Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Shri Vile Parle Kelavani Mandal's
Dwarkadas J. Sanghvi College of Engineering

(Autonomous College affiliated to the University of Mumbai)

Scheme and detailed Syllabus (DJS22)

of

Honors Degree Program

in

Robotics

Revision: 1 (2024)

With effect from the Academic Year: 2024-2025

Scheme for Honors Robotics
(DJS22)

Sr. No.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (Marks)			Semester End Assessment (B) (Marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th/ Cb	O	P	P&O	Total SEA (B)		
Semester V																
1	DJS22MEHN2C1	Introduction to Robotics	4	--	--	4	35	--	35	65	--	--	--	65	100	4
Semester VI																
1	DJS22MEHN2C2	Modelling and Design of Robotics	4	--	--	4	35	--	35	65	--	--	--	65	100	4
3	DSJ22MEHN2L1	Robotics Laboratory I	--	2	--	1	--	25	25	--	--	--	25	25	50	1
Semester VII																
4	DJS22MEHN2C3	Advanced Robotics	4	--	--	4	35	--	35	65	--	--	--	65	100	4
5	DJS22MEHN2L2	Robotics Laboratory II	--	2	--	1	--	25	25	--	--	--	25	25	50	1
Semester VIII																
6	DJS22MEHN2C4	AI and ML for Robotics	4	--	--	4	35	--	35	65	--	--	--	65	100	4
		Total	**16**	**4**	**--**	**18**	**140**	**50**	**190**	**260**	**--**	**--**	**50**	**310**	**500**	**18**

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Honors in Robotics	T.Y. B.Tech	Semester: V
Program: Mechanical Engineering		
Course: Introduction to Robotics (DJS22MEHN2C1)		

Pre-requisite:

1. Knowledge of basic elements of mechanical engineering
2. Knowledge of electrical engineering like motors & drives
3. Knowledge of instrumentation related topics like sensors & applications
4. Basic knowledge of control systems engineering

Objectives:

1. Gain a comprehensive understanding of automation principles and its various types, along with the historical evolution of robotics.
2. Familiarize oneself with the anatomy of robots, including drive systems, actuators, power transmission systems, and activation components.
3. Learn about the different types of sensors used in robotics and their applications, including touch sensors, proximity sensors, force sensors, and encoders.
4. Understand the materials used in robot design, transmission devices, end effectors, and their classifications.
5. Gain knowledge about robot controllers, their types, the significance of programming in robotics, and the various programming languages and techniques used in industrial robot programming.
6. Explore the wide range of applications of robots in industries, while also considering social, environmental, and economic implications.

Outcomes: On completion of the course, the learner will be able to:

1. Develop a thorough understanding of the fundamentals of robotics, including automation principles, historical evolution, and the definition of robots.
2. Describe the components of robot anatomy, including drive systems, actuators, and power transmission systems.
3. Explain sensor technology and its applications in robotics, including touch sensors, proximity sensors, and encoders.
4. Select mechanical systems in robotics, including materials used in design, transmission devices, and end effectors.
5. Develop robot control, simulation, and industrial applications, using various programming languages and techniques.
6. Identify applications of robotics in different industries.

Introduction to Robotics (DJS22MEHN2C1)		
Unit		**Duration**
1	**Introduction to Robotics :** Automation & its types, History & evolution of robotics, Definition of robots, Robotic manipulators, Types of robots, Generations of robots, Laws of robotics, Classification of robots & its applications, Specifications of robots.	9
2	**Robot Anatomy :** Anatomy of robots, Drive systems, Actuators and Power Transmission systems, Types of drives & its applications, Hydraulic drives, Pneumatic drives, Electric drives, Hybrid drives, Robot activation & feedback components.	9
3	**Sensors in robotics :** Touch Sensors, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Force Sensors, Light sensors, Pressure sensors, Ultrasonic sensors, Infra-red sensors, Pots, Encoders, Position & Velocity Sensors.	9
4	**Articulated Mechanical System:** Materials used for robot design & its properties, Transmission devices in robots & its types, End effectors, Types of end effectors, Tools & Grippers, Classification of tools & grippers, Types of tool & gripper actuations.	9
5	**Robot Controllers & Programming :** Robot brain, Controller & its types, Need for controller in robots, Robot simulation, Robot software, Robot Programming & the Languages, Types of robot programming, Industrial robot programming.	8
6	**Robot Applications :** Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Social, Environmental & economic issues in robot applications, Advantages & Disadvantages of Robotization.	8
	Total	52

Books Recommended:

Text books:

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

Reference Books:

- Grover, Weiss, Nagel, Ordey, “Industrial Robotics, Technology, Programming & Applications”, McGraw Hill.

- S. R. Deb, “Robotic technology & Flexible Automation”, TMH.
- Yoram Koren, “Robotics for Engineers”, Mc Graw hill.
- Larry Health, Fundamentals of Robotics, Reston Pub Co.
- H. Asada, JJE Slotine, “Robot Analysis & Control”, John Wiley & Sons.
- A. Pugh, “Robot Technology”, Peter Peregrinus Ltd. IEE, UK.
- Shimon, “Handbook of Industrial Robotics”, John Wiley.
- Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, US.
- Robert Schilling, “Fundamentals of Robotics: Analysis & Controls”, Prentice Hall Inc. India.
- P. A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

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Honors in Robotics	**T.Y. B.Tech**	**Semester: VI**
Program: Mechanical Engineering		
Course: Modelling and Design of Robotics (DJS22MEHN2C2)		

Pre-requisites:

1. Knowledge of basics of mechanics like kinematics
2. Knowledge of basics knowledge of mathematics like vector algebra
3. Knowledge of basics knowledge of mathematics like vector matrices

Objectives:

1. To impart knowledge of the fundamental concepts of robotics & its mathematical interpretations in 3- dimensional analysis.
2. To make the student to develop the direct kinematic & inverse kinematic model for successful robotic manipulation
3. To 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. To make the robotic system to follow a well-defined trajectory from source to destination during manipulation.
6. To introduce the basic principles, techniques, state of art techniques in modelling & design of robots using direct & inverse dynamics

Outcomes: On completion of the course, the learner will be able to:

1. Demonstrate a clear understanding of the fundamental concepts of robotics, including the ability to mathematically interpret robotic motions in three-dimensional space.
2. Develop direct kinematic models and analyze them to describe the motion of robotic systems accurately.
3. Design and implement inverse kinematic models to achieve successful robotic manipulation for tasks such as pick-and-place (PNP) operations.
4. Evaluate and compare various robotic structures and configurations to optimize their performance within specified workspaces.
5. Design and implement robotic systems capable of following well-defined trajectories from source to destination during manipulation tasks.
6. Apply foundational and advanced principles, including state-of-the-art modelling and design techniques, to solve real-world problems in robotic dynamics and control.

Modelling and Design of Robotics (DJS22MEHN2C2)		
Unit	**Description**	**Duration**
1	**Modelling of robots:** An introduction (Kinematic & dynamical models), Design of Robots – An introduction (Kinematic & dynamical design), Mathematical Notations & Symbols, Coordinate Frames & its different types of Transformations with matrices, Coordinate Transformations, Rotations & Translations.	**9**
2	**Robot Direct / Forward Kinematics Modelling & Design:** Introduction to robot arm direct kinematics, Kinematic model, Kinematic parameters (Joint & Link parameters), General Link Coordinate Transformation matrix, Kinematic Parameter Table (KPT), DH Algo, Direct Kinematic model of 1 axis robot, Direct Kinematic model of 2 axis robot.	**9**
3	**Robot Inverse / Backward Kinematics Modelling & 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.	**9**
4	**Robot Work Space Analysis Modelling & 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.	**9**
5	**Robot Trajectory Planning Modelling & Design:** Robot Path, Robot Trajectory, Shape of trajectory, Speed Distribution Functions(SDF), Types of robot motions, Pick & Place trajectory design, Point to Point trajectory design, Interpolated trajectory design, Piecewise linear interpolated trajectory design, Cubic polynomial path & trajectory.	**8**
6	**Robot Dynamics:** Robot dynamical model, Kinetic energy model, Potential energy model, Lagrange-Euler Dynamical model, Dynamical modelling & design of a 1-axis robot, Direct dynamical & Inverse dynamical model, Tool configuration Jacobian matrix, TCJM of a 1-axis, 2-axis robots.	**8**
	Total	**52**

Books Recommended:

Text books:

- T. C. Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005.
- K. S. Fu, R. C. Gonzalez, C. S. G. Lee, “Robotics: Control Sensing Vision & Intelligence”, McGraw Hill, USA, 5th Edition, 2010.
- T. C. Manjunath, “Fast Track to Robotics”, Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
- Robin R. Murphy, “Introduction to AI and Robotics”, MIT Press, Second Edition, 648 pp., Oct. 2019. 5. Fundamentals of Robotics – Analysis & Controls, Robert Schilling, Prentice Hall Inc., India.

Reference Books:

- Grover, Weiss, Nagel, Ordey, “Industrial Robotics, Technology, Programming &

Applications", McGraw Hill.

- S. R. Deb, "Robotic technology & Flexible Automation", TMH.
- Yoram Koren, "Robotics for Engineers", McGraw hill.
- Larry Health , Fundamentals of Robotics, Reston Pub Co.
- H. Asada, JJE Slotine, "Robot Analysis & Control", John Wiley & Sons.

Honors in Robotics	**T.Y. B.Tech**	**Semester: VI**
Program: Mechanical Engineering		
Course: Robotics Laboratory I (DSJ22MEHN2L1)		

Pre-requisites:
1. Knowledge of Python Programming Basics
2. Knowledge of Matlab Programming & Simulink in Matlab
3. Knowledge of C/C++, Java, LabVIEW

Objectives:
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 & 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.

Outcomes: On completion of the course, the learner will be able to:

1. Simulate the workspace of a robotic arm, demonstrating an understanding of its reach, flexibility, and operational constraints.
2. Develop program to simulate pick-and-place applications, ensuring precise and efficient manipulation of objects in virtual environments.
3. Demonstrate the ability to simulate direct kinematics, calculating the position and orientation of the robot's end-effector based on given joint angles.
4. Develop simulations that solve inverse kinematics problems, determining the joint parameters required for specific end-effector positions and orientations.
5. Select optimal routes from source to destination in a 2D environment, integrating pathfinding algorithms and obstacle avoidance.
6. Simulate various robot work envelopes, analyzing their suitability for specific tasks and optimizing robotic performance within defined spatial constraints.

Robotics Laboratory I (DSJ22MEHN2L1)	
Exp.	**Suggested experiments**
1	Graphical simulation of a 4-axis SCARA robot arm (2D & 3D View)
2	Work-space analysis of a 4-axis SCARA robot arm
3	Direct Kinematic Analysis of a 4-axis SCARA robot arm
4	Inverse Kinematic Analysis of a 4-axis SCARA robot arm
5	Graphical simulation of a 3-axis planar articulated robot arm (2D & 3D View)
6	Graphical simulation of a cylindrical coordinate robot arm (2D & 3D View)
7	Graphical simulation of any one type of robot arm (2D & 3D View), either a rectangular or cylindrical or polar or articulated robot arm.
8	Work Space Envelope of 3-axis Cartesian coordinate robot

9	Work Space Envelope of 3-axis Polar coordinate robot.
10	Robot Path Planning using General Voronoi Diagram (GVD) methods – generation of path from source to goal (2D)
11	Trajectory-planning (linear interpolation) from source to goal.
12	Development of a program to show Bounded Deviation Algorithm for achieving straight line motion in the TCS.

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.

Books Recommended:

Text Books

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

Web Resources

- https://nptel.ac.in/courses/106/106/106106182/
- https://nptel.ac.in/courses/115/104/115104095/
- https://www.coursera.org/courses?query=python

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Honors in Robotics	**Final Year B.Tech**	**Semester: VII**
Program: Mechanical Engineering		
Course: Advanced Robotics (DJS22MEHN2C3)		

Pre-requisites:

1. Knowledge of basics of mechanics like kinematics
2. Knowledge of basics knowledge of mathematics like vector algebra
3. Knowledge of basics knowledge of mathematics like matrix theory & algebra
4. Knowledge of integration, differentiation & numerical methods

Objectives:

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 & nanobots. 6. Learn the different replicas of humans w.r.t. the 2-legged walking mechanism and their working natures.

Outcomes: On completion of the course, the learner will be able to:

1. Demonstrate an understanding of the fundamental principles and technologies underlying machine-to-machine interactions in robotic systems.
2. Develop and analyze strategies for implementing flexible manufacturing systems to optimize production efficiency and adaptability.
3. Design and develop robotic structures tailored to assist handicapped individuals, addressing diverse needs and functionalities.
4. Evaluate the behavior of robotic systems in external and dynamic environments, ensuring adaptability and precision in diverse scenarios.
5. 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.

Advanced Robotics (DJS22MEHN2C3)		
Unit	**Description**	**Duration**
1	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 & national security, Speaking robots, Surveillance machines, Cybernetics, Human-robot interactions, micro aerial vehicles.	9
2	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.	9
3	Cognitive robotics, Robotic exoskeletons, Artificial Legs & Limbs, Remote Surgery, Orthesis, Telethesis, Surgical robots doing surgery, Robots working together, Interactive	9

	robotics, Co-operative robotics, Farming robots for agricultural applications, IoT & Robotics for different applications	
4	Interaction of manipulator with the environment, Flexibots & Flexible Robotics, CAD CAM & CIM, Human centered robotics, complex robotic systems, Soccer robotics, Advanced perceptions for intelligent robots, Composite Materials for Robotic Applications, Case study.	8
5	Microbots & Nanobots, Applications, Surgical Applications in Medicine, Modelling of a typical Microbots & 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.	9
6	Boston Dynamics, Walking mechanisms, Bipeds, Cyborgs, Multimodal legged mobile robots, Wheeled robots, Terrained robots, Terminators, Humanoid types & its applications, Case study	8
	Total	**52**

Books Recommended:

Text books:

- T. C. Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005.
- K. S. Fu, R. C. Gonzalez, C. S. G. Lee, “Robotics: Control Sensing Vision & Intelligence”, Mac Graw Hill, USA, 5th Edition, 2010.
- T. C. Manjunath, “Fast Track to Robotics”, Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
- Robin R. Murphy, “Introduction to AI and Robotics”, MIT Press, Second Edition, 648 pp., Oct. 2019.
- Robert Schilling, “Fundamentals of Robotics: Analysis & Controls”, Prentice Hall Inc., India.

Reference Books:

- Grover, Weiss, Nagel, Ordey, “Industrial Robotics, Technology, Programming & Applications”, Mc Graw Hill.
- S R Deb, “Robotic technology & Flexible Automation”, TMH.
- Yoram Koren, “Robotics for Engineers”, Mc Graw hill.
- Larry Health, Fundamentals of Robotics, Reston Pub Co
- H Asada, JJE Slotine, “Robot Analysis & Control”, John Wiley & Sons
- Ed. A Pugh, “Robot Technology”, Peter Peregrinus Ltd. IEE, UK.
- Ed. Shimon, “Handbook of Industrial Robotics”, John Wiley
- Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, US
- Robert Schilling, “Fundamentals of Robotics – Analysis & Controls”, Prentice Hall Inc, India.
- P. A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

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Honors in Robotics	**Final Year B.Tech**	**Semester: VII**
Program: Mechanical Engineering		
Course: Robotics Laboratory II (DJS22MEHN2L2)		

Pre-requisite:
1. Knowledge of Python Programming Basics
2. Knowledge of Matlab Programming & Simulink in Matlab
3. Knowledge of C/C++, Java, LabVIEW

Objectives:
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 & 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.

Outcomes: On completion of the course, the learner will be able to:
1. Demonstrate the ability to program and visualize the operational workspace of a robotic arm, evaluating its reach and effectiveness for given tasks.
2. Develop the programming skills to simulate robotic pick-and-place operations, ensuring precision and reliability in object manipulation.
3. Apply simulating techniques to solve direct kinematics problems, accurately determining the position and orientation of the end-effector based on joint parameters.
4. Simulate and solve inverse kinematics problems, calculating the joint angles necessary for specific end-effector positions and orientations.
5. Develop and implement path-planning algorithms, enabling robots to navigate from a source to a destination in a 2D environment while avoiding obstacles.
6. Apply programming methods to simulate various robot work envelopes, analyzing their configurations and optimizing their designs for specific applications.

Robotics Laboratory 2 - DJS22MEHN2L2	
Exp.	**Suggested experiments**
1	To develop the work-space model, trajectory planning & a pick-place operation of a four axis SCARA robot arm.
2	To do the DK & IK of a four axis SCARA robot arm.
3	To develop the work-space model, trajectory planning & a pick-place operation of a three-axis planar articulated robot arm.
4	To do the DK & IK of a three-axis planar articulated robot arm.
5	To develop the work-space model, trajectory planning & a pick-place operation of a two-axis planar articulated robot arm.
6	To do the DK & IK of a two-axis planar articulated robot arm.
7	Graphical simulation of any one type of robot arm (2D & 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 & 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 & 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 & a 4-axis SCARA robot arm.
12	Develop a program to develop Screw Transformations (ST) & 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.

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.

Books Recommended:

Text books:

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

Web Resources:

- https://nptel.ac.in/courses/106/106/106106182/
- https://nptel.ac.in/courses/115/104/115104095/
- https://www.coursera.org/courses?query=python

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Honors in Robotics	Final Year B.Tech	Semester: VIII
Program: Mechanical Engineering		
Course: AI and ML for Robotics (DJS22MEHN2C4)		

Pre-requisites:

1. Knowledge of basics of image processing
2. Some basic ideas about the cameras & its operations
3. Knowledge of basics knowledge of AI & ML
4. Knowledge of logical thinking for solving simple problems.

Objectives:

1. To impart knowledge of the use of Artificial Intelligence in solving robotic problems.
2. To 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. To make 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.
6. To make the learner know the concepts of digital imaging & vision to identify objects using camera.

Outcomes: On completion of the course, the learner will be able to:

1. Demonstrate the ability to utilize Artificial Intelligence techniques to address and solve complex robotic problems effectively.
2. Analyze and differentiate between various machine learning approaches and apply them in the context of robotics for enhanced decision-making and autonomy.
3. Design and implement motion planning algorithms to determine efficient paths for robotic systems in three-dimensional space.
4. Apply task planning methodologies to enable robotic systems to autonomously solve given tasks with precision and adaptability.
5. Apply the fundamental principles of robotic vision, enabling robots to interpret and interact with their environments.
6. Use digital imaging and computer vision techniques, including camera-based object recognition, to identify and classify objects in robotic applications.

AI and ML for Robotics (DJS22MEHN2C4)		
Unit	**Description**	**Duration**
1	**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 & 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.	9

2	**Machine Learning in Robotics:** Supervised learning, Unsupervised learning, Reinforcement learning, Deep learning, Automated Machine Learning, Convergence of IoT & 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.	9
3	**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 & the GVD method, Fine motion planning, Guarded & Compliant motion, Grasp planning, Safe grasp planning, Secured grasp planning, Reachable grasp planning.	9
4	**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 & Part ordering, Autonomous vehicles, Application to Chandrayan, Mars Rovers, Problems	9
5	**Introduction to Robotic Vision 1:** Features of Robotic Vision, Image Representation & Analysis, Digitization of Images, Sampling - Quantization - Coding of Images, Digital, Black-White & 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 & its Algorithm, Perspective & Inverse Perspective Transformations, Camera Calibration, Illumination Techniques, Case study of Robot Vision in Engineering-1, Problems.	8
6	**Introduction to Robotic Vision 2:** Pattern Recognition, Shape Analysis & Methods of Performing Shape Analysis, Line & Area Descriptors, Moments, Segmentation & its types, Region, Thresholding, Histogram, Region Labelling and Region Growing Algorithm, Iterative Processing of Images & its methods, Pixel Function Definition, Shrink, Bulk & Swell Operators, Applications, Euler Number & its uses, Connectedness, Types of lighting schemes (Back, Front, Side, Advanced), Ranging Techniques, Triangulation, Image Compression Techniques, Types, Run Length Coding, Case study of Robot Vision in Engineering-2, Problems.	8
	Total	**52**

Books Recommended:

Text books:

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

Reference Books:

- Robin R. Murphy, "Introduction to AI and Robotics", MIT Press, Second Edition,

- T. C. Manjunath, “Fundamentals of Robotics”, Nandu Publishers, 5th Edn., India, 2005.
- T. C. Manjunath, “Fast Track to Robotics”, Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
- Robert Schilling, “Fundamentals of Robotics: Analysis & Controls”, Prentice Hall Inc., India.
- Pavithra, et.al., “Machine Learning for Web Applications”, Notion Publishers, India, 2021
- T. C. Manjunath, et.al., “Image Processing & Machine Vision”, Notion Publishers, India, 2022
- Pavithra, et.al., “Computer Vision Techniques”, Notion Publishers, India, 2022
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- T. C. Manjunath, et. al., “Computational Intelligence”, Notion Publishers, India, 2021

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