

## **Class 1**

### **Programming Concepts, Basics of Computer Science, Software, Memory, Bits, Bytes, Digital Electronics, Binary and Decimal Conversion, Addition of Numbers in Binary, Hex Representation, Conversion between Hex and Binary**

- 1) What is a computer program?
- 2) How do you translate amongst bits, bytes and storage?
- 3) Find and Discover how AND and OR gates are made with transistors in chips.
- 4) What is 1s complement and 2s complement representation? How does subtraction work in digital electronics.
- 5) What is a half adder and a full adder.
- 6) How do you easily convert between Hex Representation and Binary Representation of Numbers.
- 7) What are the rules for AND operation and OR operations?
- 8) Find and Discover the various logic types that are currently in force and used.
- 9) If a computer has 2048KB of memory, what is the last memory address?
- 10) How much memory can a computer with 16 bit memory address access?
- 11) In terms of memory, what is Flash Memory and RAM memory. Research why the difference in behaviour exists and how the two are constructed.
- 12) What would happen if the address of memory in the CPU somehow gets changed inadvertently?
- 13) Design a method by which you can find out if there was a change in the value of a bit, inside a byte, when it was sent across from one place to another.
- 14) Now, for question 13, what if you had to find out which bit changed, in a group of bytes, how would you do it?
- 15) Research how decimal numbers are stored in a computer's memory. How does multiplication and division of decimal numbers happen in the computer's memory?
- 16) What is gray code and how is it useful?

## **Class 2**

**Syntax of Arduino Language and C, Programming constructs, Flow Statements, Inputs and Outputs, Introduction to Idiotware Shield, Design of Idiotware Shield, Overview of Design Process and Manufacturing a product, Writing our first program with Inputs and Outputs, Pattern generation on LED Lights, Input Output Combinations with LED's**

- 1) What is a compiler? What is a high level language and a low level language? What is machine code?
- 2) Why does the C language continue to be used even after it was developed in the late 1960's?
- 3) What is a programming construct?
- 4) What are the different flow statements we encountered in the class today?
- 5) Choose a flow statement and deconstruct how the flow statement will be create and executed in a computer CPU.
- 6) Draw, understand and explain what a TOTEM Pole is in electrical circuits.
- 7) How does the same Arduino Pin function as a digital output and an input?
- 8) When you manufacture a electronic product, what are the steps you need to follow to ensure success?
- 9) What is HIGH and LOW denote in Arduino?
- 10) What other variants exist for the Arduino?
- 11) What functions are required to change the state of an OUTPUT Pin?
- 12) Can a specific pin be input and output in the same program? Explain your answer with a diagram or explanation.

### **Class 3**

**Introduction to Arduino Libraries, Importing a Library, Using a library to access sensor data, In depth fundamentals of external hardware connections, Precautions, Testing.**

**Using two or more libraries in tandem, Building a use case of a visual proximity indicator for hearing impaired people.**

- 1) What is an Arduino Library and why do we use it? Is there a disadvantage in using a library?
- 2) To know how to use a library, what are the most common places to look for help?
- 3) When connecting external hardware, what is to be consulted first? What are the most common mistakes to be avoided?
- 4) Why is it important to remove all power connections before making a new hardware connection?
- 5) What are the five important verification steps you have to follow before you turn on power?
- 6) What are the signs of mismatched hardware, wrong connections and part failure?
- 7) When using more than one library in tandem, what are the aspects to consider before finalising on the design.
- 8) Draw up better ways to solve the problem of the visual proximity indicator.

## **Class 4**

**Introduction to The ADC, Digital and Analog Realms, The concept of the SAR ADC, Measuring Analog sensors and reporting, Nyquist Frequency, Quantization and errors.**

- 1) Why do we need ADC?
- 2) How does one go from Analog to Digital domain using an Arduino?
- 3) What are the benefits of using the digital domain?
- 4) In the SAR ADC, what is the use of the internally generated analog voltage?
- 5) When you measure analog voltages, how do these voltages get converted to the physical quantity being measured?
- 6) What errors can occur if you do not choose the right data type for the ADC measurements?
- 7) How fast can the ADC in the arduino measure signals?
- 8) What is the maximum frequency that the Arduino can measure?
- 9) Is there a faster way to measure the signal and increase the Nyquist Frequency?
- 10) If there was an audio signal which you were given to measure and digitise using the Arduino, what precautions would you take to ensure it is digitised correctly?
- 11) In question 10, what would be lowest amplitude of the signal which can be measured well with the arduino? How can you improve the lower range of measurement?
- 12) What effect does the system voltage have on the measured signal?

## **Class 5**

**Introduction to the Internet of Things, The Global Scenario, Introduction to Cloud Computing, Servers and Clients, Web Servers, API Services**

## **Class 6 and 7**

### **Writing our first IoT program, Fetching data from bitcoin servers, Displaying on the Idiotware Shield**

- 1) How does one find the right source of data?
- 2) How is the price of bitcoin determined?
- 3) What are the roles people play in a bitcoin network?
- 4) How to pick the right source of data in an HTML?
- 5) How to test if the data is coming right?
- 6) What is the ESP-01 device and how does it fetch the data?
- 7) Modify the program to fetch the current price of a stock ( Reliance Industries, Yes Bank, Google) and show it on the display
- 8) What is I2C and why was the specific protocol devised? How long can I2C wires be?
- 9) What is Bus contention on I2C and how is it mitigated?
- 10) What other kind of Display's can you interface with the Arduino? What would you need to change if the display changed?
- 11) Can you predict the occurrence of an event and show an alert before hand by fetching data from the web?
- 12) Can you display the local time of the Arduino? What challenges occur if you did that?
- 13) What organic compounds are used in OLED displays?
- 14) On the I2C bus, how many devices can be connected? Is there a limitation and where does that limitation come from?
- 15) What is Bus contention? What is Bus conflict?

## **Class 8 and 9**

### **Build a IoT Temperature Monitor for keeping food cold and preserving the food at cold temperature.**

- 1) What is the optimum temperature at veg food and non-veg food should be kept at? Is it a range of temperatures?
- 2) What kind of sensor can measure food at temperatures below 0C? How do you measure temperatures below -30C with an arduino? What effect does low temperature have on the accuracy of the arduino board and its components?
- 3) What other application does is this idea suited for? Construct a prototype of your idea? What are the savings in time or money that your application is designed for?.
- 4) If you had a 100 of these sensors, think about an application where you can use them.

## **Class 10**

### **Open Session: Ideate, design and build stories using the Idiotware Shield.**

- Debate between your team on what are three potential solutions to the same problem
- Conduct a research with other teams
- Finalise your idea
- Sketch and draw your idea
- Write down how will it be implemented in minimum 300 words.
- Draw a table of activities that each person( who will be directly influenced by your idea) has to do
- Make a parts list
- Draw a Circuit Diagram
- Write a flowchart for your program
- Start to collect parts, build an enclosure for your design using cardboard.



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## **Class 11 and 12**

**Exposure to a Computer and its Architecture, Introduction to Basics of Programming, Program Flow and Algorithms, Introduction to Compiled and Interpreted Languages, Introduction to Python as a High Level Language, Installation of Packages for use during the course, Hello World Program , Exposure to Basic constructs in Python building a calculator, Finding Prime numbers**

- Why would you choose a compiled language over an interpreted language and vice versa?
- What is a cache? What is the difference between a L0, L1 and L2 Cache?
- What is an interrupt and how does the computer look after it?
- What is Program flow?
- Why do you write an algorithm? Is it written for the computer to execute?
- How does your hello world program work? Draw and sketch in detail the steps that would happen inside the computer.
- Imagine building a calculator program for a user. Ask the user for 2 numbers, and print the sum, the difference, the product and the quotient of the two numbers.
- How do you find prime numbers say, upto a number 2000?
- Research how the discoverer of the algorithm to find prime numbers also measured the radius of the earth using a stick.

## Class 13 and 14

**Hone Python Skills Build and write program for Sorting numbers, searching numbers, Introduction to Regular Expressions, external libraries, concepts in Object Oriented Programming, validate and search for emails, phone numbers and text in datasets**

- Write a flowchart to sort a list of 5 numbers.
- Why is sorting important?
- If a list is sorted, how do you search for a number within it?
- What kind of problems does a computer encounter when searching for an email address in a file? Will the same problems occur if the computer is looking for phone numbers?
- You are entrusted with the job to break a military secret code and the password lies within a text file.
  - The password to the code is 9 characters long and is of the following format.
  - The first three characters are letters, followed by two numbers, followed by an ! sign, followed by two letters and a number.
  - The military secret code is 4b59c4c159196d29c6f3beab9872474f
  - You also know that the secret message hidden inside the code is encoded using MD5 hashing method, that a spy has communicated to you. You have to find the correct password.
  - The file in which the secret code is hidden is here  
<https://raw.githubusercontent.com/CuriosityGym/Asset-Summer-Program/master/passwordFile.txt>

## **Class 15**

**Introduction to Raspberry Pi, navigating in the operating system, concept of SSH, logins, configuring the Pi. Executing all past Python programs on the Pi. Github as a tool to use to share code and data between computers and teams**

- What is a SBC? How does it differ from a standard PC?
- Why do you change the IP address in the SD card?
- How does SSH work, explain by a block diagram.
- What is a shell in Linux?
- Find out a Shell command in Linux to list files inside a folder by date.
- When you expand the filesystem on the Raspberry Pi, what happens inside the SD card?
- What is git? How is it useful for collaboration between teams?
- How do you resolve merge conflicts in git?
- How do you create a release and a tag for your project in Github?
- How do you create documentation for your project on Github?
- Create a Github Repository for your project. In the readme file of the repository, explain your project, with sections about Introduction, The need to build the project, Hardware Required, Software Required and Steps to replicate your project. Use Markdown format to create readable documentation.

## **Class 16**

### **Python Essentials- File I/O, JSON Parsing, Sending data to Arduino, Exchanging data between Arduino and Raspberry Pi Via Serial Communication, Raspberry Pi GPIO**

- 1) Download the file from location <https://github.com/CuriosityGym/Asset-Summer-Program/blob/master/musicStatistics.json>. Open this file, which has names of songs their duration, and how many times a person has heard them. This data is in JSON format. Print the total time the person has spent in listening to music, and the most listened song.
- 2) Receive Data from an Arduino using a Serial Port. When you press the Button on the Idiotware Shield, print that the key has been pressed. Play a tone on the Computer based on how many times the button has been pressed.
- 3) In Question 2, change the computer to a raspberry Pi and turn on a LED when the button is pressed. Turn it off again when the button is pressed.

## **Class 17**

**Key Concepts in Machine Vision, images, pixels, resolution, color depth, bits per pixel, calculating size of image, introduction to Raspberry Pi Camera, clicking images, seeing results. Introduction to Boto3 Library with Amazon Rekognition services**

- 1) If you wish to find out if there is a red circle in the field of view of the camera, what strategy and algorithms would you use to find out the center of the circle?
- 2) If you had to find out the distance from the camera to the circle in question 1, how would you do it?
- 3) If you had a RGB image of 1200 x 1400 pixels, how big in megabytes is this image?
- 4) The Raspberry Pi Camera connects to the CSI interface on the Raspberry Pi. Is this a faster method to accessing images versus using a USB webcam? Justify your answer.
- 5) Can you change the resolution of the image captured through the Raspberry Camera?
- 6) How do you change the brightness and contrast of the camera?
- 7) What features does Amazon Rekognition support?
- 8) What are the limitations of the Amazon Rekognition Service?
- 9) Which features of the Amazon Rekognition Service are applicable to your project?
- 10) How do you convert the Pi camera image to grayscale?
- 11) Expand what you understand about convolution in images?
- 12) How does pattern matching work in image recognition?
- 13) Figure out, how will you recognise a QR code in an image taken by a camera.

## **Class 18 and 19**

**Boto3 abstracted Functions, verifying results for images clicked from Raspberry Pi Camera, sending to AWS cloud and parsing information.**

**Build an example application on the Raspberry Pi to detect between an apple and a pineapple in photograph.**

- 1) Test and validate sample images for your project, to be working with Amazon Rekognition Services.
- 2) What are the conditions under which you will have less than ideal results?
- 3) Build an application that takes a photo when the touchpad on the Idiotware is touched. The application must be able to tell you does the photo have a paper cup in it or a plastic bottle. If it is a bottle, then show a green color on the Idiotware Shield LED. If it is a Bottle, show a Red color on the LED. The application for this is to segregate waste into plastic and paper.
- 4) You can also integrate an ultrasonic sensor to take a picture only when the bottle or the cup is placed on a table.

**Class 20- 25**

- Open Session: Work towards your chosen project.
- If project has been reviewed, work in an alternate team to help them complete their project, or build another one from the list of projects.
- Test your project in live conditions. Tune and modify to accommodate most common use cases.
- Identify the outlier cases, which do not lead to expected results. Find a way to solve them, or mark them as unsolvable in current scope of project.
- Document project on tech sites like instructables, hackster.io and hackaday.com Submit entries for Hackaday Prize.
- Complete your presentation of project. Plan and do a test run of presentation to limit to 3 minutes.
- Anticipate and be ready with answers for questions from audience.
- Calculate cost of components required to build the project. Think like an entrepreneur. Build your business plan, how do you plan to market the product, how much funds will you require in research and complete the product, along with a timeframe ( 3 months, 6 months, 45 days).
- Identify your customer. Create a pitch document on how your product solves a problem for them.