



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

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



CURRICULUM & SYLLABUS

Minor in Robotics & Automation

Offered by: Department of Electronics and Computer Engineering (ER)

Eligible Departments: AD, CA, CC, CE, CS, EC, EE, ER, ME

2024 SCHEME

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	3	1	0	5	40	60	4	4
2	4	24SJMNRUT409	Advances in Robotics and Automation	3	1	0	5	40	60	4	4
3	5	24SJMNRUT509	AI and Machine Learning for Robotics	3	1	0	5	40	60	4	4
4	6	24SJMNRUT609	Introduction to Mobile Robotics	3	0	0	4.5	40	60	3	3
Total							20			15	15

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

#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 S3 (MINOR)**BASICS OF ROBOTICS**

Course Code	24SJMNRUT309	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0	ESE Marks	60
Credits	4	Exam Hours	2.30
Prerequisites (if any)	None	Course Type	Theory

Course objectives:

- To provide students with a foundational understanding of robotics
- To develop the ability to model and analyze robot motion using kinematics

SYLLABUS

Mod. No.	Syllabus Description	Contact Hours
1	Introduction to Robotics and Automation Definition: Robots, Robotics; Laws of robot, Brief history of robotics, Basic components of robot. Types of Robots: Industrial, Mobile, Humanoid, Aerial, Medical, etc., Applications of Robots: medical, mining, space, defence, security, domestic, entertainment, Industrial Applications-Material handling, welding, Spray painting, Machining.	11
2	Robot Components and Kinematics Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller. Degrees of Freedom, Robot considerations for an application- number of axes, work volume, capacity & speed, stroke & reach, Repeatability, Precision and Accuracy, Operating environment. Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot. Kinematic Chains: Open & Closed, Introduction to direct and inverse kinematics, transformations and rotation matrix, DH Parameter Representation.	11
3	Sensors, Actuators and Configurations Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, noncontact type; Vision - Elements of vision sensor, Selection of sensors. Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators, Electric actuators- Stepper motors, DC motors, DC servo motors, AC motors, Linear actuators, Hydraulic actuators- Components and typical circuit, advantages and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages and disadvantages. Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots.	11

4	Robot Control, Motion Planning & Programming Robot Control: Concept of Open-loop and Closed-loop Control, Block Diagram Representation of a Robotic Control System. Transfer function and State Space representation, Role of Feedback in Robotics. PID Control for robot motion. Motion Planning: Types of Robot Motion-Joint Space vs. Cartesian Space, Cubic Polynomial Trajectory Planning, Linear Trajectory with Parabolic Blends, Point to point vs continuous path planning. Robot Programming: Low-Level vs. High-Level Programming in Robotics, Overview of Industrial robot programming languages (RAPID, VAL, AML etc.) Basics of ROS (Robot Operating System).	11
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Course Assessment Method

(CIE: -40 Marks, ESE: 60 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Micro project	Internal Ex-1	Internal Ex-2	Total
10	10	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"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 = 24marks) 	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Familiarise the fundamental concepts of robotics, types of robots, and their applications in various domains.	K2
CO2	Explain robot components, end effectors, and kinematics for motion analysis.	K2
CO3	Describe the types of sensors, actuators, and robot configurations.	K2
CO4	Understand robot control, motion planning, and programming concepts for efficient robotic operation	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
CO1	3	2	2	1	2	1	-	1	2	-	3
CO2	3	3	2	2	3	1	-	-	2	1	3
CO3	3	3	3	2	3	2	-	-	2	2	3
CO4	3	3	3	3	3	2	-	2	3	2	3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Textbooks

SL No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Robotics	S K Saha	Mc Graw Hill Education	3 rd Edition
2	Fundamentals of robotics Analysis and control	Robert. J. Schilling	Prentice Hall of India	2 nd Edition
3	Robotics and Control	R K Mittal and I J Nagrath	Mc Graw Hill Education	1 st Edition
4	Introduction to Robotics- Analysis, Systems, Applications	Saeed B Niku	PHI	Eastern Economy Edition

Reference Books

1	Introduction to Robotics (Mechanics and control)	John. J. Craig	Pearson Education Asia	2002
2	Robotics-Fundamental concepts and analysis	Ashitava Ghosal	Oxford University press	
3	Robotics Technology and Flexible Automation	S. R. Deb	Tata Mc Graw Hill Education	2 nd Edition

Video Links (NPTEL, SWAYAM etc):

Module - I	https://nptel.ac.in/courses/112107289 Robotics and Control: Theory and Practice https://nptel.ac.in/courses/112108298 Robotics: Basics and Selected Advanced Concepts
Module - II	https://nptel.ac.in/courses/112107289 Robotics and Control: Theory and Practice https://nptel.ac.in/courses/112108298 Robotics: Basics and Selected Advanced Concepts
Module - III	https://nptel.ac.in/courses/112107289 Robotics and Control: Theory and Practice https://nptel.ac.in/courses/112108298 Robotics: Basics and Selected Advanced Concepts
Module - IV	https://nptel.ac.in/courses/112107289 Robotics and Control: Theory and Practice https://nptel.ac.in/courses/112108298 Robotics: Basics and Selected Advanced Concepts

SEMESTER: S4 (MINOR)**ADVANCES IN ROBOTICS AND AUTOMATION**

Course Code	24SJMNRT 409	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:1:0	ESE Marks	60
Credits	4	Exam Hours	2.30
Prerequisites (if any)	None	Course Type	Theory

Course objectives:

- To introduce the foundational principles and technological advancements in humanoid robotics
- To understand the fundamentals and challenges of Human-Robot Interaction (HRI)

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Humanoid Robotics Technology Humanoid Robotics-Introduction, Sensors in Humanoid Robot: Position and motion sensors-Inductive type, Encoders, LVDT, RVDT, Photo electric, Thermoelectric, Capacitive, Linear potentiometer, Strain gauges, Vision Sensors, Touch Sensors, Inertial Measurement Units (IMU), Microphones & Speech Recognition Sensors. Actuation types for humanoid Robot: Electric, Hydraulic and pneumatic actuators.	11
2	Social Robots and Swarm Robotics Social Robot, Need of Social Robots, Assistive and Social Robots in the Healthcare Sector, Case study on Humanoid Robot- ASIMO, Sophia. Swarm Robotics: Characteristics, Swarm Robotics and Multi-Robotic Systems, Experimental Platforms in Swarm Robotics, Tasks in Swarm Robotics, Swarm Robots used in Real world applications.	11
3	Human Robot Interaction (HRI) Definition, History, Need of HRI, Ethical Issues for HRI, Multi-Modal Perception, Social, Service, and Assistive Robotics, HRI Architecture, Collaborative Robots, Definition, Types of Collaboration, Applications of collaborative robots, collaborative Robot Technology.	11
4	Robot Automation and Control Electro-pneumatic/Electro hydraulic automation: Control valves – direction, pressure and flow, Basic electrical elements – relay, solenoid, pneumatic – electrical converters. Automation Control: Sequence control and programmable controllers – logic control and sequencing elements, ladder diagram, PLC, programming the PLC. Practical Examples on PLC ladder programming.	11

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Assignment/Micro project</i>	<i>Internal Ex-1</i>	<i>Internal Ex-2</i>	<i>Total</i>
10	10	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"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks) 	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand how humanoid robots work, including their sensors, actuators, and movement.	K2
CO2	Understand how social and swarm robots work and where they are used in real life.	K2
CO3	Understand how humans and robots interact, their uses, and the role of collaborative robots.	K2
CO4	Understand robot automation, control systems, and PLC programming for real-world applications.	K2

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

CO-PO Mapping Table:

Course Articulation Matrix (Mapping of course outcomes with program outcomes):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	2	2	2	2	2	3
CO2	3	3	3	2	3	3	2	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	2	2	3	3	3	3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Textbooks				
SL No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Humanoid Robotics	Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada, Kazuhito Yokoi	Springer	2014
2	An Introduction to Swarm Robotics	Iñaki Navarro and Fernando Matía	ISRN Robotics	2013
3	Human-Robot Interaction	Christoph Bartneck, Tony Belpaeme, Friederike Eyszel, Takayuki Kanda, Merel Keijsers, Selma Šabanović	Cambridge University Press	2020
4	Pneumatic Control for Industrial Automation	Peter Rohner & Gordon Smith	John Wiley and Sons	1987
5	Industrial Automation and Control	S.K. Singh	McGraw Hill	3 rd , 2017

Reference Books				
1	Robotics: Control, Sensing, Vision, and Intelligence	K.S. Fu, R.C. Gonzalez, C.S.G. Lee	McGraw Hill	1987
2	Springer Handbook of Robotics	Bruno Siciliano, Oussama Khatib	Springer	2 nd , 2016
3	Swarm Robotics: Principles and Applications	Beniamino Siciliano, Oussama Khatib	Springer	2016
4	Designing for collaborative robotics	Jeff Faneuff, Jonathan Follett	O'Reilly Media	2016
5	Mechatronics: A Multidisciplinary Approach	W. Bolton	Pearson Education India.	4 th , 2014
6	Programmable Logic Controllers	Frank D. Petruzella	McGraw Hill	6 th , 2023
7	Pneumatic and Hydraulic Systems	R. Srinivasan	Tata McGraw Hill	3 rd , 2019

Video Links (NPTEL, SWAYAM etc):	
Module - I	Introduction to Robotics. https://onlinecourses.nptel.ac.in/noc21_de13/preview Advanced Robotics Applications. https://onlinecourses.nptel.ac.in/noc25_me85/preview
Module - II	Experimental Robotics. https://onlinecourses.nptel.ac.in/noc24_ge31/preview
Module - III	Collaborative Robots (COBOTS): Theory and Practice. https://onlinecourses.nptel.ac.in/noc25_me86/preview
Module - IV	Industrial Automation and Control. https://onlinecourses.nptel.ac.in/noc23_ee56/preview