Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

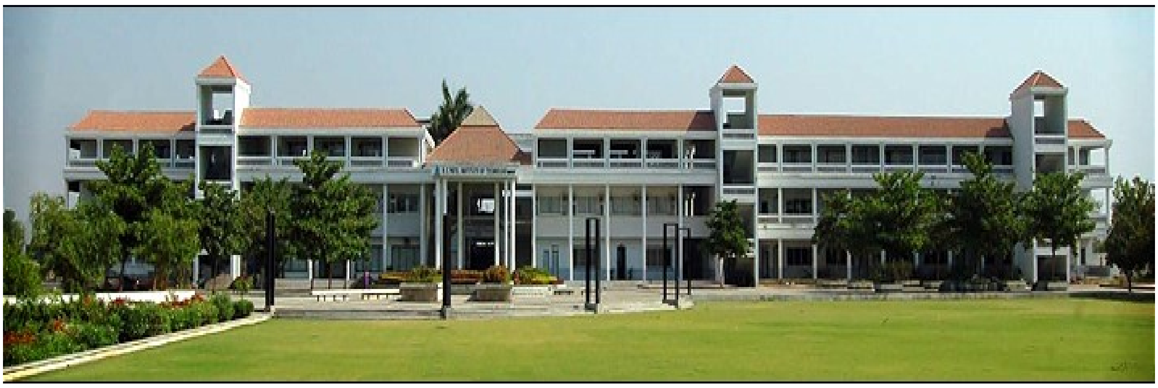
(An Autonomous Institute)

Honours Program in Electrical Engineering

Robotics

Electrical Engineering

with effect from Academic Year 2025-26



Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405
Ph. No.: 02563 259 802, web: www.rcpit.ac.in

Vision of the Institute

To become a leading Institute in Technical education fostering innovation, research, ethical values, and sustainable development for the betterment of society.

Mission of the Institute

To impart high quality Technical Education through:

- **M1:** Innovative and Interactive learning process and high quality, globally recognized instructional programs.
- **M2:** Fostering a collaborative scientific temper among students with ethical responsibility towards the society.
- **M3:** Preparing students from diverse backgrounds to have aptitude for employment, entrepreneurship and research with a spirit of professionalism.
- **M4:** To contribute to the nation's sustainable development.

Vision of the Electrical Engineering Department

To produce competent Electrical Engineers committed to innovation, sustainability and service to society.

Mission of the Electrical Engineering Department

- **M1:** Deliver innovative, interactive learning fostering excellence in Electrical Engineering and emerging technologies.
- **M2:** Cultivate scientific inquiry, ethical responsibility, and interdisciplinary collaboration to address energy, automation, and societal challenges.
- **M3:** Empower diverse students with skills for employment, entrepreneurship, and research, nurturing professionalism and lifelong learning.

Program Educational Objectives

The educational objectives of the Undergraduate Programmes of Electrical Engineering are:

- **PEO1:** Graduates will apply electrical engineering knowledge and innovation to solve complex industrial and societal problems.
- **PEO2:** Graduates will demonstrate ethical leadership and collaborate across disciplines to promote sustainable and inclusive development.
- **PEO3:** Graduates will pursue careers in employment, entrepreneurship, or research, embracing professionalism and lifelong learning.

R. C. Patel Institute of Technology, Shirpur
SES
Autonomous

Electrical Engineering Honours Track- 2
Robotics

S.N.	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credits	
							Continuous Assessment (CA)							
							TA	Term Test-I (TT-I)	Term Test-II (TT-II)	Average of TT-I and TT-II	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
Semester-IV														
1	H	RCP23LH2251	Introduction to Robotics and Its Application	4			25	15	15	15	60	100	4	4
Semester-V														
2	H	RCP23LH2301L	Robotics Laboratory-I			4	25				25	50	2	2
Semester-VI														
3	H	RCP23LH2351L	Modelling and Design of Robotics	3			25	15	15	15	60	100	3	4
	H	RCP23LH2351L	Robotics Laboratory-II			2	25				25	50	1	
4	H	RCP23LH2352	Advanced Robotics	3			25	15	15	15	60	100	3	4
	H	RCP23LH2352L	Robotics Laboratory-III			2	25				25	50	1	
Semester-VII														
5	H	RCP23LH2401L	AI and ML for Robotics	4			25	15	15	15	60	100	4	4
			Total	**14**		**8**	**175**			**60**	**315**	**550**		**18**

Prepared by
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Checked by
Dr. Nadeem Akhtar

BOS Chairman
Dr. S. A. Patil

Dean Academic/Dy. Director
Prof. Dr. P. J. Deore

C.O.E.
Prof. S. P. Shukla

Director
Prof. Dr. J. B. Patil

Program: Electrical Engineering	Honours Track- 2	Semester: IV
Introduction to Robotics and Its Applications (RCP23LH2251)		

Prerequisite: Sensors, motor and drives, control system.

Course Objective(s):

1. To impart knowledge of the fundamental concepts of robotics in the modern-day world from the olden days.
2. Make the student know the anatomical structure of the fixed and mobile robots with actuating systems.
3. To develop the student's knowledge in various types of sensors & its applications.
4. Making the robotic system to know how to do robotic manipulation using different types of end- effectors, viz., the tools and grippers.
5. To introduce the basic principles, techniques, state of art techniques in robot programming with control strategies.
6. Make the learner know about the different types of applications of robots in the modern-day world.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the basic structure of robots with their mathematical interpretations in the 3- dimensional analysis.	L2	Understand
CO2	Explain the kinematic analysis while doing the PNPO.	L2	Understand
CO3	Apply the knowledge of mathematics in developing all possible solutions to the inverse kinematic analysis while doing the PNPO.	L3	Apply
CO4	Analyze the area in which the robot can do the effective PNPO with a well-defined optimized shortest path trajectory.	L4	Analyze
CO5	Evaluate the performance of difference learning schemes used for solving a typical robotic application using AI concepts.	L5	Evaluate
CO6	Create a typical robotic application to solve any type of automated works without human intervention.	L6	Create

Introduction to Robotics and Its Applications (RCP23LH2251) Course Contents

Unit-I 09 Hrs.

Introduction to Robotics: Introduction to automation & its types, History and evolution of robotics, Definition of robots, Robotic manipulators, Types of robots, Generations of robots, Laws of robotics, Classification of robots and its applications in engineering sector, Difference human hand and robot hands, Robot joints and links, Serial chain and closed chain manipulators, Need for robots in the modern-day world, Specifications of robots.

Unit-II 09 Hrs.

Robot Anatomy: Anatomy of robots, Drive systems, Actuators and Power Transmission systems, Types of drives and its applications, Hydraulic drives, Pneumatic drives, Electric drives, Hybrid drives, Basic control system design for actuations, Robot activation and feedback components, Types of actuators, Applications of drives in robotics, Types of control for robot movements, Types of motion and its interpretations.

Unit-III 10 Hrs.

Sensors in robotics: Touch Sensors, Tactile Sensors, Proximity and Range Sensors, Sensor Based Systems, Force Sensors, Light sensors, Pressure sensors, Ultrasonic sensors, Infra-red sensors, Pots, Encoders, Position and Velocity Sensors, Vision systems and Equipments, Introduction to Machine vision and Computer vision for robotic systems, Interceptive sensors and Exteroceptive sensors, Sensor integration, calibrations and its performance, Applications of each sensor, A case study for sensory feedback design for a particular application.

Unit-IV 10 Hrs.

Articulated Mechanical System: Materials used for robot design and its properties, Transmission devices in robots and its types, End effectors, Types of end effectors, Tools and Grippers, Classification of tools and grippers, Types of tool and gripper actuations, Gripper selection for particular application, Gripper design, Robot wrist mechanisms, Spherical wrists and non spherical wrists, Purpose and need for grippers, A case study for gripper design for a particular.

Unit-V 09 Hrs.

Robot Controllers and Programming: Robot brain, Controller and its types, Need for controller in robots, Robot simulation, Robot software, Robot Programming and the Languages, Types of robot programming, Industrial robot programming, Job scenario in industrial robot programming, Motion commands in some languages, On-line and Off-line programming of robots, A case study of a typical robot programming for a particular application (Say, Python or Matlab or Simulink or any other language)

Unit-VI 09 Hrs.

Robot Applications: Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defence, Rehabilitation, Disaster management, Microbots and Nanorobots, Social, Environmental and economic issues in robot applications, Advantages and Disadvantages of Robotization, Use of IoT application in Robotics and Automation, Future Applications and Trends in Robotics.

Text Books:

1. T. C. Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005.
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Mac Graw Hill, Singapore, 3rd Edn., 2017.
3. T. C. Manjunath, “Fast Track to Robotics”, Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, “Robotics: Control Sensing Vision & Intelligence”, Mac Graw Hill, USA, 5th Edition, 2010.
5. Robin R. Murphy, “Introduction to AI and Robotics”, MIT Press, Second Edition, 648 pp., Oct. 2019.

Reference Books:

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2. S R Deb, “Robotic technology and Flexible Automation”, TMH.
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6. Ed. A Pugh, “Robot Technology”, Peter Peregrinus Ltd. IEE, UK.
7. Ed. Shimon, “Handbook of Industrial Robotics”, John Wiley
8. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, US

9. Robert Schilling, “Fundamentals of Robotics – Analysis & Controls”, Prentice Hall Inc, India.

10. P. A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

Program: Electrical Engineering	Honours Track- 2	Semester: V
Robotics Laboratory-I (RCP23LH2301L)		

Prerequisite: Python Programming, Matlab Programming and Simulink, C/C++, Java, LabVIEW.

Course Objective(s):

1. To know the basic programming skills to develop simulations for workspace of a robot arm.
2. To know the basic programming skills to develop simulations for pick and place applications.
3. To know the basic programming skills to develop simulations to develop the graphical representation of the robot arm.
4. To know the basic programming skills to develop simulations for simulating the different types of robot work envelopes.
5. To equip students with the skills to graphically simulate and analyze various types of robotic arms in both 2D and 3D views, providing a strong foundation in understanding robotic kinematics and workspaces.
6. To enable students to implement and simulate practical robotic operations such as pick-and-place tasks and screw transformations.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Simulate and analyze the kinematic behavior of various robotic arm configurations (Planar Articulated, Cylindrical, Rectangular, Polar, SCARA) in both 2D and 3D views.	L4	Analyze
CO2	Determine the workspace of different robotic arms graphically and numerically, enhancing understanding of reach and motion capabilities.	L3	Apply
CO3	Develop proficiency in simulating robotic control systems using Simulink, enabling them to observe and evaluate the dynamic response of robots to control inputs.	L5	Evaluate
CO4	Apply practical skills in programming and executing pick-and-place operations with Planar Articulated and SCARA robotic arms, demonstrating their application in real-world scenarios.	L3	Apply
CO5	Use screw transformations, threading, and unthreading operations, deepening their comprehension of complex robotic motions and transformations.	L3	Apply
CO6	Apply experience with graphical simulation software, reinforcing theoretical concepts through practical applications and enhancing their problem-solving skills in robotics.	L3	Apply

Robotics Laboratory-I (RCP23LH2301L)

List of Laboratory Experiments

Suggested Experiments:

Group A: Study-Type Experiments (Theoretical and Conceptual Learning)

1. Orientation to the laboratory course – Programming skills and concepts
2. Study of Drive Systems and Motion Control
3. Sensor Integration and Feedback Control Design
4. Kinematic Analysis of Robotic Manipulators
5. Robot Gripper Design and Application

Group B: Simulation and Analysis Experiments (Python/ MATLAB/ Simulink, etc.)

1. Program-1: Graphical simulation of a 3-axis planar articulated robot arm (PARA) (2D and 3D View)
2. Program-2: Graphical simulation of 3-axis cylindrical coordinate robot arm and its work space of cylindrical robot (2D and 3D View)
3. Program-3: Graphical representation of a 3-axis Rectangular Coordinate Robot arm (2D and 3D View)
4. Program-4: Graphical representation of a 3-axis Polar Coordinate Robot arm (2D and 3D View)
5. Program-5: Graphical representation of a 4-axis SCARA Robot arm (2D and 3D View)
6. Program-6: Pick and place operation using a 3-axis planar articulated robot arm
7. Program-7: Pick and place operation using a 4-axis SCARA Robot arm
8. Program-8: Determination of horizontal and Vertical reach of cylindrical coordinate robot with graphical and numerical simulations.
9. Program-9: Program to develop Screw Transformations (ST), threading of a screw and un-threading of a screw

Group C: Assignments based on syllabus, Mini project or case study/literature-based seminar/presentation

1. Open ended experiment
   Students should make a robot model bringing components from outside with motors, wheels, Arduino board, battery (power supply), wheels, ultrasonic sensors (obstacle detection and avoidance), connecting wires, links, screws, gripper, etc... to make the student know the practical aspects of how a robot looks like (similar to doing any type of mini-project).

8 experiments from the above-suggested list or any other experiments based on syllabus can be included to be performed in 10 weeks with the first week orientation, the last week internal test and the repetitions, which would take 13 weeks and which would help the learner to apply the concept learnt. Assignments based on syllabus, Mini project or case study/literature-based seminar/presentation relevant to the subject may be included, which would help the learner to apply the concept learnt.

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2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Mac Graw Hill, Singapore, 3rd Edn., 2017.
3. T. C. Manjunath, “Fast Track to Robotics”, Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, “Robotics: Control Sensing Vision and Intelligence”, Mac Graw Hill, USA, 5th Edition, 2010.
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3. Yoram Koren, “Robotics for Engineers”, Mc Graw hill.
4. Larry Health, Fundamentals of Robotics, Reston Pub Co.
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10. P. A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

Program: Electrical Engineering	Honours Track- 2	Semester: VI
Modelling and Design of Robotics (RCP23LH2351)		

Prerequisite: vector algebra.

Course Objective(s):

1. To impart knowledge of the fundamental concepts of robotics and its mathematical interpretations in 3- dimensional analysis.
2. Make the student to develop the direct kinematic and inverse kinematic model for successful robotic manipulation
3. Make the student to develop the inverse kinematic model for successful robotic manipulation to do a PNP operation.
4. To develop the student's knowledge in various robot structures to work effectively in its workspace.
5. Making the robotic system to follow a well-defined trajectory from source to destination during manipulation.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate a clear understanding of the fundamental concepts of robotics, including the ability to mathematically interpret robotic motions in three-dimensional space.	L2	Understand
CO2	Construct direct kinematic models and analyze them to describe the motion of robotic systems accurately.	L4	Analyze
CO3	Design and implement inverse kinematic models to achieve successful robotic manipulation for tasks such as pick-and-place (PNP) operations.	L6	Create
CO4	Evaluate and compare various robotic structures and configurations to optimize their performance within specified workspaces.	L5	Evaluate
CO5	Design and implement robotic systems capable of following well-defined trajectories from source to destination during manipulation tasks.	L6	Create

Modelling and Design of Robotics (RCP23LH2351) Course Contents

Unit-I — 08 Hrs.

Modelling of robots: An introduction (Kinematic and dynamical models), Design of Robots – An introduction (Kinematic and dynamical design), Mathematical Notations and Symbols, Coordinate Frames and its different types of Transformations with matrices, Coordinate Transformations, Rotations and Translations.

Unit-II — 09 Hrs.

Robot Direct / Forward Kinematics Modelling and Design: Introduction to robot arm direct kinematics, Kinematic model, Kinematic parameters (Joint and Link parameters), General Link Coordinate Transformation matrix, Kinematic Parameter Table (KPT), DH Algorithm, Direct Kinematic model of 1 axis robot, Direct Kinematic model of 2 axis robot.

Unit-III — 09 Hrs.

Robot Inverse / Backward Kinematics Modelling and Design: Introduction to robot inverse kinematics problems, Definition of IK, Inverse kinematic model, Tool Configuration Vector (TCV), Inverse Kinematic model of 1 axis robot, Inverse Kinematic model of 2 axis robot.

Unit-IV — 08 Hrs.

Robot Work Space Analysis Modelling and Design: Work space, Definition, Work space envelope, Definition, Types of work envelopes, Types of work space envelopes, Joint space work envelope design, Total work envelope design, Dexterous work envelope design, Work space analysis of 1 axis robot, Work space analysis of 2 axis.

Unit-V — 08 Hrs.

Robot Trajectory Planning Modelling and Design: Robot Path, Robot Trajectory, Shape of trajectory, Speed Distribution Functions(SDF), Types of robot motions, Pick and Place trajectory design, Point to Point trajectory design, Interpolated trajectory design, Piecewise linear interpolated trajectory design, Cubic polynomial path and trajectory.

Unit-VI — 09 Hrs.

Robot Applications: Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defence, Rehabilitation, Disaster management, Microbots and Nanorobots, Social, Environmental and economic issues in robot applications, Advantages and Disadvantages of Robotization, Use of IoT application in Robotics and Automation, Future Applications and Trends in Roboti

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9. Robert Schilling, “Fundamentals of Robotics – Analysis and Controls”, Prentice Hall Inc, India.
10. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

Program: Electrical Engineering	Honours Track- 2	Semester: VI
Robotics Laboratory-II (RCP23LH2351L)		

Prerequisite: Python Programming, Matlab Programming and Simulink, C/C++, Java, LabVIEW.

Course Objective(s):

1. To know the basic programming skills to develop simulations for workspace of a robot arm.
2. To know the basic programming skills to develop simulations for pick and place applications.
3. To know the basic programming skills to develop simulations to solve direct kinematics problems.
4. To know the basic programming skills to develop simulations for solving inverse solution problems.
5. To know the basic programming skills to develop simulations for finding the routes form source to destination by searching paths in the 2D environment.
6. To know the basic programming skills to develop simulations for simulating the different types of robot work envelopes.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Design and simulate the workspace of a robotic arm, visualizing its reach and operational limits in a 3D environment.	L6	Create
CO2	Execute pick-and-place operations in a simulated environment, ensuring smooth and accurate object handling.	L3	Apply
CO3	Demonstrate the ability to simulate and solve direct kinematics problems, determining the end-effector position from given joint parameters.	L3	Apply
CO4	Analyze inverse kinematics, enabling the determination of joint configurations for specific end-effector positions.	L4	Analyze
CO5	Simulate robotic path planning in 2D environments and visualizing various robot work envelopes for optimized task execution.	L6	Create
CO6	Design and implement simulations that effectively utilize path-planning algorithms to identify optimal routes from a source to a destination in a 2D environment, ensuring obstacle avoidance and efficient navigation.	L6	Create

Robotics Laboratory-II (RCP23LH2351L)

List of Laboratory Experiments

Suggested Experiments:

Group A: Study-Type Experiments (Theoretical and Conceptual Learning)

1. Program to study the work space of a 3-axis Cylindrical Coordinate Articulated robot arm
2. Program to study the work space of a 3-axis Planar Articulated robot arm
3. Program to study the work space of a 3-axis Rectangular Articulated robot arm
4. Program to study the work space of a 3-axis Polar-Spherical Coordinate Articulated robot arm
5. Program to study the work space of a 3-axis SCARA robot arm

Group B: Simulation and Analysis Experiments (Python/ MATLAB/ Simulink, etc.)

1. Work-space analysis of a 4-axis SCARA robot arm
2. Direct Kinematic Analysis of a 4-axis SCARA robot arm
3. Inverse Kinematic Analysis of a 4-axis SCARA robot arm
4. Graphical simulation of a cylindrical coordinate robot arm (2D and 3D View)
5. Graphical simulation of any one type of robot arm (2D and 3D View), either a rectangular or cylindrical or polar or articulated robot arm.
6. Work Space Envelope of 3-axis Cartesian coordinate robot
7. Work Space Envelope of 3-axis Polar coordinate robot.
8. Robot Path Planning using General Voronoi Diagram (GVD) methods – generation of path from source to goal (2D)
9. Trajectory-planning (linear interpolation) from source to goal.
10. Development of a program to show Bounded Deviation Algorithm for achieving straight line motion in the TCS.

Group C: A case study or seminar report

8 experiments from the above-suggested list or any other experiments based on syllabus can be included to be performed in 10 weeks with the first week orientation, the last week internal test and the repetitions, which would take 13 weeks and which would help the learner to apply the concept learnt. Assignments based on syllabus, Mini project or case study/literature-based seminar/presentation relevant to the subject may be included, which would help the learner to apply the concept learnt.

Text Books:

1. T. C. Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005.
2. Kenneth Lambert, “Fundamentals of Python: Data Structures”, Cengage Learning PTR (2013).
3. Gowrishankar S, Veena A, “Introduction to Python Programming”, 1st Edition, CRC Press/ Taylor & Francis, 2018. ISBN-13: 978-0815394372.
4. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015.

Web References::

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://nptel.ac.in/courses/115/104/115104095/
3. https://www.edx.org/learn/python
4. https://www.coursera.org/courses?query=python

R. C. Patel Institute of Technology, Shirpur
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Program: Electrical Engineering	Honours Track- 2	Semester: VI
Advanced Robotics (RCP23LH2352)		

Prerequisite: vector algebra, integration, differentiation and numerical methods, matrix theory.

Course Objective(s):

1. To impart knowledge of the fundamental concepts of machine-to-machine interactions.
2. Make the student to develop the knowledge in flexible manufacturing systems.
3. To develop the student's knowledge in developing various types of robot structures w.r.t. handicapped persons.
4. Making the robotic system to know the behaviour of robots in the external environments.
5. Objective of this module is to introduce the basic principles, techniques, state of art techniques in the development of microbots and nanobots.
6. Learn the different replicas of humans w.r.t. the 2-legged walking mechanism and their working natures.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate an understanding of the fundamental principles and technologies underlying machine-to-machine interactions in robotic systems.	L2	Understand
CO2	Analyze and develop strategies for implementing flexible manufacturing systems to optimize production efficiency and adaptability.	L4	Analyze
CO3	Develop robotic structures tailored to assist handicapped individuals, addressing diverse needs and functionalities.	L6	Create
CO4	Evaluate and model the behaviour of robotic systems in external and dynamic environments, ensuring adaptability and precision in diverse scenarios.	L5	Evaluate
CO5	Apply advanced principles to the design and functioning of microbots and nanobots, as well as develop and analyze robotic replicas of humans, focusing on two-legged walking mechanisms and their working dynamics.	L3	Apply

Advanced Robotics (RCP23LH2352)
Course Contents

Unit-I **08 Hrs.**

Factory automation: Large-scale machine to machine communication (M2M), Factory automation, Industry 4.0, Automated robotic drones, Healthcare robots, Autonomous cars, Robots in educational sectors, Robotics in public and national security, Speaking robots, Surveillance machines, Cybernetics, Human-robot interactions, micro aerial vehicles.

Unit-II **09 Hrs.**

Flexible Manufacturing Systems: FMS definition and classification of flexible manufacturing systems, automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement, FMS Equipments, Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS.

Unit-III **09 Hrs.**

Cognitive Robotics: Cognitive robotics, Robotic exoskeletons, Artificial Legs and Limbs, Remote Surgery, Orthesis, Telethesis, Surgical robots doing surgery, Robots working together, Interactive robotics, Co-operative robotics, Farming robots for agricultural applications, IoT and Robotics for different applications.

Unit-IV **08 Hrs.**

manipulator Interaction: Interaction of manipulator with the environment, Flexibots and Flexible Robotics, CAD CAM and CIM, Human centered robotics, complex robotic systems, Soccer robotics, Advanced perceptions for intelligent robots, Composite Materials for Robotic Applications, Case study.

Unit-V **08 Hrs.**

Applications: Microbots and Nanobots, Applications, Surgical Applications in Medicine, Modelling of a typical Microbots and Nanobots, Parameters for nanorobot design, Simulation tools for designing nanorobots, Cancer treatment cure using nanobots, Corona detection using nanorobots, Micro-surgical tools, Drug delivery pellets, Nano sensors.

Unit-VI **09 Hrs.**

Robot Applications: Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defence, Rehabilitation, Disaster management, Microbots and Nanorobots, Social, Environmental and economic issues in robot applications, Advantages and Disadvantages of Robotization, Use of IoT application in Robotics and Automation, Future Applications and Trends in Robotics.

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1. T. C. Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005.
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3. Robotics for Engineers, Yoram Koren, Mc Graw hill.
4. Fundamentals of Robotics, Larry Health.
5. Robot Analysis and Control, H Asada, JJE Slotine.
6. Robot Technology, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK.
7. Handbook of Industrial Robotics, Ed. Shimon. John Wiley
8. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, US
9. Fundamentals of Robotics – Analysis and Controls, Robert Schilling, Prentice Hall Inc, India.
10. Robotics – Amitabh Bhattacharya
11. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995

Program: Electrical Engineering	Honours Track- 2	Semester: VII/VIII
Robotics Laboratory-III (RCP23LH2401L)		

Prerequisite: Python Programming, Matlab Programming and Simulink, C/C++, Java, LabVIEW.

Course Objective(s):

1. To know the basic programming skills to develop simulations for workspace of a robot arm.
2. To know the basic programming skills to develop simulations for pick and place applications.
3. To know the basic programming skills to develop simulations to solve direct kinematics problems.
4. To know the basic programming skills to develop simulations for solving inverse solution problems.
5. To know the basic programming skills to develop simulations for finding the routes form source to destination by searching paths in the 2D environment.
6. To know the basic programming skills to develop simulations for simulating the different types of robot work envelopes.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Evaluate the role of M2M communication in Industry 4.0 and propose applications for real-time connectivity and decision-making in smart factories.	L5	Evaluate
CO2	Explain the classification and measurement of flexibility in FMS and its impact on production efficiency and customization.	L2	Understand
CO3	Explain sensor integration, material properties, and design principles in advanced robotic systems, including healthcare robotics and nanobots.	L2	Understand
CO4	Create simulations to solve inverse kinematics for determining robot joint configurations corresponding to desired end-effector positions.	L6	Create
CO5	Develop simulations for robotic path planning and workspace visualization in 2D environments.	L6	Create
CO6	Design and implement simulations using path-planning algorithms for optimal 2D robot navigation with obstacle avoidance.	L6	Create

Robotics Laboratory-III (RCP23LH2401L)

List of Laboratory Experiments

Suggested Experiments:

Group A: Study-Type Experiments (Theoretical and Conceptual Learning)

1. Comparative Study of M2M Communication in Industry 5.0
2. Analysis of Flexibility in Flexible Manufacturing Systems (FMS)
3. Study of Sensors and Materials in Advanced Robotics
4. Case Study on Healthcare Robotics
5. Theoretical Design and Analysis of Microbots and Nanobots

Group B: Simulation and Analysis Experiments (Python/ MATLAB/ Simulink, etc.)

1. To develop the work-space model, trajectory planning and a pick-place operation of a four axis SCARA robot arm.
2. To do the DK and IK of a four axis SCARA robot arm.
3. To develop the work-space model, trajectory planning and a pick-place operation of a three-axis planar articulated robot arm.
4. To do the DK and IK of a three-axis planar articulated robot arm.
5. To develop the work-space model, trajectory planning and a pick-place operation of a two-axis planar articulated robot arm.
6. To do the DK and IK of a two-axis planar articulated robot arm.
7. Graphical simulation of any one type of robot arm (2D and 3D View), either a rectangular or cylindrical or polar or articulated robot arm.
8. Design a Robot Path Planning, i.e., the generation of path from source to goal (2D) using configuration space method, General Voronoi Method, Dijkstra's methods.
9. Design a robotic path, i.e., do the Interpolation using parabolic blends and Trajectory-planning (linear interpolation) from source to goal for the movement of the robot.
10. Write a program to find the coordinates of the point p w.r.t. F frame given the coordinates of the point p w.r.t. M frame with both rotations and translations, i.e., both.
11. Write a program to develop the graphical display of the link coordinate diagram (LCD) of a 2-axis PARA, 3-axis PARA and a 4-axis SCARA robot arm.

12. Develop a program to develop Screw Transformations (ST) and to show the navigation through obstacles using Shortest Path from source to goal along with the Bounded Deviation Algorithm for achieving straight line motion in the TCS.

Group C: A case study or seminar report

A minimum of six experiments from the above-suggested list or any other experiment based on syllabus may be included, which would help the learner to apply the concept learnt. A case study or seminar report relevant to the topics may be included, which would help the learner to apply the concept learnt.

Text Books:

1. T. C. Manjunath, "Fundamentals of Robotics", Nandu Publishers, 5th Edn., India, 2005.
2. Kenneth Lambert, "Fundamentals of Python: Data Structures", Cengage Learning PTR (2013).
3. Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372.
4. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015.

Web References::

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://nptel.ac.in/courses/115/104/115104095/

Program: Electrical Engineering	Honours Track- 2	Semester: IV
AI and ML for Robotics (RCP23LCH2402)		

Prerequisite: AIML, image processing, logical thinking.

Course Objective(s):

1. To impart knowledge of the use of Artificial Intelligence in solving robotic problems.
2. Make the student understand different types of machine learning approaches in robotics.
3. To develop the different types of motion planning techniques to find the paths in the space.
4. Making the robotic system know how to solve the given task using task planners.
5. To introduce the student to know the fundamental concepts lying under the robotic vision.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate the ability to utilize Artificial Intelligence techniques to address and solve complex robotic problems effectively.	L3	Apply
CO2	Analyze and differentiate between various machine learning approaches and apply them in the context of robotics for enhanced decision-making and autonomy.	L4	Analyze
CO3	Design and implement motion planning algorithms to determine efficient paths for robotic systems in three-dimensional space.	L6	Create
CO4	Apply task planning methodologies to enable robotic systems to autonomously solve given tasks with precision and adaptability.	L3	Apply
CO5	Apply knowledge of the foundational principles of robotic vision, enabling robots to interpret and interact with their environments.	L3	Apply

AI and ML for Robotics (RCP23LCH2402)
Course Contents

Unit-I 11 Hrs.

AI in Robotics: Human Intelligence, Artificial Intelligence, Definition, Types of Artificial Intelligence, Goals of AI, Tenets of AI, Applications of AI, Problem representation in AI, Knowledge representation and Reasoning, Intelligent Agents, Swarm Intelligence, Distributed Intelligence, Imitation learning, Multi agent learning, Project based learning, Artificial Neural Networks, Convolution Neural Networks, Recurrent Neural Networks, Natural Language Processing, Speech Recognition, Cognitive Sciences, Expert Systems, AI based programming languages, Future research trends in AI, A case study to solve a typical robotic problem using AI, Problems.

Unit-II 12 Hrs.

Machine Learning in Robotics: Supervised learning, Unsupervised learning, Reinforcement learning, Deep learning, Automated Machine Learning, Convergence of IoT and ML, ML algorithms, Classification, Clustering, Prediction, Motion Heuristics, Types, State space search techniques, Graph theory techniques, AND/OR graphs, Breadth first search techniques, Hill Climbing, Best first search techniques, Semantic networks and petri-nets, Dijkstra's algorithm, Wide Path Motion Heuristics Method of Path Planning, Sophisticated Motion Heuristics, A case study to solve a typical robotic problem using ML, Problems.

Unit-III 11 Hrs.

AI based Robot Task Planning - 1: Task Planners, Automatic Program Generators, Uncertainty – Introduction, Illustration of Uncertainty Using an Example, Robot Motion Planning Techniques, Methods, Gross Motion Planning, Configuration space method and the GVD method, Fine motion planning, Guarded and Compliant motion, Grasp planning, Safe grasp planning, Secured grasp planning, Reachable grasp planning.

Unit-IV 11 Hrs.

AI based Robot Task Planning - 2: Computation of Sector Boundaries, Peg in a Hole Problem, Simulation of Planar Motion, Polygon Penetration Algorithm, A Task Planning Simulation Problem – Introduction, Source and Goal Scenes, Task Planning Sub-Problems, Scene analysis and Part ordering, Autonomous vehicles, Application to Chandrayan, Mars Rovers, Problems

Unit-V 11 Hrs.

Introduction to Robotic Vision: Features of Robotic Vision, Image Representation and Analysis, Digitization of Images, Sampling - Quantization - Coding of Images, Digital, Black-White and Gray

Scale Image, Template Matching, Performance Index, Normalized Cross-Correlation, Comparison, Explanation Using an Example, Polyhedral Objects (Edge Detection and Corner Point Detection Algorithms), Selection of the Edge Threshold, Corner Point Detection, Principle of CP Detection and its Algorithm, Perspective and Inverse Perspective Transformations, Camera Calibration, Illumination Techniques, Case study of Robot Vision in Engineering- 1, Problems.

Text Books:

1. Pavithra, T. C. Manjunath, et.al., "Playing Smart – Artificial Intelligence", Notion Publishers, India, 2022
2. Stuart J. Russell and Peter Norvig, "Artificial Intelligence a Modern Approach", Second Edition, Pearson Education.
3. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
4. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education, Fourth edition.
5. Deepak Khemani, "A first course in Artificial Intelligence", Mc Graw Hill.

Reference Books:

1. Robin R. Murphy, "Introduction to AI and Robotics", MIT Press, Second Edition,
2. T. C. Manjunath, "Fundamentals of Robotics", Nandu Publishers, 5th Edn., India, 2005.
3. T. C. Manjunath, "Fast Track to Robotics", Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
4. Robert Schilling, "Fundamentals of Robotics: Analysis and Controls", Prentice Hall Inc, India.
5. Pavithra, et.al., "Machine Learning for Web Applications", Notion Publishers, India, 2021
6. Pavithra, et.al., "Computer Vision Techniques", Notion Publishers, India, 2022
7. Pavithra, et.al., "Deep Learning and its Techniques", Notion Publishers, India, 2021
8. T. C. Manjunath, et.al., "Computational Intelligence", Notion Publishers, India, 2021