Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester-2 (B.Tech)

Subject: Robotics Workshop - BET1XX12208

Type of course: Engineering Science Courses

Prerequisite: Basic understanding of Electronics and Programming.

Rationale: This workshop-based course provides a hands-on introduction to the fundamental principles of robotics. Students will learn to design, build, and program robotic systems by integrating microcontrollers, sensors, and actuators. The course progresses from basic movement and sensing to wireless control and IoT integration, culminating in a comprehensive mini-project that fosters practical skills in embedded systems and autonomous robot design.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
CI	T	P	C	SEE	CCE	
0	0	4	2	50	50	100

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; SEE - Semester End Evaluation; CCE-Continuous and Comprehensive Evaluation.

Course Content:

Sr. No.	Course Content	Hrs.	% Weight age
1	**Introduction to Robotics & Basic Movement** **Topics:** • Robotics Introduction: History and applications. • Core components: Structure, Controller, Actuators, Sensors, Power • Electronics in Robotics: DC Motors, Servo Motors, Motor Drivers, Batteries, Voltage Regulators, Wireless Modules, etc. • Introduction to Microcontrollers & Microprocessors. **Practical:** 1. IDE & Blink: Set up the Arduino IDE and upload a "Blink" program to an Arduino in an online simulator. 2. Servo Sweep: Program a servo motor to sweep through its range of motion. 3. DC Motor Control: Interface and control the speed and direction of a single DC motor using a motor driver. 4. Differential Drive: Assemble and program a 4-wheel robotic chassis for forward, backward, left, and right movements.	P:12	20%

Evaluation Method

Sr. No.	Evaluation Component	SEE (Marks)	CCE (Marks)	Description
1	Chassis Performance Test	10	–	SEE: Robot must successfully execute a predefined sequence of movements on a test track.
2	Design File & Wiring Documentation Review (ALA-1)	–	10	CCE: Students submit wiring diagrams, connection charts, and component layout for chassis + motor driver system on the GMIU web portal.
	Total	10	10	

2	**Sensor Integration & Data Acquisition**	**P:12**	**20%**

Topics:

- Ultrasonic Sensor for Obstacle detection and distance measurement
- IR Proximity Sensor for object presence detection
- IR Line Sensor for line following and path tracking
- LDR for light intensity detection and automatic lighting
- Temperature & Humidity Sensor for environment monitoring

Practical:

1. IR Sensor Calibration: Read digital output from an IR obstacle sensor and print "Obstacle Detected" to the Serial Monitor.
2. Ultrasonic Ranger: Measure distance to an object using an HC-SR04 sensor and display it on the Serial Monitor.
3. Light Meter: Read analog values from an LDR and map them to a 0-100% light intensity scale.
4. Obstacle Avoider Robot: Program the robot to autonomously navigate a space without colliding using an ultrasonic sensor.
5. Line Follower Robot: Program the robot to follow a black line on a white surface using two to three IR sensors.

Evaluation Method

Sr. No.	Evaluation Component	SEE (Marks)	CCE (Marks)	Description
1	Maze Navigator	10	–	SEE: The obstacle-avoiding robot must successfully navigate an unknown maze.
2	Sensor Mapping & Data Log Submission (ALA-2)	–	10	CCE: Students submit a log showing sensor readings (IR, Ultrasonic, LDR) under different conditions with analysis on the GMIU web portal.
	Total	10	10	

3	**Wireless Control & IoT for Robotics** **Topics:** • Introduction to Communication Protocols (Wi-Fi). • Basics of web server hosting on NodeMCU. • Creating a simple HTML User Interface (UI). • Introduction to MQTT for lightweight IoT communication. **Practical:** 1. Wi-Fi Connect: Program a NodeMCU to connect to a local Wi-Fi network and print its IP address. 2. Basic Web Server: Create a simple web server that displays "Hello from Robot!" on a web page. 3. Web-Controlled LED: Create a web UI with buttons to turn an onboard LED ON and OFF. 4. Web-Controlled Robot: Create a web UI with directional buttons (Forward, Back, Left, Right, Stop) to control the robot's movement. 5. Sensor Data Monitor: Host a web page that displays real-time data from the ultrasonic sensor (distance) and LDR (light level).	**P:12**	**20%**

Evaluation Method

Sr. No.	Evaluation Component	SEE (Marks)	CCE (Marks)	Description
1	Remote Control Challenge	10	–	SEE: Using a web browser, remotely drive the robot via the web UI through a simple obstacle track.
2	IoT Interface Layout & Flow Diagram Submission (ALA-3)	–	10	CCE: Students create a flow diagram + UI layout plan for their web interface, showing button-to-action mapping and data update flow, and submit it on the GMIU web portal.
	Total	10	10	

4	**Robot Manipulator Arm Control & Integration**	**P:12**	**20%**

Robot Manipulator Arm Control & Integration

Topics:

- Introduction to DOF Robotic Manipulator Arm
- Mechanical structure: Base rotation, shoulder, elbow, gripper
- Working principles of SG90 servo motors
- Movement control using microcontroller PWM signals
- Inverse movement logic for multi-DOF control
- Coordinated motion for pick-and-place tasks
- Load limits, calibration, and accuracy improvement
- Safety and servo protection techniques

Practical:

1. Servo Identification & Calibration: Identify base, shoulder, elbow, and gripper servos. Calibrate each servo to achieve the correct zero position.
2. Individual Joint Control: Write separate programs to control each DOF using PWM.
3. Coordinated Arm Motion: Move shoulder + elbow together to reach a fixed position. Smooth movement using incremental angle steps

4. Gripper Operation Practice: Open/close claw; Test gripping of different small objects.
5. Pick-and-Place Task: Program the DOF arm to pick an object from location A and Place it at location B with stable movement.

Evaluation Method

Sr. No.	Evaluation Component	SEE (Marks)	CCE (Marks)	Description
1	Precision & Repeatability Test	10	–	SEE: Students have to run a predefined accuracy test: The arm should repeatedly reach 3 given coordinate points. Evaluated on precision, stability, and repeatability - not just movement.
2	Motion Planning Diagram + Joint Angle Table	–	10	CCE: Students have to submit: (a) Motion flow diagram, (b) Joint angle table for pick-and-place cycle, (c) Explanation of sequence. No coding - only planning & documentation.
	Total	10	10	

5	**Project: Autonomous Robot** **Topics:** • Project planning and design thinking. • Integrating multiple sensors and actuators. • State-machine logic for autonomous behaviour. • Troubleshooting and debugging complex systems.	**P:12**	**20%**

Practical:

1. Test the robot's battery management by measuring run-time under continuous operation.
2. Tune the motor speed using PWM to achieve smooth, stable autonomous movement.
3. Test sensor placement by comparing readings at different mounting positions.
4. Implement an emergency stop feature using a dedicated button or sensor trigger.
5. Create a simple diagnostic mode that prints all sensor and motor statuses to the Serial Monitor.

Evaluation Method

Sr. No.	Evaluation Component	SEE (Marks)	CCE (Marks)	Description
1	Final Project Demo & Performance	10	–	SEE: Live demonstration of the fully integrated project, evaluated on functionality, autonomy, and task completion in a final challenge.
2	Final Project Report (Design + Code + Circuit)	–	10	CCE: Students submit a structured project report including design diagrams, system flow, code snippets, and testing results.
	Total	10	10	

Suggested Specification Table with Marks:

Distribution of Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage %	05%	15%	15%	10%	05%	50%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the evaluation may vary slightly from the above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Program basic robot movements using microcontrollers and motor systems.
CO2	Interface and utilise sensors to enable autonomous navigation tasks.
CO3	Implement wireless control and IoT-based monitoring for robotic systems.
CO4	Operate and integrate a DOF robotic arm for precise and coordinated tasks.
CO5	Design and demonstrate a fully autonomous robot integrating all learned modules.

Instructional Method:

The course delivery method will depend on the content requirements and students' needs. The teacher, in addition to the conventional teaching method by the blackboard, may also use any of the tools, such as demonstration, role play, quizzes, brainstorming, MOOCs, etc.

From the content, 10% of topics are suggested for flipped-mode instruction.

Students will utilise supplementary resources, including online videos, NPTEL/SWAYAM videos, e-courses, and Virtual Laboratories.

The internal evaluation will be done on the basis of the CCE-Continuous and Comprehensive Evaluation.

SEE: Semester End Evaluation will be conducted at the end of each module for the evaluation of the performance of students in the laboratory.

Reference Books

[1] J. J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2005.

[2] R. J. Schilling, *Fundamentals of Robotics: Analysis and Control*. Englewood Cliffs, NJ, USA: Prentice Hall, 1990.

[3] J.-D. Warren, J. Adams, and H. Molle, *Arduino Robotics*. New York, NY, USA: Apress, 2011.

[4] T. Barrett and T. Kerr, *Arduino IV: DIY Robots—3D Printing, Instrumentation, and Control*. Cham, Switzerland: Springer, 2022.

[5] S. Thrun, W. Burgard, and D. Fox, *Probabilistic Robotics*. Cambridge, MA, USA: MIT Press, 2005.

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Robotics Workshop (CSE – 2nd Sem, B.Tech Premium)
Component List for Students

No	Component
1	NodeMCU ESP8266 (Microcontroller)
2	4-Wheel Double Layer Robot Chassis Kit
3	Robotic Arm Kit (Servo motors not included)
4	Servo Motor (SG90)
5	L298N Motor Driver Module
6	HC-SR04 Ultrasonic Sensor
7	Jumper Wires
8	Micro-USB Cable