



**ST. JOSEPH'S**  
COLLEGE OF ENGINEERING  
AND TECHNOLOGY,  
- PALAI -  
AUTONOMOUS

Choondacherry P.O., Pala, Kottayam - 686579  
Kerala, India



# SYLLABUS

Minor *in*

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**ROBOTICS AND AUTOMATION**

OFFERED BY: Department of Electronics and Computer Engineering (ER)

ELIGIBLE DEPARTMENTS: AD, CA, CC, CE, CS, EC, EE, ER, ME

2024 SCHEME

Semester V & VI

[www.sjcetpalai.ac.in](http://www.sjcetpalai.ac.in)

## CURRICULUM

Minor in Robotics and Automation											
Sl. No	Semester	Course Code	Course Title	Credit Structure			SS	Total Marks		Credits	Hrs./ Week
				L	T	P		CIA	ESE		
1	3	24SJMNRUT309	Basics of Robotics* / MOOC <sup>#</sup>	3	1	0	5	40	60	4	4
2	4	24SJMNRUT409	Advances in Robotics and Automation* / MOOC <sup>#</sup>	3	1	0	5	40	60	4	4
3	5	24SJMNRUT509	AI and Machine Learning for Robotics / MOOC	3	1	0	5	40	60	4	4
4	6	24SJMNRUT609	Introduction to Mobile Robotics / MOOC	3	0	0	4.5	40	60	3	3
<b>Total</b>							<b>20</b>			<b>15</b>	<b>15</b>

*\*Students must register for theory courses listed in the 3<sup>rd</sup> and 4<sup>th</sup> semesters of the Minor curriculum.*

*<sup>#</sup>Students who fail a theory course listed in the Minor curriculum are permitted to register for an alternate MOOC course specified in the Minor curriculum.*

**SEMESTER - S5 (MINOR)**  
**AI AND MACHINE LEARNING FOR ROBOTICS**

<b>Course Code</b>	24SJMNRUT509	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:1:0	<b>ESE Marks</b>	60
<b>Credits</b>	4	<b>Exam Hours</b>	2 Hrs 30 Mins
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

**Course objectives:**

- To understand the fundamental concepts, importance, and applications of Artificial Intelligence, including its foundations, learning paradigms, and machine learning techniques.
- To explore the design and implementation of AI-driven systems using deep learning, computer vision, and robotics techniques for solving real-world problems such as object detection, localization, and automation.

**SYLLABUS**

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to Artificial Intelligence</b> Artificial intelligence - Introduction, its importance, The Turing test, Foundations of artificial intelligence, A brief historical overview Application areas of AI -natural language processing, vision and speech processing, robotics, expert systems -basic overview.	<b>11 hrs</b>
<b>2</b>	<b>Machine Learning Foundations</b> Learning - Forms of learning, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Reinforcement based learning - overview with basic elements agent, environment, action, state, reward only; Stochastic Gradient Descent, Challenges Motivating Deep Learning	<b>11 hrs</b>
<b>3</b>	<b>Deep Learning and Sequence Models</b> Deep Feedforward Networks – Learning XOR, Gradient-Based Learning, Hidden Units, and Back-Propagation. Convolutional Neural Networks (CNN) – Basic architecture and layer functions. Sequence Modelling – Need for sequence models, Basic RNN architecture and types. Case Studies – Line follower robot using CNN, Speech recognition using RNN (overview).	<b>11 hrs</b>
<b>4</b>	<b>AI in Vision and Robotics</b> Machine vision - Introduction, Computer vision - Introduction, Image formation, Basic image processing operations - edge detection, texture, optical flow, segmentation. challenges in image detection, Image features optimization. Robotics - Robotic perception, Localization and mapping, Machine learning in robot perception, Application domains. Case study- Use of AI in typical pick and place task, localization of a differential drive robot.	<b>11 hrs</b>

**Course Assessment Method****(CIE: -40 Marks, ESE: 60 Marks)****Continuous Internal Evaluation Marks (CIE):**

Attendance	Assignment	Internal Evaluation -1	Internal Evaluation-2	Total
5	15	10	10	40

**End Semester Examination Marks (ESE):**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks <b>(8x3 =24marks)</b></li> </ul>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 sub divisions. <b>(4x9 = 36 marks)</b></li> </ul>	<b>60</b>

**Course Outcomes (COs)**

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Appreciate the role of AI in solving problems in different domains and their evolution of AI	K2
CO2	Explain the different learning techniques used in Machine learning	K2
CO3	Explain the fundamental concepts of Image processing and its application in computer vision	K2
CO4	Explain the principles of machine vision and robotics, and AI-based localization and tracking techniques.	K2

*K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
<b>CO1</b>	2	2	-	-	-	-	-	-	-	-	2
<b>CO2</b>	3	2	2	-	-	-	-	-	-	-	2
<b>CO3</b>	3	2	2	-	-	-	-	-	-	-	2
<b>CO4</b>	3	2	2	-	-	-	-	-	-	-	2

**Text Books**

SL No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	2016
2	Artificial Intelligence - A Modern Approach	Stuart J. Russell and Peter Norvig	Pearson	4e, 2022
3	Pattern Recognition and Machine Learning	Bishop, C. M	Springer	2006
4	Robot vision	Berthold Klaus, Paul Horn	The MIT Press	1987
5	Computer Vision: Algorithms and Applications	Richard Szeliski		2010
6	A survey of deep learning techniques for autonomous driving.	Grigorescu, Sorin, et al.	Journal of Field Robotics	2020

**Reference Books**

SL No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to AI Robotics	Robin R. Murphy	The MIT Press	2000
2	Artificial Intelligence and Machine Learning	Chandra S.S.V, Anand Hareendran S.	PHI	2014

3	Computer Vision – Models, Learning and Inference	Simon J. D. Prince	Cambridge University Press	2012
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<b>Video Links (NPTEL, SWAYAM etc):</b>	
<b>Module No.</b>	<b>Link ID</b>
1	<a href="https://onlinecourses.nptel.ac.in/noc25_ge55/preview">https://onlinecourses.nptel.ac.in/noc25_ge55/preview</a>
2	<a href="https://onlinecourses.nptel.ac.in/noc25_ge55/preview">https://onlinecourses.nptel.ac.in/noc25_ge55/preview</a>
3	<a href="https://onlinecourses.nptel.ac.in/noc25_ge55/preview">https://onlinecourses.nptel.ac.in/noc25_ge55/preview</a>
4	<a href="https://onlinecourses.nptel.ac.in/noc25_ge55/preview">https://onlinecourses.nptel.ac.in/noc25_ge55/preview</a>



**SEMESTER -S6 (MINOR)**  
**INTRODUCTION TO MOBILE ROBOTICS**

<b>Course Code</b>	<b>24SJMRUT609</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs 30 Mins
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

**Course objectives:**

- To understand the basic concepts, motion, and sensing methods used in mobile robots.
- To learn how mobile robots locate themselves, plan paths, avoid obstacles, and move autonomously.

**SYLLABUS**

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Introduction to Mobile Robots and Locomotion</b> Introduction, key issues for locomotion, Wheeled Mobile Robots, Wheeled locomotion: The design space, Wheeled locomotion: Case studies. Legged Mobile Robots- Leg configurations and stability, Examples of legged robot locomotion, aerial robots, underwater robots and surface water robots.	<b>9 hrs</b>
<b>2</b>	<b>Kinematics and Dynamics of Mobile Robots</b> Basic understanding of Differential-Drive WMR, Car-Like WMR, Three-Wheel Omnidirectional Mobile Robot, Four Mecanum-Wheel Omnidirectional Robot Kinematic model of a differential drive and a steered mobile robot, degree of freedom and manoeuvrability, Degree of steerability, different wheel configurations, holonomic and non-holonomic robots. Omnidirectional Wheeled Mobile Robots. Dynamic modelling of differential drive WMR: Lagrange and Newton-Euler methods	<b>9 hrs</b>
<b>3</b>	<b>Sensing and Perception for Mobile Robots</b> Sensors for mobile robot navigation: Sensor classification, characterizing sensor performance, Wheel /motor sensors, Heading sensors, Accelerometers, IMUs, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors. Robot Vision: Sensing, Preprocessing, Segmentation, Description, Recognition, Interpretation, feature extraction.	<b>9 hrs</b>
<b>4</b>	<b>Navigation, Path Planning, and Control</b> Robot localization and mapping, challenges in localization, odometric error modelling, probabilistic localization using Kalman filter, simultaneous localization and mapping (SLAM), path planning strategies – local and global path planning, graph-based algorithms (Dijkstra's and A*), obstacle avoidance methods – potential field and Dynamic Window Approach (DWA), control of differential drive robot using kinematic model, case study on navigation of a differential drive robot.	<b>9 hrs</b>

**Course Assessment Method**  
(CIE: -40 Marks, ESE: 60 Marks)

**Continuous Internal Evaluation Marks (CIE):**

Attendance	Assignment	Internal Evaluation -1	Internal Evaluation-2	Total
5	15	10	10	40

**End Semester Examination Marks (ESE):**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks (8x3 =24marks)</li> </ul>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)</li> </ul>	<b>60</b>

**Course Outcomes (COs)**

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basic concepts and types of locomotion used in mobile robots.	K2
CO2	Describe the kinematic and dynamic models of different wheeled mobile robots.	K2
CO3	Explain various sensors and vision systems used for mobile robot perception and navigation.	K2
CO4	Illustrate the principles of localization, mapping, path planning, obstacle avoidance, and control of mobile robots.	K2

*K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
<b>CO1</b>	2	2	-	-	-	-	-	-	-	-	3
<b>CO2</b>	2	2	-	-	-	-	-	-	-	-	3
<b>CO3</b>	2	2	2	-	-	-	-	-	-	-	3
<b>CO4</b>	3	2	2	-	-	-	-	-	-	-	3

<b>Text Books</b>				
<b>SL No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Introduction to Autonomous Mobile Robots	R Siegwart, IR Nourbakhsh, D Scaramuzza	MIT Press, USA	2011
2	Introduction to Mobile Robot Control	Spyros G. Tzafestas	Elsevier, USA	2014
3	Sensors for mobile robot	HR Everett	CRC Press	2010

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Mobile Robotics: Mathematics, Models and methods	A Kelly	Cambridge University Press, USA	2013
2	Computational Principles of Mobile Robotics	G Dudek, M Jenkin	Cambridge University Press, USA	2010
3	Principles of Robot Motion, Theory, Algorithms, and Implementation	Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A Kantor, Wolfram Burgard, Lydia E. Kavraki, Sebastian Thrun	MIT Press	2005

<b>Video Links (NPTEL, SWAYAM etc):</b>	
<b>Module No.</b>	<b>Link ID</b>
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3	<a href="https://onlinecourses.nptel.ac.in/noc21_me44/preview">https://onlinecourses.nptel.ac.in/noc21_me44/preview</a>
4	<a href="https://onlinecourses.nptel.ac.in/noc21_me44/preview">https://onlinecourses.nptel.ac.in/noc21_me44/preview</a>