ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

(Anjugramam-Kanyakumari Main Road, Palkulam,Variyoor P.O.-629 401, K.K.Dist.)

Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

Accredited with A+ Grade by NAAC

Minor Degree Course

ROBOTICS

Curriculum & Syllabus

(*2024-2025 Admitted Students Onwards*)

Proceedings of the 3rd Academic Council [28.11.2025]

CREDIT INFO		
Sl.No	**Category**	**Credits**
1	**Minor Courses**	**18**

CREDIT DISTRIBUTION

Course Category	Credit/Semester								No. of Credits
	I	II	III	IV	V	VI	VII	VIII	
Minor Courses					**6**	**6**	**6**	**-**	**18**

Minor in Robotics							
Sl.no	Course Code	Course Title	Course Type	L	T	P	Credit
1.	24 RS 501	Fundamentals of Robotics and Intelligent Automation	PEC	3	0	0	3
2.	24 RS 502	Robot Programming, ROS and Embedded Control	PEC	3	0	0	3
3.	24 RS 601	Computer Vision and Intelligent Robot Perception	PEC	2	0	2	3
4.	24 RS 602	Autonomous Mobile Robots and Industrial Robotics	PEC	3	0	0	3
5.	24 RS 701	AI, Digital Twin and Human–Robot Collaboration	PEC	3	0	0	3
6.	24 RS 702	Robotics Applications In Smart Engineering Systems	PEC	0	0	6	3

Course Code:	**24 RS 501**	**Course Title:**	**Fundamentals of Robotics and Intelligent Automation**
Credits:	**3**	**L-T-P**	**3 – 0 – 0**
Prerequisite: Basic Engineering Mathematics and Computer Fundamentals			

Course Objectives:

1. Understand the fundamentals of robotics, intelligent automation, and Industry 4.0/5.0 technologies used in modern engineering systems.
2. Explain the working principles of robot components, sensors, actuators, end-effectors, and robotic configurations.
3. Apply basic robot kinematics, workspace analysis, and motion planning concepts to engineering applications.
4. Develop simple robot programming and simulation models for industrial and service robotics using modern software tools.
5. Design intelligent robotic solutions for manufacturing, healthcare, agriculture, logistics, and smart infrastructure applications.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive Lectures with Industrial Case Studies
2. Demonstration-Based Learning using Robot Simulators
3. Hands-on Programming Sessions
4. Project-Based Learning
5. Problem-Based Learning
6. Flipped Classroom
7. Virtual Robotics Laboratory
8. Industry Expert Lectures
9. Collaborative Team Activities
10. Mini Project and Technical Presentation

Unit-I Introduction to Robotics and Intelligent Automation	**[9 hours]**
Evolution of Robotics – Types of Robots – Industrial Robots – Service Robots – Collaborative Robots (Cobots) – Mobile Robots – Humanoid Robots – Autonomous Systems – Intelligent Automation – Industry 4.0 and Industry 5.0 – Robotics in Smart Manufacturing – Applications of	

Robotics in Healthcare, Agriculture, Construction, Logistics, Energy, and Smart Cities – Future Trends in Robotics.	
Unit II Robot Components, Sensors and Actuators	**[9 hours]**
Robot Anatomy – Robot Configurations – Degrees of Freedom (DOF) – Coordinate Systems – Robot Workspace – Robot Joints and Links – End Effectors – Grippers – Electric, Hydraulic and Pneumatic Actuators – Position, Force, Proximity, Vision and Inertial Sensors – Sensor Integration – Safety Devices – Human–Robot Interaction – Robot Selection Criteria.	
Unit-III Robot Kinematics and Motion Control	**[9 hours]**
Introduction to Robot Kinematics – Forward and Inverse Kinematics (Concepts) – Coordinate Transformations – Homogeneous Transformation Matrix (Conceptual) – Robot Motion Planning – Point-to-Point and Continuous Path Motion – Trajectory Planning – Velocity and Acceleration Profiles – Introduction to Robot Dynamics – Motion Control Concepts – Industrial Robot Programming Basics.	
Unit-IV Robot Programming and Simulation	**[9 hours]**
Introduction to Robot Programming – Programming Logic for Robots – Python Fundamentals for Robotics – Graphical Robot Programming – Robot Simulation Tools – Robot Operating System (ROS) Overview – Robot Communication Concepts – Simulation of Pick-and-Place Operations – Autonomous Navigation Concepts – Digital Twin for Robotics – Virtual Commissioning – Safety in Robot Programming.	
Unit-V Robotics Applications In Smart Engineering Systems	**[9 hours]**
Robotics in Smart Manufacturing – Automated Material Handling – Warehouse Automation – Healthcare and Rehabilitation Robotics – Precision Agriculture Robots – Construction and Infrastructure Inspection Robots – Inspection Drones – Power Line Inspection Robots – Disaster Response Robots – Environmental Monitoring – AI-Enabled Robotics – Ethical and Responsible Robotics – Engineering Case Studies.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Explain the architecture, components, and operating principles of industrial and service robots used in intelligent automation.	K3
CO2	Apply robot kinematics, coordinate transformations, and motion control concepts to solve basic robotic engineering problems.	K3
CO3	Analyze the performance of robotic sensors, actuators, and end-effectors for different automation applications.	K3
CO4	Develop and simulate simple robotic programs for industrial and service robot operations.	K3
CO5	Design intelligent robotic solutions for smart manufacturing, healthcare, agriculture, logistics, and infrastructure monitoring.	K3

COs and POs Mapping

CO/ PO	**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**
CO1	3	2										2	3	-	-
CO2	3	3	2	2	2								3	-	-
CO3	2	3	2	3	2	1							3	-	-
CO4	2	3	2										3	-	-
CO5	2	3	3	2	2	1							3	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE) - Theory	CIE – I	100	60	100	25
	CIE – II	100			
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
Continuous Internal Examination (CIE) - Laboratory	Continuous Assessment	75	75	100	25
	Model Lab Exam	25	25		
End Semester Examination (ESE)	Theory Exam	100	35	50	50
	Lab Exam	100	15		
Total					100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	**2**	
Remember	40	20	20
Understand	60	60	60
Apply	0	20	20
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Saeed B. Niku, **Introduction to Robotics: Analysis, Control, Applications**, 3rd Edition, Wiley, 2020.
2. John J. Craig, **Introduction to Robotics: Mechanics and Control**, 4th Edition, Pearson, 2022.
3. Mikell P. Groover, **Automation, Production Systems, and Computer-Integrated Manufacturing**, 5th Edition, Pearson, 2020.

Reference Books:

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, **Robotics: Modelling, Planning and Control**, Springer.
2. Kevin M. Lynch and Frank C. Park, **Modern Robotics: Mechanics, Planning, and Control**, Cambridge University Press.
3. Richard D. Klafter, Thomas A. Chmielewski, and Michael Negin, **Robotic Engineering: An Integrated Approach**, Prentice Hall.
4. Robin R. Murphy, **Introduction to AI Robotics**, MIT Press.
5. Angelo Cangelosi and Minoru Asada, **Cognitive Robotics**, MIT Press.

Suggested Skill Activities

1. Prepare a comparative study of Industrial Robots, Service Robots, Cobots, Mobile Robots, and Humanoid Robots with their applications.
2. Develop an infographic or presentation on Industry 4.0, Industry 5.0, and Intelligent Automation in Smart Manufacturing.
3. Conduct a case study on robotics applications in healthcare, agriculture, logistics, or smart cities and present the findings.

4. Identify and demonstrate the functions of robot components, joints, links, end effectors, and actuators using physical models or simulation software.
5. Interface a proximity or ultrasonic sensor with an Arduino/microcontroller and display sensor output.
6. Compare different robot sensors and actuators by preparing a selection matrix for a specific industrial application.
7. Solve simple forward and inverse kinematics problems for basic robot manipulators using software tools or spreadsheets.
8. Simulate point-to-point and continuous-path robot motion using RoboDK, CoppeliaSim, or equivalent software.
9. Develop and analyze basic robot trajectories with velocity and acceleration profiles using Python or MATLAB.
10. Write and execute simple Python programs for robot movement and decision-making logic.
11. Simulate a pick-and-place robotic operation using RoboDK, CoppeliaSim, or Webots.
12. Install and demonstrate basic Robot Operating System (ROS) concepts or develop a simple digital twin of a robotic workcell.
13. Design a conceptual robotic solution for smart manufacturing, healthcare, agriculture, logistics, or disaster response.
14. Develop a mini-project or simulation demonstrating an AI-enabled robotic application such as warehouse automation or inspection robotics.
15. Prepare a case study report on ethical, sustainable, and responsible robotics in modern engineering systems.

Course Code:	24 RS 502	Course Title:	ROBOT PROGRAMMING, ROS AND EMBEDDED CONTROL
Credits:	**3**	**L-T-P**	**3 – 0 – 0**
Prerequisite: Fundamentals of Robotics and Intelligent Automation			

Course Objectives:

1. Understand the principles of robot programming, Robot Operating System (ROS2), and embedded control for intelligent robotic systems.
2. Develop robot control programs using Python and ROS2 for communication, navigation, and task execution.
3. Interface embedded controllers, sensors, actuators, and communication modules with robotic platforms.
4. Apply simulation and visualization tools to design, test, and validate robotic applications in virtual environments.
5. Design intelligent robotic systems integrating ROS2, embedded controllers, sensors, and actuators for real-world engineering applications.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive Lectures with Industrial Robotics Case Studies
2. Live Coding Sessions using Python and ROS2
3. Hands-on Laboratory Sessions
4. Simulation-Based Learning using Gazebo and RViz
5. Project-Based Learning
6. Problem-Based Learning
7. Flipped Classroom
8. Collaborative Programming Activities
9. Industry Expert Talks
10. Mini Projects and Technical Demonstrations

Unit-I ROBOT PROGRAMMING FUNDAMENTALS	[9 hours]

Introduction to Robot Programming – Programming Languages for Robotics – Python Fundamentals for Robot Programming – Robot Motion Commands – Variables, Functions, and Control Structures – Robot Control Logic – Coordinate Frames – Trajectory Commands – Robot Task Sequencing – Programming Pick-and-Place Operations – Introduction to Simulation-Based Programming – Applications in Industrial and Service Robotics.

Unit II ROBOT OPERATING SYSTEM (ROS2)	[9 hours]
Introduction to ROS2 – ROS2 Architecture – ROS2 Installation and Workspace – Packages and Nodes – Topics – Messages – Publishers and Subscribers – Services and Clients – Actions – Parameters – Launch Files – ROS2 Command-Line Tools – Robot Description (URDF Concepts) – Visualization using RViz – Applications of ROS2 in Autonomous Robots and Industrial Automation.	
Unit-III EMBEDDED CONTROL FOR ROBOTICS	**[9 hours]**
Embedded Systems Fundamentals – Microcontrollers and Single Board Computers – Arduino and Raspberry Pi Overview – GPIO Programming – Sensor Interfacing – Actuator Control – Motor Drivers – Servo and Stepper Motor Control – PWM Control – Interrupts and Timers – Serial Communication (UART, I²C, SPI Concepts) – Wireless Communication (Bluetooth and Wi-Fi Concepts) – Embedded Control for Mobile Robots.	
Unit-IV ROBOT SIMULATION, NAVIGATION AND CONTROL	**[9 hours]**
Robot Simulation Fundamentals – Gazebo Simulation Environment – Robot Model Creation – Robot Visualization using RViz – Robot Localization Concepts – Mapping and Navigation – Path Planning Concepts – Obstacle Detection and Avoidance – Sensor Fusion Concepts – SLAM Overview – Autonomous Navigation – Simulation of Mobile Robot Applications – Testing and Performance Evaluation.	
Unit-V ROBOT PROGRAMMING APPLICATIONS IN SMART ENGINEERING SYSTEMS	**[9 hours]**
Robot Programming for Smart Manufacturing – Warehouse Automation – Autonomous Mobile Robots (AMRs) – Automated Guided Vehicles (AGVs) – Healthcare Robotics – Agricultural Robotics – Inspection and Surveillance Robots – Drone Programming Concepts – Human–Robot Collaboration – Edge AI for Robotics – Digital Twin Concepts – Engineering Case Studies – Safety and Ethical Considerations in Robotic Programming.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Develop robot programs using Python and ROS2 to control robotic systems and automate engineering tasks.	K3
CO2	Configure ROS2 packages, nodes, topics, services, and actions for communication and coordination among robotic components.	K3
CO3	Interface embedded controllers, sensors, and actuators to implement real-time robot control applications.	K3
CO4	Simulate robotic systems using ROS2 visualization and simulation tools for navigation, manipulation, and autonomous operation.	K3
CO5	Design integrated robotic solutions for smart manufacturing, healthcare, logistics, agriculture, and autonomous engineering systems.	K3

COs and POs Mapping

CO/ PO	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
CO1	3	2										2	3	-	-
CO2	3	3	2	2	2								3	-	-
CO3	2	3	2	3	2	1							3	-	-
CO4	2	3	2										3	-	-
CO5	2	3	3	2	2	1							3	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Theory	CIE – I	100	60	100	25
	CIE – II	100			
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
Continuous Internal Examination (CIE) - Laboratory	Continuous Assessment	75	75	100	25
	Model Lab Exam	25	25		
End Semester Examination (ESE)	Theory Exam	100	35	50	50
	Lab Exam	100	15		
Total					100

Assessment Pattern

Bloom's Category	Continuous Assessment Tests 1	Continuous Assessment Tests 2	Terminal Examination
Remember	40	20	20
Understand	60	60	60
Apply	0	20	20
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Morgan Quigley, Brian Gerkey and William D. Smart, Programming Robots with ROS, O'Reilly Media, 2015.
2. Aaron Martinez and Enrique Fernández, Learning ROS for Robotics Programming, Packt Publishing, Latest Edition.
3. John H. Davies, MSP430 Microcontroller Basics, Newnes (for embedded control concepts), or equivalent embedded systems text.

Reference Books:

1. Kevin M. Lynch and Frank C. Park, Modern Robotics: Mechanics, Planning, and Control, Cambridge University Press.
2. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley.
3. Anis Koubaa (Ed.), Robot Operating System (ROS): The Complete Reference, Springer.
4. Steven F. Barrett and Daniel J. Pack, Arduino Microcontroller: Processing for Everyone!, Morgan & Claypool.
5. Simon Monk, Programming Raspberry Pi, McGraw-Hill.

Suggested Skill Activities

Students shall complete the following laboratory and skill-oriented activities.

1. Develop Python programs to control basic robot movements.
2. Create and execute ROS2 nodes using publishers and subscribers.
3. Configure ROS2 services and actions for robot task execution.
4. Interface sensors and actuators using Arduino or Raspberry Pi.
5. Control DC, servo, and stepper motors for robotic applications.
6. Simulate a mobile robot using Gazebo and visualize it using RViz.
7. Implement obstacle detection using ultrasonic or LiDAR sensors.
8. Develop a simple autonomous navigation program using ROS2.
9. Integrate embedded hardware with ROS2 for robot communication.
10. Complete a mini project on a ROS2-based intelligent robotic application.

Course Code:	24 RS 601	Course Title:	COMPUTER VISION AND INTELLIGENT ROBOT PERCEPTION
Credits:	3	L-T-P	2 – 0 – 2
Prerequisite: Robot Programming, ROS and Embedded Control			

Course Objectives:

1. Understand the principles of computer vision, image processing, and intelligent robot perception for autonomous robotic systems.
2. Apply image processing and computer vision techniques using OpenCV and deep learning models for object detection, recognition, and scene understanding.
3. Integrate vision sensors, depth cameras, and LiDAR with robotic systems for perception, localization, and navigation.
4. Develop intelligent perception systems for autonomous robots using computer vision, sensor fusion, and AI techniques.
5. Design vision-based robotic applications for smart manufacturing, healthcare, agriculture, logistics, and infrastructure inspection.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive Lectures with Industrial Case Studies
2. Live Demonstration using OpenCV and ROS2
3. Hands-on Laboratory Sessions
4. Project-Based Learning
5. Problem-Based Learning
6. Simulation-Based Learning
7. Flipped Classroom
8. Team-Based Learning
9. Industry Expert Sessions
10. Mini Projects and Technical Demonstrations

Unit-I FUNDAMENTALS OF COMPUTER VISION FOR ROBOTICS	[9 hours]
Introduction to Robot Perception – Human Vision versus Robot Vision – Digital Image Formation – Image Acquisition Systems – Cameras and Vision Sensors – Image Representation – Pixels, Resolution and Color Models – Image Enhancement – Image Filtering – Histogram Processing –	

Feature Extraction – Introduction to OpenCV – Applications of Computer Vision in Robotics, Manufacturing, Healthcare, Agriculture, Logistics, and Smart Cities.	
Unit II IMAGE PROCESSING AND OBJECT RECOGNITION	**[9 hours]**
Image Transformations – Thresholding – Edge Detection – Morphological Operations – Contour Detection – Feature Detection and Matching – Image Segmentation – Object Detection Techniques – Template Matching – Motion Detection – Face Detection – QR Code and Barcode Recognition – Real-Time Video Processing – Industrial Applications of Machine Vision.	
Unit-III AI-BASED ROBOT PERCEPTION AND DEEP LEARNING	**[9 hours]**
Introduction to Deep Learning for Computer Vision – Convolutional Neural Networks (CNNs) – Image Classification – Transfer Learning – Data Augmentation – Object Detection using YOLO – Semantic Segmentation – Instance Segmentation – Vision Transformers (Concepts) – Model Performance Evaluation – Deployment of AI Vision Models – Explainable AI for Vision Systems.	
Unit-IV SENSOR FUSION, LOCALIZATION AND ROBOT NAVIGATION	**[9 hours]**
Vision Sensors – Stereo Cameras – RGB-D Cameras – LiDAR Fundamentals – Ultrasonic Sensors – Inertial Measurement Unit (IMU) – Sensor Calibration – Sensor Fusion Techniques – Visual Odometry – Localization Concepts – Simultaneous Localization and Mapping (SLAM) Overview – Path Planning Concepts – Vision-Based Navigation – ROS2 Integration for Robot Perception.	
Unit-V COMPUTER VISION APPLICATIONS IN SMART ROBOTIC SYSTEMS	**[9 hours]**
Machine Vision for Quality Inspection – Warehouse Automation – Autonomous Mobile Robots – Agricultural Robots – Medical and Healthcare Robotics – Construction and Infrastructure Inspection – Surveillance and Security Robots – Drone Vision Systems – Human–Robot Interaction – Edge AI for Robot Perception – Ethical AI in Vision Systems – Engineering Case Studies..	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Apply image processing and computer vision techniques to enable intelligent perception in robotic systems.	K3
CO2	Develop object detection, recognition, and image classification models using Open CV and deep learning frameworks.	K3
CO3	Integrate cameras, depth sensors, and LiDAR data for robot localization, mapping, and navigation.	K3
CO4	Analyze visual information using sensor fusion techniques to improve autonomous robot perception and decision-making.	K3
CO5	Design vision-enabled robotic solutions for industrial automation, healthcare, agriculture, logistics, and smart infrastructure.	K3

COs and POs Mapping

CO/ PO	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
CO1	3	2										2	3	-	-
CO2	3	3	2	2	2								3	-	-
CO3	2	3	2	3	2	1							3	-	-
CO4	2	3	2										3	-	-
CO5	2	3	3	2	2	1							3	-	-

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

<table>
<tr><th>Component</th><th>Type of assessment</th><th>Max Marks</th><th>Reduced Marks</th><th>Total</th><th>Final marks</th></tr>
<tr><td rowspan="4">Continuous Internal Examination (CIE) - Theory</td><td>CIE – I</td><td>100</td><td rowspan="2">60</td><td rowspan="4">100</td><td rowspan="4">25</td></tr>
<tr><td>CIE – II</td><td>100</td></tr>
<tr><td>Skill Assessment - I</td><td>40</td><td rowspan="2">40</td></tr>
<tr><td>Skill Assessment - II</td><td>40</td></tr>
<tr><td rowspan="2">Continuous Internal Examination (CIE) - Laboratory</td><td>Continuous Assessment</td><td>75</td><td>75</td><td rowspan="2">100</td><td rowspan="2">25</td></tr>
<tr><td>Model Lab Exam</td><td>25</td><td>25</td></tr>
<tr><td rowspan="2">End Semester Examination (ESE)</td><td>Theory Exam</td><td>100</td><td>35</td><td rowspan="2">50</td><td rowspan="2">50</td></tr>
<tr><td>Lab Exam</td><td>100</td><td>15</td></tr>
<tr><td colspan="5">Total</td><td>100</td></tr>
</table>

Assessment Pattern

<table>
<tr><th rowspan="2">Bloom’s Category</th><th colspan="2">Continuous Assessment Tests</th><th rowspan="2">Terminal Examination</th></tr>
<tr><th>1</th><th>2</th></tr>
<tr><td>Remember</td><td>40</td><td>20</td><td>20</td></tr>
<tr><td>Understand</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td>Apply</td><td>0</td><td>20</td><td>20</td></tr>
<tr><td>Analyze</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Evaluate</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Create</td><td>0</td><td>0</td><td>0</td></tr>
</table>

End semester

Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Richard Szeliski, **Computer Vision: Algorithms and Applications**, 2nd Edition, Springer, 2022.
2. Jan Erik Solem, **Programming Computer Vision with Python**, O'Reilly Media.
3. Simon J.D. Prince, **Computer Vision: Models, Learning and Inference**, Cambridge University Press.

Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods, **Digital Image Processing**, 5th Edition, Pearson, 2023.
2. Adrian Rosebrock, **Practical Python and OpenCV**, PyImageSearch.
3. Kevin M. Lynch and Frank C. Park, **Modern Robotics: Mechanics, Planning, and Control**, Cambridge University Press.
4. Robin R. Murphy, **Introduction to AI Robotics**, MIT Press.
5. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2023.

Suggested Skill Activities

Students shall complete the following laboratory and skill-oriented activities.

1. Develop image processing applications using Python and OpenCV.
2. Perform edge detection, segmentation, and feature extraction on engineering images.
3. Develop an object detection model using OpenCV and pre-trained YOLO models.
4. Build a CNN model for image classification using TensorFlow or PyTorch.
5. Integrate USB or Raspberry Pi cameras with a robotic platform.
6. Perform real-time object tracking using computer vision techniques.
7. Simulate robot perception and navigation using ROS2 and Gazebo.
8. Develop a vision-based quality inspection system for manufacturing.
9. Build a crop disease detection system using computer vision.
10. Complete a mini project on intelligent robot perception for a real-world engineering application.

Course Code:	24 RS 602	Course Title:	AUTONOMOUS MOBILE ROBOTS AND INDUSTRIAL ROBOTICS
Credits:	**3**	**L – T – P**	**3 – 0 – 0**
Pre-requisite			Robot Programming, ROS and Embedded Control

Course objectives:

The course enables the students to:

1. Understand the principles of autonomous mobile robots, industrial robots, and intelligent robotic systems used in modern engineering applications.
2. Apply localization, mapping, path planning, and navigation techniques for autonomous robot operation in dynamic environments.
3. Integrate sensors, Robot Operating System (ROS2), and Artificial Intelligence techniques for autonomous perception, decision-making, and control.
4. Develop robotic solutions for industrial automation, logistics, healthcare, agriculture, and infrastructure inspection using simulation and programming tools.
5. Design autonomous robotic systems capable of performing real-time engineering tasks safely and efficiently in Industry 5.0 environments.

Teaching-Learning Process:

- Interactive Lectures with Industrial Robotics Case Studies
- Hands-on Programming using ROS2 and Python
- Robot Simulation using Gazebo and RViz
- Project-Based Learning
- Problem-Based Learning
- Flipped Classroom
- Laboratory Experiments
- Industrial Demonstrations
- Team-Based Design Activities
- Mini Projects and Technical Presentations

UNIT I - FUNDAMENTALS OF AUTONOMOUS MOBILE ROBOTS	[9 hours]

Introduction to Autonomous Mobile Robots (AMRs) – Mobile Robot Architecture – Types of Mobile Robots – Wheeled, Tracked and Legged Robots – Robot Coordinate Systems – Robot Locomotion – Mobile Robot Kinematics – Robot Workspace – Degrees of Freedom – Robot Motion Models – Applications of Mobile Robots in Manufacturing, Healthcare, Logistics, Agriculture, Smart Cities, and Disaster Management.

UNIT II – LOCALIZATION, MAPPING AND AUTONOMOUS NAVIGATION	[9 hours]
Localization Concepts – Global and Local Localization – Mapping Techniques – Occupancy Grid Maps – Simultaneous Localization and Mapping (SLAM) Concepts – Path Planning Algorithms – Obstacle Detection and Avoidance – Motion Planning – Navigation Stack in ROS2 – Autonomous Navigation using LiDAR, Cameras, IMU, GPS and Ultrasonic Sensors – Navigation Performance Evaluation.	
UNIT III – INDUSTRIAL ROBOTICS AND COLLABORATIVE AUTOMATION	**[9 hours]**
Industrial Robot Configurations – Robot Work Cells – Industrial Robot Programming Concepts – Material Handling Robots – Assembly Robots – Welding Robots – Painting Robots – Inspection Robots – Automated Guided Vehicles (AGVs) – Collaborative Robots (Cobots) – Flexible Manufacturing Systems – Human–Robot Collaboration – Industrial Robot Safety Standards – Applications in Smart Manufacturing and Warehouse Automation.	
UNIT IV – AI, ROS2 AND INTELLIGENT ROBOT CONTROL	**[9 hours]**
Robot Operating System (ROS2) for Autonomous Robots – Sensor Integration – Vision-Based Navigation – Artificial Intelligence for Robot Decision-Making – Reinforcement Learning Concepts – Sensor Fusion – Edge AI for Robotics – Cloud Robotics Concepts – Digital Twin for Robot Monitoring – Multi-Robot Coordination – Swarm Robotics Fundamentals – Performance Monitoring and Optimization.	
UNIT V – AUTONOMOUS ROBOTICS APPLICATIONS IN SMART ENGINEERING SYSTEMS	**[9 hours]**
Warehouse Automation – Smart Manufacturing – Healthcare and Rehabilitation Robots – Precision Agriculture Robots – Infrastructure Inspection Robots – Construction Robotics – Autonomous Drones – Smart Transportation Systems – Environmental Monitoring – Search and Rescue Robots – Smart Campus Robots – Ethical and Responsible Robotics – Engineering Case Studies and Emerging Trends.	

Total Period:45

Course outcomes:

On completion of the course, the student will have the ability to:

CO No	Course Outcomes	Cognitive Level
CO1	Explain the architecture, components, and operational principles of autonomous mobile robots and industrial robotic systems.	K2
CO2	Develop localization, mapping, navigation, and path-planning algorithms for autonomous robotic applications.	K3
CO3	Integrate sensors, embedded controllers, and ROS2 for autonomous robot control and intelligent decision-making.	K3
CO4	Analyze the performance of industrial robots and collaborative robots for smart manufacturing and service applications.	K4
CO5	Design autonomous robotic solutions for logistics, healthcare, agriculture, smart infrastructure, and industrial automation	K3

COs and POs Mapping:

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
CO1	3	1	1	1	1	-	-	-	-	-	1
CO2	3	2	1	1	1	-	-	-	-	-	1
CO3	3	2	3	2	1	-	-	-	-	-	1
CO4	2	2	3	3	1	-	-	-	-	-	2
CO5	3	2	2	2	1	-	-	-	-	-	1

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Assessment Pattern:

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	10
Understand	80	30	30
Apply	0	40	40
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

TEXT BOOKS

1. Roland Siegwart, Illah Nourbakhsh and Davide Scaramuzza, **Introduction to Autonomous Mobile Robots**, 2nd Edition, MIT Press, 2011.
2. Bruno Siciliano and Oussama Khatib (Eds.), **Springer Handbook of Robotics**, 2nd Edition, Springer, 2016.
3. Mikell P. Groover, **Automation, Production Systems, and Computer-Integrated Manufacturing**, 5th Edition, Pearson, 2020.

REFERENCE BOOKS

1. Kevin M. Lynch and Frank C. Park, **Modern Robotics: Mechanics, Planning, and Control**, Cambridge University Press, 2017.
2. Saeed B. Niku, **Introduction to Robotics: Analysis, Control, Applications**, 3rd Edition, Wiley, 2020.
3. Morgan Quigley, Brian Gerkey and William D. Smart, **Programming Robots with ROS**, O'Reilly Media.
4. Robin R. Murphy, **Introduction to AI Robotics**, MIT Press.
5. Anis Koubaa (Ed.), **Robot Operating System (ROS): The Complete Reference**, Springer.

WebLinks and Video Lectures (E-Resources):

1. Mobile Robot Systems https://www.cl.cam.ac.uk/teaching/2526/MRS/

2. https://www.youtube.com/results?search_query=LiDAR+Autonomous+Navigation

3. https://www.youtube.com/@ABBRobotics

4. https://www.youtube.com/results?search_query=Digital+Twin+Robotics

5. https://www.youtube.com/results?search_query=Autonomous+Drones

Online Courses:

1.https://nptel.ac.in/courses/112101098

2.https://nptel.ac.in/courses/106106139

Suggested Skill Activities:

Students shall complete the following laboratory and skill-oriented activities.

1. Simulate autonomous mobile robots using ROS2 and Gazebo.
2. Develop path-planning algorithms for robot navigation.
3. Implement obstacle detection and avoidance using LiDAR or ultrasonic sensors.
4. Configure ROS2 Navigation Stack for autonomous robot movement.
5. Develop robot localization using vision or sensor-based techniques.
6. Program an industrial robot simulation for pick-and-place operations.
7. Implement collaborative robot work-cell simulation.
8. Develop a digital twin dashboard for robot monitoring.
9. Analyze robot navigation performance using simulated environments.
10. Complete a mini project on an autonomous robotic solution for a real-world engineering application.

Course Code:	24 RS 701	Course Title:	AI, DIGITAL TWIN AND HUMAN–ROBOT COLLABORATION
Credits:	3	L – T – P	3 – 0 – 0
Pre-requisite			Computer Vision and Intelligent Robot Perception

Course objectives:

The course enables the students to:

1. Understand the role of Artificial Intelligence, Digital Twin, and Human–Robot Collaboration (HRC) in next-generation intelligent robotic systems and Industry 5.0.
2. Apply machine learning, reinforcement learning, and Generative AI techniques to improve robot perception, decision-making, planning, and autonomous operation.
3. Develop Digital Twin models for simulation, monitoring, predictive maintenance, and optimization of robotic systems.
4. Design safe and intelligent collaborative robotic systems integrating AI, sensors, cloud computing, and Industrial IoT technologies.
5. Develop AI-enabled robotic solutions for smart manufacturing, healthcare, logistics, agriculture, and smart infrastructure applications.

Teaching-Learning Process:

- Interactive Lectures with Industry 5.0 Case Studies
- AI-Based Robotics Demonstrations
- Hands-on Programming using Python and ROS2
- Simulation-Based Learning using Digital Twin Platforms
- Project-Based Learning
- Problem-Based Learning
- Flipped Classroom
- Industry Expert Lectures
- Collaborative Design Activities
- Mini Projects and Technical Presentations

UNIT I - ARTIFICIAL INTELLIGENCE FOR INTELLIGENT ROBOTICS	[9 hours]
Introduction to Artificial Intelligence in Robotics – Machine Learning for Robotics – Supervised and Unsupervised Learning Concepts – Reinforcement Learning Fundamentals – AI-Based Robot Perception – Intelligent Decision-Making – Motion Planning – Robot Learning from Demonstration – Generative AI for Robot Programming – Explainable AI – Applications of AI in Smart Manufacturing, Healthcare, Agriculture, Logistics, and Autonomous Systems.	

UNIT II – DIGITAL TWIN FOR ROBOTIC SYSTEMS	[9 hours]
Introduction to Digital Twin – Physical and Virtual Robot Models – Digital Thread – Digital Shadow – Digital Twin Architecture – Real-Time Data Acquisition – Sensor Integration – Robot Simulation – Virtual Commissioning – Predictive Maintenance – Performance Monitoring – Asset Lifecycle Management – Cloud-Based Digital Twins – Applications in Industrial Robotics and Smart Factories.	
UNIT III – HUMAN–ROBOT COLLABORATION	**[9 hours]**
Introduction to Collaborative Robotics – Human–Robot Interaction (HRI) – Collaborative Robots (Cobots) – Shared Workspaces – Robot Safety Standards – Human Intention Recognition – Gesture and Voice-Based Robot Control – Wearable Sensors – Ergonomics in Human–Robot Collaboration – Safety Monitoring – Collaborative Task Planning – Applications in Manufacturing, Healthcare, Rehabilitation, and Logistics.	
UNIT IV – CLOUD ROBOTICS, EDGE AI AND INTELLIGENT AUTOMATION	**[9 hours]**
Cloud Robotics – Edge AI for Robotic Systems – Industrial Internet of Things (IIoT) – Sensor Networks – Cloud-Based Robot Management – AI-Based Predictive Analytics – Multi-Robot Coordination – Swarm Robotics Concepts – Digital Manufacturing – Autonomous Inspection Systems – Smart Warehouse Automation – AI-Based Performance Optimization – Cyber Security Considerations in Collaborative Robotics.	
UNIT V – AI, DIGITAL TWIN AND HUMAN–ROBOT COLLABORATION APPLICATIONS	**[9 hours]**
AI-Enabled Smart Manufacturing – Digital Twin-Based Production Optimization – Predictive Maintenance of Robotic Systems – Healthcare and Rehabilitation Robotics – Precision Agriculture Robotics – Autonomous Logistics Systems – Construction and Infrastructure Inspection Robots – Disaster Response Robots – Smart Campus Automation – Sustainable Robotics – Ethical AI and Responsible Robotics – Engineering Case Studies and Future Trends	

Total Period:45

Course outcomes:

On completion of the course, the student will have the ability to:

CO No	Course Outcomes	Cognitive Level
CO1	Apply Artificial Intelligence techniques to enhance robot perception, planning, learning, and autonomous decision-making	K3
CO2	Develop Digital Twin models for simulation, monitoring, predictive maintenance, and performance optimization of robotic systems	K3
CO3	Design safe Human–Robot Collaboration (HRC) systems by integrating intelligent sensors, AI, and collaborative robot technologies	K3
CO4	Analyze AI-enabled robotic systems using cloud platforms, Industrial IoT, and data analytics for real-time monitoring and control	K4
CO5	Develop intelligent robotic solutions for smart manufacturing, healthcare, agriculture, logistics, and infrastructure using AI, Digital Twin, and collaborative automation.	K3

COs and POs Mapping:

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
CO1	3	1	1	1	1	-	-	-	-	-	1
CO2	3	2	1	1	1	-	-	-	-	-	1
CO3	3	2	3	2	1	-	-	-	-	-	1
CO4	2	2	3	3	1	-	-	-	-	-	2
CO5	3	2	2	2	1	-	-	-	-	-	1

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

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	Skill Assessment - II	40			
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				Total	100

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TEXT BOOKS

1. **Bruno Siciliano and Oussama Khatib (Eds.)**, *Springer Handbook of Robotics*, 2nd Edition, Springer, 2016.
2. **Kevin M. Lynch and Frank C. Park**, *Modern Robotics: Mechanics, Planning, and Control*, Cambridge University Press, 2017.
3. **Michael Grieves and John Vickers**, *Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems*, Springer.

REFERENCE BOOKS

1. **Robin R. Murphy**, *Introduction to AI Robotics*, MIT Press.
2. **Saeed B. Niku**, *Introduction to Robotics: Analysis, Control, Applications*, 3rd Edition, Wiley, 2020.
3. **Chip Huyen**, *AI Engineering: Building Applications with Foundation Models*, O'Reilly Media, 2025.
4. **Anis Koubaa (Ed.)**, *Robot Operating System (ROS): The Complete Reference*, Springer.
5. **Mikell P. Groover**, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 5th Edition, Pearson, 2020.

WebLinks and Video Lectures (E-Resources):

1.Artificial intelligence for intelligent robotics**:** https://www.youtube.com/watch?v=htjRUL3neMg

2. Machine Learning for Robotics: https://www.youtube.com/watch?v=vWI4UhNdyKM

3. Physical and Virtual Robot Models: https://www.youtube.com/watch? v=S4tvirlG8sQ

4. Introduction to Collaborative Robotics: https://www.youtube.com/watch?v=u-_CTwx_ki8

5. Industrial Internet of Things (IIoT): https://www.youtube.com/watch?v=HmbUJEShA-8&t=151s

Online Courses:

1.https://nptel.ac.in/courses/106105195

2. https://nptel.ac.in/courses/106107001

Suggested Skill Activities:

Students shall complete the following laboratory and skill-oriented activities.

1. Develop AI-based robot decision-making algorithms using Python.
2. Simulate a robotic system using a Digital Twin platform.
3. Create a Digital Twin dashboard for robot performance monitoring.
4. Develop a collaborative robot work-cell simulation.
5. Implement gesture- or voice-based robot control using AI libraries.
6. Integrate ROS2 with cloud services for robot monitoring.
7. Analyze predictive maintenance data for robotic equipment.
8. Simulate multi-robot coordination for warehouse automation.
9. Design an AI-assisted collaborative robotic system for an engineering application.
10. Complete a mini project on AI, Digital Twin, or Human–Robot Collaboration for a real-world industrial problem.

Course Code:	24 RS 702	Course Title:	ROBOTICS APPLICATIONS IN SMART ENGINEERING SYSTEMS
Credits:	**3**	**L – T – P**	**0 – 0 – 6**
Pre-requisite			AI, Digital Twin and Human–Robot Collaboration

Course objectives:

The course enables the students to:

1. Apply robotics, Artificial Intelligence, computer vision, embedded systems, and autonomous navigation technologies to solve multidisciplinary engineering problems.
2. Design and develop intelligent robotic systems for smart manufacturing, healthcare, agriculture, logistics, infrastructure, and environmental monitoring.
3. Integrate Robot Operating System (ROS2), intelligent sensors, cloud platforms, and Digital Twin technologies to develop real-time robotic applications.
4. Evaluate robotic system performance through simulation, testing, validation, safety assessment, and optimization using industry-standard tools.
5. Demonstrate professional competency by developing an industry-oriented robotic prototype addressing real-world engineering and societal challenges.

Teaching-Learning Process:

- Project-Based Learning
- Design Thinking Approach
- Challenge-Based Learning
- Hands-on Robotics Laboratory
- Simulation-Based Learning
- Industry Case Studies
- Collaborative Team Projects
- Industry Expert Sessions
- Technical Reviews and Demonstrations
- Capstone Project Presentation

UNIT I - ROBOTICS FOR SMART MANUFACTURING AND INDUSTRIAL AUTOMATION	[9 hours]
Industry 5.0 and Smart Manufacturing – Flexible Manufacturing Systems – Collaborative Robots (Cobots) – Automated Guided Vehicles (AGVs) – Autonomous Mobile Robots (AMRs) – Material Handling Robots – Automated Inspection Systems – Vision-Based Quality Control – Predictive Maintenance – Human–Robot Collaboration – Digital Manufacturing – Industrial Case Studies.	

UNIT II – ROBOTICS FOR SMART INFRASTRUCTURE, TRANSPORTATION AND CONSTRUCTION	[9 hours]
Infrastructure Inspection Robots – Bridge and Tunnel Inspection – Construction Robotics – Autonomous Surveying Systems – Building Information Modelling (BIM) Integration – Smart Building Automation – Intelligent Transportation Systems – Autonomous Delivery Robots – Road and Railway Inspection Robots – Disaster Response Robotics – Environmental Monitoring – Smart City Applications.	
UNIT III – ROBOTICS FOR HEALTHCARE, AGRICULTURE AND SERVICE APPLICATIONS	**[9 hours]**
Healthcare Service Robots – Rehabilitation Robotics – Telepresence Robots – Autonomous Medicine Delivery – Precision Agriculture Robots – Crop Monitoring – Smart Irrigation Systems – Agricultural Drones – Livestock Monitoring – Service Robots – Hospitality and Retail Robotics – Educational Robotics – Assistive Robotics – Sustainable Development Applications.	
UNIT IV – AI, DIGITAL TWIN AND CLOUD ROBOTICS APPLICATIONS	**[9 hours]**
Artificial Intelligence for Robotics – Computer Vision-Based Robotic Applications – Cloud Robotics – Edge AI – Digital Twin for Robot Monitoring and Simulation – Industrial Internet of Things (IIoT) Integration – Multi-Robot Coordination – Swarm Robotics – Human–Robot Collaboration – Cyber Security for Robotic Systems – Ethical AI and Responsible Robotics – Engineering Case Studies.	
UNIT V – – CAPSTONE PROJECT: ROBOTICS SOLUTIONS FOR SMART ENGINEERING SYSTEMS	**[9 hours]**
Problem Identification – Requirement Analysis – Literature Survey – System Design – Robot Selection – Sensor and Actuator Integration – ROS2-Based Programming – AI Model Development – Simulation and Prototype Development – Testing and Validation – Performance Evaluation – Technical Documentation – Demonstration – Project Presentation – Viva Voce.	

Total Period:45

Course outcomes:

On completion of the course, the student will have the ability to:

CO No	Course Outcomes	Cognitive Level
CO1	Analyze engineering problems and identify suitable robotic technologies for intelligent automation and autonomous operation.	K4
CO2	Develop robotic systems integrating AI, computer vision, ROS2, embedded controllers, and intelligent sensors for engineering applications.	K6
CO3	Implement autonomous navigation, perception, communication, and control strategies for smart robotic systems.	K3
CO4	Evaluate robotic system performance, reliability, safety, and operational efficiency using simulation and real-time testing.	K5
CO5	Design, develop, and demonstrate an innovative robotics solution that addresses industrial or societal challenges in smart engineering systems.	K6

COs and POs Mapping:

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
CO1	3	1	1	1	1	-	-	-	–	-	1
CO2	3	2	1	1	1	-	-	-	–	-	1
CO3	3	2	3	2	1	-	-	-	–	-	1
CO4	2	2	3	3	1	-	-	-	–	-	2
CO5	3	2	2	2	1	-	-	-	–	-	1

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

TEXT BOOKS

1. **Bruno Siciliano and Oussama Khatib (Eds.)**, *Springer Handbook of Robotics*, 2nd Edition, Springer, 2016.
2. **Kevin M. Lynch and Frank C. Park**, *Modern Robotics: Mechanics, Planning, and Control*, Cambridge University Press, 2017.
3. **Mikell P. Groover**, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 5th Edition, Pearson, 2020.

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2. **Robin R. Murphy**, *Introduction to AI Robotics*, MIT Press.
3. **Anis Koubaa (Ed.)**, *Robot Operating System (ROS): The Complete Reference*, Springer.
4. **Roland Siegwart, Illah Nourbakhsh and Davide Scaramuzza**, *Introduction to Autonomous Mobile Robots*, 2nd Edition, MIT Press.
5. **Chip Huyen**, *AI Engineering: Building Applications with Foundation Models*, O'Reilly Media, 2025.

WebLinks and Video Lectures (E-Resources):

1. https://new.abb.com/products/robotics
2. https://www.ieee-ras.org/
3. https://www.who.int/health-topics/digital-health
4. https://www.edge-ai-vision.com/
5. https://www.raspberrypi.com/

Online Courses:

1. https://nptel.ac.in/courses/108107589

2. https://www.coursera.org/courses?query=robotics&utm

Suggested Skill Activities:

Students shall complete **one major project** and **two mini projects** based on real-world engineering applications.

Mini Skill Activities

1. Design and simulate an autonomous mobile robot using ROS2 and Gazebo.
2. Develop a computer vision-based robotic inspection system.
3. Build a robotic application integrating intelligent sensors and embedded controllers.
4. Implement autonomous navigation with obstacle avoidance.
5. Develop a Digital Twin dashboard for monitoring robotic systems.
6. Program a collaborative robot workcell for industrial automation.
7. Integrate cloud services with robotic systems for remote monitoring.
8. Design an AI-based predictive maintenance solution for robotic equipment.
9. Evaluate robotic system safety and performance using simulation tools.
10. Present project outcomes through technical reports and demonstrations.

CAPSTONE PROJECT DOMAINS

Students shall undertake projects in any one of the following domains.

Civil Engineering

- Autonomous Bridge Inspection Robot
- Smart Building Inspection Robot
- Construction Site Monitoring Robot
- Autonomous Surveying Robot

Electrical and Electronics Engineering

- Smart Grid Inspection Robot
- Autonomous Power Line Inspection Robot
- Renewable Energy Plant Monitoring Robot
- Industrial Automation Robot

Computer Science / Artificial Intelligence / Information Technology

- Warehouse Automation Robot
- AI-Based Autonomous Mobile Robot
- Computer Vision-Based Inspection Robot
- Multi-Robot Coordination System

Biomedical Engineering

- Hospital Delivery Robot
- Rehabilitation Robot
- Telemedicine Assistance Robot
- Intelligent Healthcare Monitoring Robot

Agricultural Engineering

- Precision Agriculture Robot
- Autonomous Crop Monitoring Robot
- Smart Irrigation Robot
- Agricultural Drone-Based Monitoring System

Multidisciplinary Projects

- Smart Campus Service Robot
- Disaster Response Robot
- Autonomous Waste Collection Robot
- Environmental Monitoring Robot
- Search and Rescue Robot
- Intelligent Logistics and Warehouse Robot