ROBOTICS AND ARTIFICIAL INTELLIGENCE (66)

Aims:

1. To develop an understanding of concepts and applications in Robotics and Artificial Intelligence (AI).
2. To develop competencies in Robotics and AI via classroom instruction, laboratory and self-directed project-based learning approach.
3. To facilitate appreciation, understanding and application of concepts of Robotics and AI through learning and engaging in hands-on activities.
4. To instill AI-Readiness skills in students vide key concepts in AI, such as, Data, Computer Vision and Natural Language Processing.
5. To introduce the students to the concepts of AI Project Framework.
6. To familiarize students with computational skills (basic python coding language).
7. To create awareness about ethical considerations of AI.

CLASS IX

THEORY-100 Marks

There will be one internal paper of two hours duration carrying 100 marks and an internal assessment of 100 marks.

PART I

ROBOTICS

1. Introduction to Robotics

(i) Understanding Robots.

Basic understanding of what a robot is; definition and characteristics; benefits of using robots (with respect to humans): increased quality, increased productivity, increased efficiency, longer working span, working in hazardous environments, improved workplace.

(ii) Evolution of Robots; Laws of Robotics.

Brief history of Robots with respect to their evolution from 1900's till date. Definition of Robotics, the three Laws of Robotics by Isaac Asimov (statements only).

(iii) Classification of Robots.

Classification of Robots as: field/terrain based (arial, ground, underwater) and control based (manual, automatic): Meaning and examples of each. Bio-inspired robots: meaning, purpose and examples (humanoids, birds, snakes and insects).

(iv) Real world Robots and their applications.

Application of robots in different fields (domestic, industry, medical, defense, entertainment and agriculture) with at least one example of each.

2. Robot as a System

(i) Building blocks of Robots.

General block diagram of a robot. A detailed study of the building blocks of a robot.

Concept of a robot as having mechanical, electronic and computational blocks; functioning and working principle of each block. Design aspects using examples of humanoid, aerial, underwater and mobile robots.

(ii) Identification of Robots.

Identification of robots (through demonstration/ video/graphic details).

Illustration using an industrial robot (e.g., Industrial Robotic Arm), humanoid and

mobile robot. The idea that a mechanical body can be of any form must be emphasized.

3. Concepts in Robotics

(i) Types of motion; motion in one-dimension and two-dimension; types of joints and links.

Types of motion (linear, angular, and circular); a brief understanding of motion in one-dimension and two-dimension; types of joints (prismatic, revolute, and spherical); types of links (rigid and soft). Relevant examples for each of the above.

(ii) Using links and joints to create specific motion.

A detailed study of how links and joints help create specific motion. Identification of links and joints used in a given system. Examples for the demonstration can include Industrial Robot Arms.

(iii) Degree of freedom of a robot

Definition; identification through illustration.

PART II

ARTIFICIAL INTELLIGENCE (AI)

1. Introduction to Artificial Intelligence (AI)

(i) Meaning and brief history.

Definition of Artificial Intelligence; brief account of the history of AI since the time John McCarthy first coined the term in 1956; Turing Test, its use and importance.

(ii) Applications and Benefits of AI.

Applications of AI in different fields: commercial, industry, medical/health care, defense, banking, entertainment, transport, security and agriculture. Commonly used AI applications in daily life such as, online shopping, search engines, chatbots, voice assistants, entertainment portals, facial recognition, driver assisting vehicles, augmented/ virtual reality.

Benefits of using AI - Automation, smart decision making, assisting humans, remote patient monitoring & monitoring the progression of contagious diseases, analysis of data for research and development, efficiently solving complex problems, speedy disaster recovery strategy, performing recurring business tasks, reducing the chances of manual errors, ensuring 24-hour service availability with the same performance and consistency throughout the day.

(iii) Ethical considerations in AI.

A brief understanding of ethics in artificial intelligence including bias, prejudice, fairness, accountability, transparency, interpretability and explainability.

2. Role of Data and Information, Evolution of Computing

(i) Data and Information: Types of Data (audio, visual, numeric, text); Data to Information.

Understanding that data is pivotal to Artificial Intelligence. A brief introduction to how relevant data is identified, acquired, and explored, as a precursor to the AI Project Cycle.

(ii) Evolution of Computing: Pre AI/ML Binary Logic System, Conditional Gates, Deterministic computing for deterministic problems.

An introduction to above mentioned topics, with the emphasis that earlier computing was suited for only deterministic problems; explaining deterministic computing and deterministic problems giving relevant examples. Illustrating the limitations of deterministic computing in solving real life problems, Comparison between deterministic and probabilistic nature of real-life problems.

***Note:** Explanation of how AI can solve a new class of problems, based on a probabilistic paradigm. Hence Need for AI: Probabilistic, real-life problems; The AI Discretion (AI is not needed for solving deterministic problems) for example –the difference in description of temperatures by a machine and*

a human. A machine would make a discrete distinction between cool and hot at a given temperature for instance if 35°C is hot, then any temperature 34.9° C and below would be cool. Humans would, however, describe the temperature on a range of 'cool, pleasant, warm, hot' and so on based on their subjective experience of the temperature.

3. Introduction to Data and Programming with Python

(i) Familiarization with Python.

Introduction to Python and its elementary concepts: object-oriented, high-level, general purpose programming language. Uses and advantages of Python.

(ii) Introduction to data types and variables.

Introduction to a simple python program structure and the concept of indentation in Python, different data types in Python - numeric (int, float), Boolean, sequence type (tuple, list, strings), sets and dictionary, an understanding of what kind of data types should be used in different use cases.

Introduction to variables and assignment of values.

(iii) Introduction to Operators.

Usage of different operators (arithmetic, logical, assignment, comparison, identity, membership) on data types, kind of statements which can be executed in Python.

(iv) Conditional Statements

Introduction to blocks in Python, if conditions, if else conditions, nested if conditions, if-else-if (elif) conditional block, case and switch. Shorthand conditional statements.

(v) Control Statements.

Meaning and use of loops in python. Different types of loops (while, for), nested loops, syntax used. 'for' loop for different types of iterables (list, tuple, string, dictionary) along with the idea of break, continue and pass statements, 'while' loop and their use cases.

(vi) Functions

An understanding of both built in and user defined functions; the importance of functions to maintain modularity; arguments given to a function (fixed and variable length); the concept of default arguments and return type of a function.

4. AI Concepts and AI Project Framework

(i) AI Concepts

Broad and narrow AI, strong versus weak AI. Expert systems in AI (for e.g., Eliza). Computer vision (CV), Natural Language Processing (NLP) and Neural Network (NN).

(ii) Components and Stages (alias AI Project Cycle).

Understanding of AI Project Framework, Stages involved in AI project: Problem Scoping, Data Acquisition, Data Exploration, Modelling and Evaluation (brief understanding of each).

INTERNAL ASSESSMENT- 100 Marks

Students are expected to do a minimum of **15 assignments** during the year to reinforce concepts studied in class. The details are as follows:

Details of Assignments to be done during the year

Broad Area	Number of Assignments
Robotics	3
Artificial Intelligence	2
Python (Programming)	10
TOTAL	**15**

The teacher-in-charge should maintain a record of all the assignments done as a part of practical work throughout the year and give it due credit at the time of cumulative evaluation at the end of the year.

SUGGESTED LIST OF ASSIGNMENTS:

Some sample problems are given below as examples. The problems are of varying levels of difficulty:

Robotics

1. Robots are becoming smarter day by day. Identify 5 unique smart robots and make a presentation in the class as a think pair.
2. "All robots are machines, but all machines are not robots." Prepare a writeup on the same.
3. Construct a Mind map of Robots and Robotic Systems covering Features, Applications and Classification of Robots (refer to Mind Map – Tony Buzan).

Artificial Intelligence

1. Think and plan a small presentation on how AI could be used in classrooms. Which subjects could be taught and how would teaching be different in an AI-enabled classroom?
2. AI is a powerful tool; however, depending on how it is used, it can be a blessing or a curse. Discuss with examples.
3. Apply AI Project Framework to design Components and Stages required to make a 'smart school' as a use case in a chart. (Example of a Smart school: automated fee, homework, attendance, library management, etc.).

Python Programming

1. Create a mind map of various data types in Python with examples (refer to Mind Map – Tony Buzan).
2. Discuss the uses of Python functions like modularity, reducing repetition of code, keeping different functionalities separate.
3. Explain the different types of errors incurred while executing a Python script.
4. Describe 'while' loop with example in Python.
5. Write Python code to generate "AI is a Powerful Tool; however, it is to be used with "Discretion" as output.
6. Write a Python algorithm to find the larger of the two numbers.
7. Input a number and check whether it is a prime or a composite number using Python.
8. Input two numbers and find their HCF and LCM
9. To print the format:

   1

   1 1

   1 1 1

   1 1 1 1
10. Generate the first n terms of a Fibonacci Series 0, 1,1, 2,3,5,8…

Other possible scenarios:

11. **Classroom:**
    (i) Storing Student details.
    (ii) Calculating percentages, CGPA.
    (iii) Generating report card: Function to enter which student's report card is being made.
    (iv) Function to fetch student details from the saved data.
    (v) Function to display the final result.
    (vi) If-else: Checking for scholarship.
    (vii) Iterating through student details and fetching required details.
12. **Environment System:**
    (i) Storing pollution levels, temperature details of various cities.
    (ii) Calculating average temperatures across different months.
    (iii) Creating a report of temperatures in summers in different cities.
    (iv) Function to fetch temperature details from the saved data.
    (v) Function to display final result
    (vi) If programs: which city has maximum and minimum temperature.
    (vii) If-else programs: checking pollution level.
    (viii) If-elif : program to put cities into slabs of high temperatures/pollution, iterating through city temperature details and finding hottest and coolest city.
13. **E-Commerce:** if-elif-programs: based on discount on online shopping. For example: There is a sale for students on an e-commerce website on the occasion of Children's Day. A discount of 10% discount is being provided on stationery items, 12% on bags and 15% on laptops. Write an if-elif program to input student item choices and determine their total bill after the discounts.

NOTE: This list is indicative only. Teachers and students should use their imagination to create innovative and original assignments.

EVALUATION OF PROGRAMMING ASSIGNMENTS

Proposed Guidelines for Marking

The teacher should use the criteria below to judge the internal work done. Basically, four criteria are being suggested: class design, coding and documentation, variable description and execution or output. The actual grading will be done by the teacher based on his/her judgment. One possible way: divide the outcome for each criterion into one of 4 groups: excellent, good, fair/acceptable, poor/unacceptable, then use numeric values for each grade and add to get the total.

Class design:

Has a suitable class (or classes) been used?

Are all attributes with the right kinds of types present?

Is encapsulation properly done?

Is the interface properly designed?

Is the logic or pseudocode and/or algorithm is correct?

Coding and Documentation:

Is the coding done properly? (choice of names, no unconditional jumps, proper organization of conditions, proper choice of loops, error handling code layout). Is the documentation complete and readable? (class documentation, variable documentation, method documentation, constraints, known bugs – if any).

Variable Description

Format for variable description:

Name of the Variable	Data Type	Purpose/ Description

Evaluation of practical work (Assignments) will be done as follows:

Subject Teacher (Internal Examiner): 100 Marks

Criteria (Total-100 marks)	Class design (20 marks)	Variable description (20 marks)	Coding and Documentation (20 marks)	Execution OR Output (40 marks)
Excellent	20	20	20	40
Good	16	16	16	32
Fair	12	12	12	24
Poor	8	8	8	16

LABORATORY EXPERIMENTS FOR DEMONSTRATION

The following experiments can either be demonstrated physically by the teacher using a Kit/ using audio-visual material. Alternatively, these may be taken up as group projects under the guidance of the teacher:

(i) Robotics Game

(ii) Intelligent Robotic Waste Bin

Note: The purpose of these laboratory experiments is to familiarize students with robotics systems. These are not a part of the evaluation.

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LABORATORY REQUIREMENTS

(For a Class of 30 students)

Item	Number
Computer Laboratory Desktop PCs with Python installed	15
Registration ids on Tinkercad for students	30
Miscellaneous	Screwdrivers, Allen wrench, Soldering Station
For Laboratory Experiments	
Single Board Computer (*e.g.* Arduino uno/nano ble sense, raspberry pi)	10 sets
Robotics Components: Servo motors, Sensors, wires, batteries, crimper, LED	10 sets

Robotics Game

- *An introductory DIY setup analogous to a Robotic Systems with Vibration motor, and Coin battery.*
- *A Bristle Bot Race can be conducted as an activity. Bristle bot is available as a kit and can also be easily built using the following parts: Vibration Motor, Coin cell battery, Toothbrush head with the handle cut off, double sided tape.*

Intelligent Robotic Waste Bin

Intelligent Robotic Waste Bin works a supervision device for waste. This device integrates select sensors to supervise the state of waste. It includes:

- *an ultrasonic sensor to check the level of the waste, used to prevent overflows by alerting the garbage collection team.*
- *a temperature and humidity sensor to monitor the waste environment*
- *a flame sensor to check for incandescent waste and reduce the risk of fire*
- *a servo motor to open the lid whenever someone comes in the vicinity of the waste bin demonstration by teacher.*

CLASS X

THEORY- 100 Marks

There will be one internal paper of two-hour duration carrying 100 marks and an internal assessment of 100 marks.

PART I

ROBOTICS

Note: Key concepts of Class IX need to be revised as a prerequisite

1. New Age Robotic Systems

Warehouse Robots, Assistant Robots, Smart Homes, Smart Schools, Smart mobility, Autonomous Cars/Driver Assisted Cars, Autonomous Drones, Robotics for Medicine and Healthcare, any other (give examples). Why NARS are relevant and possible. Some common examples of robotic systems such as, elevator.

2. From Robots to Cobots

(i) Difference between a machine and a robot.

Difference between a machine and a robot: an understanding of how a robot must continuously sense, maintain a certain speed and do a certain task that it is programmed to do, using examples; identification of machine/robot through illustrations.

(ii) Cobots

Meaning of Cobots (as robotic systems with humans in the loop, emphasizing the provision for human interaction and a multi robot system); difference between Cobot and Robot, importance of cobots, a brief understanding of the progress from Robots to Cobots.

3. Components of Robots as a System

(i) Introduction to Gears.

Use of gears in robots- transmission and amplification of force, principles of gears, types of gears, gear ratio (brief understanding with examples).

(ii) Sensors in Robotics.

Types of Sensors based on application (Vision, tactile, temperature, range and proximity detection, motion, navigation, speech recognition) with examples only.

Classification of sensors as Internal Sensors (Position, Velocity, Acceleration and Force Sensors) and External Sensors (Contact type, Non-contact Type Sensors). Functions of sensors.

(iii) Actuators

Brief understanding of actuators and their application; types of actuators (linear and rotary) with examples such as joints and wheels.

(iv) Controller for a Robotic System

Examples of control systems from daily life: regulation of fan, refrigerator, and air conditioner.

Control systems in robotics: Meaning, functions and working; differences between manual and automatic control systems. Block diagrams to be used to illustrate

(Input-controller-robot-feedback).

(v) Integrating Sensors, Actuators and Controller in a Robotic System

Illustration using a simple example: how angular position is measured by a position sensor of a robotic arm is controlled by driving the revolute joint using a motor.

4. Visualization, Design and Creation of Components

(i) Application of Mechanical Block of Robotics.

Visualize, design and create components of a robot.

Using Tinkercad to visualize, design, and create the components of a robot; the different types of joints: revolute and prismatic, RR Mechanism.

(ii) Visualization of motion.

Use of Tinkercad to visualize motion of the components designed.

5. Integrating Robots as a System

Building simple robotic systems, wheeled mobile robot, Single Board Computer coding

Using Tinkercad to build simple robotics systems, for example, RR Mechanism. Building simple systems up to a mobile robot with four wheels.

PART II

ARTIFICIAL INTELLIGENCE

Note: Key concepts of Class IX need to be revised as a prerequisite.

1. Decision making in Machines/ Computers

(i) Automated versus Autonomous Systems.

Concept of Automated versus Autonomous Systems for Deterministic versus Probabilistic versus.

(ii) Decision Making.

Human versus machine decision making as subjective and objective respectively; An understanding of object classification by humans and computers/machines.

(iii) Machine Learning (ML).

A brief understanding of Machine Learning, role of data and information. Steps in machine learning. Importance of programming and algorithms in teaching machines/computers in subjective decision making.

Example such as fruit sorting.

2. Machine Intelligence and Cybersecurity in Computing

(i) Machine Intelligence – Turing Test.

Human intelligence vs Machine Intelligence; role of the Turing test in AI: a brief understanding only; connectivity between human intelligence and machine intelligence.

(ii) Cybersecurity

A basic understanding of security and ethical issues such as the unauthorized use of hardware, theft of software, disputed rights to products, the use of computers to commit fraud, the phenomenon of hacking and data theft, sabotage in the form of viruses, responsibility for the reliability of output, making false claims for computers, and the degradation of work.

3. Components of AI Project Framework

(i) Problem Scoping

Understanding of problem and finding out which factors affect the problem, defining the goal of the project. The 4 Ws: Who, What, Where, Why. The Problem Statement .

(ii) Data Acquisition

Types of Data, Data Features, Data Sources, Training and testing Data and System Maps. Importance of acquiring relevant data from reliable sources.

Sources of Dataset in AI – Kaggle Platform

(iii) Data Exploration

An understanding of different ways of representing data to gather meaningful information: Bar graphs/ histograms, line graphs, scatter plots, pie charts.

(iv) Modelling and Evaluation

Approaches in AI data modelling: Prediction – linear regression. Rule based approach, learning based approach, supervised learning, unsupervised learning (brief understanding of each).

4. Introduction to Data and Programming with Python

(i) Modules and Packages.

Scope and uses of packages, modules and libraries like NumPy, Pandas, SciPy, Matplotlib; implementation using simple programs in python.

An understanding of what libraries are and why we need them in the first place, the syntax of importing libraries.

(ii) Lists and Tuples in Python.

Introduction to lists, creation of list, access elements of a list, list operations (append, insert, extend, sort, search)

Introduction to tuples, creation of tuple, accessing tuples, deleting a tuple, and converting list to tuple and vice-versa.

(iii) Strings

Introduction to strings, creating strings, traversing a string, multiline strings, concatenating strings, escape sequences. String operators, string in-built functions:

int string.len()

string string.upper()

string string.lower()

boolean string.endswith(*value)*

boolean string.startswith(*value)*

int string.find(*value)*

boolean string.islower()

string string.replace(*oldvalue, newvalue)*

int string.count(*value)*

boolean string.isalpha()

boolean string.isdigit()

boolean string.isalnum()

string string.join(*iterable*)

*string s*tring[start:end:step]

INTERNAL ASSESSMENT- 100 Marks

Students are expected to do a minimum of **20 assignments** during the year to reinforce concepts studied in class. The details are as follows:

Details of Assignments to be done during the year

Broad Area	**Number of Assignments**
Robotics	3
Artificial Intelligence	2
Python (Programming)	15
TOTAL	**20**

The teacher-in-charge should maintain a record of all the assignments done as a part of practical work throughout the year and give it due credit at the time of cumulative evaluation at the end of the year.

SUGGESTED LIST OF ASSIGNMENTS:

Some sample problems are given below as examples. The problems are of varying levels of difficulty:

Robotics

1. Make a presentation on the difference between a machine/robot/cobot.
2. Technology is evolving at a fast pace. What does it mean for us? Discuss.
3. Are smart systems making humans less smart? Discuss.
4. Prepare a report on robotics systems being used in different spheres of life?

Artificial Intelligence (AI)

1. Create a concept map of a smart transport management systems for a school. (Refer Tony Buzan concept map).
2. Create a chart for AI enabled query management system for a school. (Refer Tony Buzan concept map). Use AI Project Framework.
3. Ideate and prepare a presentation on how AI could be used in a school. Which areas in a school can be benefitted using AI? Using AI Project framework ideate the implementation of AI towards a smart school.

Python Programming

1. Create a list of all students in your class and sort them in alphabetical order.
2. Find a word string of interest in a given sentence. For the same string match for exact case if a particular word string is present in a given sentence. Display output "String Name Found", or "String Name Not Found"
3. Make a dictionary dataset of all cities in India and store their average temperature and pollution details.
4. Create Numpy arrays
   a) Getting elements from Numpy arrays using index values.
   b) Numpy array slicing.
   c) Getting Numpy array shape and reshaping them.
   d) Iterating a Numpy array.
   e) Join and split Numpy arrays.

f) Searching and sorting of Numpy arrays,

g) Using mean, median and mode methods given in Numpy,

5. Display an image using matplotlib and print its numpy array form. Also check the data type and shape of the numpy array. Use the library 'skimage' for getting sample images.
6. Reading a .csv file into a Pandas DataFrame .
7. Reading json data into a Pandas DataFrame.
8. Basic data analysis on data with info(), tail(), head() commands.
9. Plotting *x* and *y* point arrays on a plot.
10. Using different type of markers and line styles on the plot.
11. Declaring labels for the axis. (Plot selling price and original price).
12. Plotting bar graphs - Use the bestselling book dataset to plot year wise data and find out what genre was bestselling across years.
13. Plotting histograms - Use the top 200 YouTubers' dataset to plot and find out what genre was most liked. Also plot followers using histogram for each genre.
14. Regression Assignment (Predicting the Future) - Plot the relationship between the year and the average temperatures. Can you predict the average temperature for future years? What do you infer from the trend?
15. Creating a normal distribution and displaying in graph (using Numpy + Matplotlib) - Display the scores of students in a graph and check if it is a normal distribution? What is the mean, median and mode of this data?
16. Write a Python program to calculate the electricity bill. Accept the last meter reading and current meter reading and the rate per unit from the user. Calculate the number of units and total bill consumption for the user.
17. A company decided to give bonus of 5% to an employee if his/her year of service is more than 5 years. Write a Python program to ask the user for their salary and year of service and print the net bonus amount.

NOTE: This list is indicative only. Teachers and students should use their imagination to create innovative and original assignments.

EVALUATION OF PROGRAMMING ASSIGNMENTS

The teacher-in-charge shall evaluate all the programming assignments done by the student throughout the year (both written and practical work). He/she shall ensure that most of the components of the syllabus have been used appropriately in the assignments. Assignments should be with appropriate list of variables and comment statements. The student has to mention the output of the programs.

Proposed Guidelines for Marking

The teacher should use the criteria below to judge the internal work done. Basically, four criteria are being suggested: class design, coding and documentation, variable description and execution or output. The actual grading will be done by the teacher based on his/her judgment. One possible way: divide the outcome for each criterion into one of 4 groups: excellent, good, fair/acceptable, poor/unacceptable, then use numeric values for each grade and add to get the total.

Class design:

Has a suitable class (or classes) been used?

Are all attributes with the right kinds of types present?

Is encapsulation properly done?

Is the interface properly designed

Coding and Documentation:

Is the coding done properly? (Choice of names, no unconditional jumps, proper organization of conditions, proper choice of loops, error handling, code layout) Is the documentation complete and readable? (class documentation, variable documentation, method documentation, constraints, known bugs - if any).

Variable description:

Format for variable description:

Name of the Variable	Data Type	Purpose/description

Execution or Output:

Does the program run on all sample input correctly?

Evaluation of programming assignments will be done as follows:

Subject Teacher (Internal Examiner)	50 marks
External Examiner	50 marks

Criteria (Total-50 marks)	Class design (10 marks)	Variable description (10 marks)	Coding and Documentation (10 marks)	Execution OR Output (20 marks)
Excellent	10	10	10	20
Good	8	8	8	16
Fair	6	6	6	12
Poor	4	4	4	8

An External Examiner shall be nominated by the Head of the School and may be a teacher from the faculty, but not teaching the subject in the relevant section/class. For example, A teacher of Computer Science of class XII may be deputed to be the External Examiner for class X.

The total marks obtained out of 100 are to be sent to CISCE by the Head of the school.

The Head of the school will be responsible for the online entry of marks on CISCE's CAREERS portal by the due date.

LABORATORY EXPERIMENTS FOR DEMONSTRATION

The following experiments can either be demonstrated physically by the teacher using a Kit/ using audio- visual material. Alternatively, these may be taken up as group projects under the guidance of the teacher.

Programmable Mobile Robots:

*Line follower, Obstacle avoidance and Edge Detection Mobile Robots.

Note: The purpose of these laboratory experiments is to familiarize students with robotics systems and are not a part of the evaluation.

**A line follower robot will be able to follow a drawn line on the floor and move accordingly. An obstacle avoidance robot will be able to detect any solid object that comes along its path and change its direction to avoid it. An edge detection mobile robot will move on the table be able to detect the edges and prevent itself from falling off the table.*

All these are excellent examples of sensors in action. These robots can help in understanding how the sensors interface with the microcontrollers to automate a specific tasks.

A plethora of examples of these systems are found in manufacturing plants, autonomous driving vehicles, space programs, automatic vacuum cleaners etc.

The fundamental design of these robots are strategically placed sensors which enable them to work in a more specialised manner. Both the Line Following and Edge Detection Robots employ a couple of IR sensors but their placement makes them perform different tasks.

In case of Line Follower, the IR sensors are placed close to each other to help in following a predefined path whereas, the edge detector has widely placed IR sensors to maximise coverage area thus preventing itself from falling off from a surface. The Obstacle Avoider Robot employs an Ultrasonic Sensor which automatically detects if any object comes in front of it at a pre-defined distance and changes its course accordingly.

LABORATORY REQUIREMENTS
(For a Class of 30 students)

Item	Number
Computer Laboratory Desktop PCs with Python and Tinkercad installed	15
Registration ids on Tinkercad for student user	30
Miscellaneous	Screwdrivers, Allen wrench, soldering station
For Laboratory Experiments	
Single Board Computer (*e.g.* Arduino uno/nano ble sense, raspberry pi)	10 sets
Robotics Components: Servo motors, sensors (Ultrasonic,IR), wires, batteries, crimper, LED	10 sets
Programmable Mobile Robots: Line follower, obstacle avoidance and Edge Detection Mobile Robot. *The aforementioned Programmable mobile robots are available as a DIY kit and can also be easily built using the Robotic components.*	