2. Simon Monk., 2016. *Programming the Raspberry Pi: getting started with Python*. McGraw-Hill Education.
3. Norris, Donald. *The internet of things: Do-it-yourself at home projects for arduino, raspberry pi, and BeagleBone black*. McGraw-Hill Education, 2015.
4. Scott Fitzgerald and Michael Shiloh, 2012. *The Arduino Projects Book*, Arduino.
5. France, Anna Kaziunas. *Make: 3D printing: The essential guide to 3D printers.* Maker Media, Inc., 2013.
6. Cline, L.S., 2017. *3D Printer Projects for Makerspaces*. McGraw-Hill Education.

G. Lecture Plan

Sl. No.	Topics	Session Outcome	Mode of Delivery	CO's
1.	Arduino Demonstration and Interfacing with PC	Application and Use of an Arduino	Presentation/Discussion	MC1030.1 MC1030.2
2.	Speed control of Servo/Stepper motor using Arduino.	Motor application in robotics	Practical/ Hands On	MC1030.1 MC1030.2
3.	An Arduino based traffic light simulator using LED.	Application light Simulator	Practical/ Hands On	MC1030.3 MC1030.4
4.	Distance measurement using IR and Ultrasonic sensors with led indication.	Application of IR/Ultrasonic Sensors	Practical/ Hands On	MC1030.3 MC1030.4
5.	Display measured value of sensors (IR and Ultrasonic sensors).	Digital Display Measurement system	Practical/ Hands On	MC1030.3 MC1030.4
6.	Introduction to RPi: Meet RPi and connect with PC	Introduction and application and of RPi.	Practical/ Hands On	MC1030.3 MC1030.4
7.	Sensors interfacing using RPi.	Interfacing of sensors using RPi	Practical/ Hands On	MC1030.3
8.	Actuators interfacing using RPi.	Interfacing of sensors using RPi	Practical/ Hands On	MC1030.3
9.	Introduction to 3D Printer and its programming.	Application of 3D printer in modern era	Practical/ Hands On	MC1030.3
10.	Create a 3D design and print using a 3D printer.	Modern manufacturing using 3D printer	Practical/ Hands On	MC1030.3 MC1030.4
Develop a mini project in integration of microcontroller (Arduino/RPi) and 3D Printer.		**Real time application of Arduino/RPi**	**Practical/ Hands On**	**MC1030.1 MC1030.2 MC1030.3 MC1030.4**

H. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[MC1030.1]	Identify the modern era of technical education.	**2**	**1**											**1**	**2**	
[MC1030.2]	Understanding the impact of iterative and experimental design thinking.	**1**	**2**											**1**	**1**	
[MC1030.3]	Recall the significance of practical and problem-based learning.		**1**			**2**				**1**					**1**	
[MC1030.4]	Understand systems using a methodical pattern of design and innovation.					**1**				**1**	**2**	**2**	**2**	**1**	**2**	

I. List of Experiments:

1. Arduino Demonstration and Interfacing with PC.
2. An Arduino based traffic light simulator using LED.
3. Distance measurement using IR and Ultrasonic sensors with led indication.
4. Speed control of Servo/Stepper motor using Arduino.
5. Display measured value of sensors (IR and Ultrasonic sensors).
6. Introduction to RPi: Meet RPi and connect with PC.
7. Sensors interfacing using RPi.
8. Actuators interfacing using RPi.
9. Introduction to 3D Printer and its programming.
10. Demonstrate a 3D design and print using a 3D printer.

Develop a mini project in integration of microcontroller (Arduino/RPi) and 3D Printer.