

AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER
Department of Automation & Robotics Engineering
Honors in Industrial Robotics & Intelligent Automation
(18 Credits)

Year	Semester	Course Code	Course Name	Credits
Second Year	Sem III	R25-AR-HOC-201	Robotics & Intelligent Automation	3
	Sem IV	R25-AR-HOC-202	Robotic Sensing & Actuation	3
Third Year	Sem V	R25-AR-HOC-301	Autonomous Robotics	3
	Sem VI	R25-AR-HOC-302	Intelligent Robot Control	3
Final Year	Sem VII	R25-AR-HOC-401	AI & Cognitive Robotics	3
	Sem VIII	R25-AR-HOC-402	Collaborative & Industrial Robotics	3



Dr. V. B. Shinde
BoS Chairman



Chairman
 BoE, Automation & Robotics Engineering
 Amrutvahini College of Engineering, Amrutnagar
 Sangamner-422608




Chairman
 Academic Council
 Amrutvahini College of Engineering, Amrutnagar
 Sangamner-422608

Program:	S. Y. B. Tech			Semester:	III		
Course:	Robotics & Intelligent Automation			Course Code:	R25-AR-HOC-201		
Teaching Scheme (Hrs. / week)			Credits (TH)	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
3	-	-	3	40	60	-	-

Course Description: This course introduces the fundamentals of industrial robotics and intelligent automation, covering robot configurations, coordinate systems, basic kinematics, robot programming, end-effectors, motion planning, robot control concepts, industrial workcell integration, safety, and introductory intelligent automation using sensors, vision, PLC/robot interfaces and ROS-based concepts.

Course Relevance: The course develops foundational knowledge required to understand, program and integrate industrial robots in automated manufacturing and service-oriented applications. It establishes the base for subsequent courses in Robotic Sensing & Actuation, Autonomous Robotics, Intelligent Robot Control, AI & Cognitive Robotics, and Collaborative & Industrial Robotics.

Prerequisite: Basic engineering mathematics, engineering mechanics, fundamentals of electrical/electronic systems, programming fundamentals, and introductory concepts of automation.

Bridge Content: Coordinate geometry and matrices; vectors and transformations; basic calculus; sensors and actuators; DC/BLDC/servo motors; PLC basics; programming logic; feedback and control fundamentals; computer and communication networks.

Course Objectives:

- **EXPLAIN** the structure, classification, terminology and operating principles of industrial robots.
- **DEVELOP** basic mathematical and programming skills for robot positioning, motion and task execution.
- **DESCRIBE** robot workcells, end-effectors, motion control, programming and integration with automation equipment.
- **EXPLAIN** the role of sensing, machine vision, PLCs, communication and safety in intelligent automation.
- **APPLY** introductory AI/robotics software concepts to analyse and design simple intelligent robotic automation applications.

Course Outcomes: After learning the course, students will be able to:

CO	Course Outcome	Bloom's Level
CO1	EXPLAIN robot anatomy, configurations, coordinate systems, workspace and basic kinematic concepts.	2
CO2	DEVELOP basic robot programs and select suitable end-effectors and workcell components for specified tasks.	3
CO3	ANALYSE robot motion, trajectory generation and feedback-based control concepts for industrial applications.	4
CO4	EXPLAIN and INTEGRATE the roles of sensors, machine vision, PLCs, communication networks and safety systems in robotic automation.	3
CO5	EVALUATE introductory intelligent-automation architectures using ROS/robot software concepts, data-driven decision making and representative industrial case studies.	4

Course Contents			
Unit 1	Fundamentals of Robotics and Industrial Robots	Weeks 1-2	CO1
Fundamentals of Robotics: Definition and evolution of robots; automation versus robotics; robot anatomy and terminology; links, joints and degrees of freedom; robot configurations—Cartesian, cylindrical, spherical, SCARA, articulated and delta; robot coordinate frames; base, tool and world coordinates; workspace and reachability; payload, speed, repeatability, accuracy and resolution; basic homogeneous transformation concepts; forward kinematics concept; introduction to Denavit–Hartenberg representation; overview of robot selection criteria.			
Exemplars / Practical Applications and usage: • Pick-and-place, assembly, material handling and machine tending applications. • Compare robot configurations for palletizing, assembly, inspection and welding tasks.			
Assignments: 1. Prepare a comparative study of five industrial robot configurations and recommend a suitable configuration for three manufacturing tasks. 2. Solve basic coordinate-frame and homogeneous-transformation problems for a two-link planar robot.			
Unit 2	Unit 2	Unit 2	Unit 2
Robot Programming and Workcell Components: Teach pendant and teach-and-repeat programming; point-to-point and continuous-path programming; motion commands, speed, acceleration, blending and tool offsets; basic program structure and sequencing; end-effectors—mechanical, vacuum, magnetic and pneumatic types; gripper selection; tool centre point (TCP); fixtures and workholding; robot cell layout; basic offline programming/simulation concepts; introduction to robot I/O and interlocks.			
Exemplars / Practical Applications and usage: • Programming a robot for pick-and-place, palletizing and machine loading. • Selection of grippers for fragile, cylindrical and sheet-metal components.			
Assignments: 1. Develop a flowchart and pseudo-code/robot program for a pick-and-place cell with sensor-based interlocking. 2. Select an end-effector for a given component and justify the selection using payload, geometry, gripping force and cycle-time considerations.			
Unit 3	Unit 3	Unit 3	Unit 3
Robot Motion Planning and Control: Joint-space and Cartesian-space motion; point-to-point versus continuous-path motion; trajectory planning; linear and circular interpolation; velocity and acceleration profiles; singularity and collision concepts; servo drives and feedback; position, velocity and torque control overview; PID control concept in robot joints; calibration and repeatability; cycle-time considerations; basic path-planning concepts for structured workspaces.			
Exemplars / Practical Applications and usage: • Welding, painting, dispensing and inspection tasks requiring continuous-path motion. • Analysis of joint trajectories and cycle time for repetitive pick-and-place operations.			
Assignments: 1. Generate and compare joint-space and Cartesian-space trajectories for a simple two/three-joint robot. 2. Study the effect of P, PI and PID control parameters on a simplified robotic joint response using			

simulation or numerical analysis.			
Unit 4	Unit 4	Unit 4	Unit 4
Intelligent Robotic Automation: Sensors used in robotic cells—proximity, photoelectric, inductive, capacitive, encoders and force/torque sensing; machine vision fundamentals; camera, illumination, image acquisition and basic inspection; PLC–robot integration; digital and analog I/O; industrial communication concepts; HMI/SCADA overview; safety circuits, emergency stop, guarding, interlocks and risk awareness; collaborative robot safety concepts; introduction to Industry 4.0 connectivity and data acquisition.			
Exemplars / Practical Applications and usage: • Vision-guided sorting and inspection. • PLC-controlled robot cell for assembly or material handling. • Safety interlocks and monitoring in automated production cells.			
Assignments: 1. Design an I/O map and sequence diagram for a PLC-controlled robotic workcell containing a robot, conveyor, sensor and emergency-stop circuit. 2. Prepare a case study on a vision-based inspection or sorting application and identify sensors, communication and safety provisions.			
Unit 5	Unit 5	Unit 5	Unit 5
Introduction to Intelligent Robotics Software and AI-Enabled Automation: Concept of intelligent automation; perception–decision–action loop; rule-based versus data-driven automation; introductory machine learning concepts relevant to robotics; object classification and anomaly detection overview; basic path planning concepts; robot operating systems and middleware—ROS/ROS 2 concepts, nodes, topics, services and coordinate frames; simulation and digital-twin concepts; human–robot interaction overview; integration architecture for an intelligent robotic cell; case studies in smart manufacturing, logistics and service robotics.			
Exemplars / Practical Applications and usage: • ROS-based simulation of a mobile/manipulator robot. • Vision-based object classification for automated sorting. • Intelligent predictive inspection and adaptive material handling.			
Assignments: 1. Develop a block-level architecture for an AI-enabled robotic sorting/inspection system showing perception, decision, control and communication layers. 2. Analyse one industrial case study and identify where conventional automation can be enhanced using sensing, software intelligence or data-driven decision making.			
Textbooks:			
1. Craig, J. J., Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson. 2. Spong, M. W., Hutchinson, S., Vidyasagar, M., Robot Modeling and Control, Wiley. 3. Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson.			
Reference Books:			
1. Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Robotics: Modelling, Planning and Control, Springer. 2. Corke, P., Robotics, Vision and Control, Springer. 3. Niku, S. B., Introduction to Robotics: Analysis, Control, Applications, Wiley.			

4. Kelly, R., Santibáñez, V., Control of Robot Manipulators in Joint Space, Springer.

MOOCs Links and additional reading material:

1. SWAYAM-NPTEL courses on Industrial Robotics, Robotics, Automation and Control.
2. ROS 2 documentation and tutorials: <https://docs.ros.org/>
3. RoboDK educational resources: <https://robodk.com/education>
4. MathWorks Robotics System Toolbox resources:
<https://www.mathworks.com/solutions/robotics.html>

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	1	1	1	1	1	1	2	3	2
CO2	2	3	3	2	3	1	1	1	2	1	1	3	3	2
CO3	3	3	3	3	3	1	1	1	2	1	2	3	3	3
CO4	2	3	3	3	3	2	2	2	2	2	2	3	3	3
CO5	2	3	3	3	3	2	2	2	2	2	2	3	3	3
Avg.	2.2	3.0	3.0	2.6	2.8	1.4	1.4	1.4	1.8	1.4	1.6	2.8	3.0	2.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

a) Continuous Comprehensive Evaluation (CCE) – 40 Marks

The Continuous Comprehensive Evaluation shall be carried out by the Department based on the student's performance throughout the duration of the SWAYAM-NPTEL course.

- Performance in NPTEL Weekly Assignments: 30 Marks
- Course Progress and Participation (completion of video lectures, timely submission of weekly assignments, and periodic progress monitored by the Faculty Mentor): 10 Marks

b) End Semester Evaluation (ESE) – 60 Marks

1. Students shall register for and appear in the SWAYAM-NPTEL Proctored Certification Examination.
2. The marks obtained in the NPTEL Proctored Examination shall be converted proportionally to 60 marks using the following formula:
3. Students who successfully obtain the NPTEL certificate shall have the converted score considered as the End Semester Evaluation (ESE) marks.
4. Students who fail to obtain the NPTEL certificate, fail to appear for the NPTEL certification examination, or fail the certification examination shall appear for the Institute End Semester Examination conducted by the College.
5. If a student appears for both the SWAYAM-NPTEL Certification Examination and the Institute End Semester Examination, the higher of the two ESE scores shall be considered for the award of the final grade.
6. The decision of the Department regarding verification of NPTEL scores and award of

marks shall be final and binding.

BT Level	CCE						ESE
	CT1	CT2	Assignments	Course Project	Field Activity / Case Study	Quiz / presentation etc.	
K1	-	-	✓	-	-	-	✓
K2	-	-	✓	-	-	-	✓
K3	-	-	✓	-	-	-	✓
K4	-	-	✓	-	-	-	✓
K5	-	-	-	-	-	-	-
K6	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:

- Design of Robot Elements
- Robot Kinematics & Dynamics
- Sensors and Vision System
- ROS
- Artificial Intelligence in Robotics
- Embedded System in Robotics
- Robot Process Automation & Design
- Autonomous Robotic Systems

Machine Learning and Deep Learning.

Job Mapping:

- Robotics/Automation Engineer
- Industrial Robot Programmer
- Robot Application Engineer
- Automation/PLC Integration Engineer
- Robotics System Integration Engineer
- Manufacturing Automation Engineer
- Junior Robotics Software/ROS Engineer
- Industrial Vision & Inspection Engineer

Program:	S. Y. B. Tech			Semester:	IV		
Course:	Robotic Sensing & Actuation			Course Code:	R25-AR-HOC-202		
Teaching Scheme (Hrs. / week)			Credits (TH)	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
3	-	-	3	40	60	-	-

Course Description: This course develops the foundations of robotic sensing and actuation required to acquire physical-world information, condition and interpret sensor signals, and convert control commands into reliable robot motion. It covers sensor characteristics and interfacing, position/orientation and proximity sensing, force/torque and tactile sensing, motor/drive technologies, actuator selection and sizing, and integrated sensor-actuator architectures. Emphasis is placed on practical selection, calibration, signal conditioning, interfacing, safety, and application-oriented design

Course Relevance: Sensing and actuation form the physical interface between a robot and its environment. The course prepares students to select and integrate sensors, actuators, drives and interfaces for manipulators, mobile robots and automated systems, and provides the hardware foundation for autonomy, robot control, AI-enabled perception, and collaborative/industrial robotics.

Prerequisite: Basic knowledge of engineering mathematics, electrical/electronic circuits, programming fundamentals, measurement and instrumentation, and introductory robotics concepts such as coordinate frames, robot joints and basic kinematics. The course Robotics & Intelligent Automation in Semester III is the immediate academic prerequisite within the Honors pathway.

Bridge Content: Brief revision of robot joints and degrees of freedom; coordinate frames and homogeneous transformations; basic kinematics; DC/BLDC/stepper/servo motor concepts; voltage, current, power and basic circuit measurements; ADC/DAC and sampling concepts; basic programming/data acquisition; units and dimensional analysis for torque, speed, force and resolution.

Course Objectives:

- **UNDERSTAND** operating principles, characteristics and selection criteria of sensors used in robotic systems.
- **ANALYZE** sensor signals and apply appropriate conditioning, calibration, filtering, conversion and interfacing methods.
- **UNDERSTAND** force, torque, tactile and proximity sensing for robot interaction and environment awareness.
- **UNDERSTAND** robotic actuators, transmissions and drives, and perform basic actuator sizing and selection.
- **INTEGRATE** sensors, actuators and interfaces into safe, reliable robotic subsystems and relate them to future autonomous and intelligent robot applications.

Course Outcomes: After learning the course, students will be able to:

CO	Course Outcome	Bloom's Level
CO1	EXPLAIN the operating principles, characteristics and performance parameters of commonly used robotic sensors.	2
CO2	SELECT and interface position, orientation, proximity and distance sensors for specified robotic applications.	3
CO3	ANALYZE and apply force/torque, tactile and inertial sensing techniques for robot interaction and motion awareness.	3
CO4	EXPLAIN robotic actuator, transmission and drive technologies and perform basic torque, speed and power calculations for actuator selection.	3
CO5	DESIGN and justify an integrated sensor-actuator subsystem considering calibration, signal conditioning, interfacing, safety and	4

	application constraints.	
Course Contents		
Unit 1	Fundamentals of Robotic Sensing & Signal Conditioning	Weeks 1-2 CO1
Role of sensing in robotics: perception–decision–action loop; sensor taxonomy; proprioceptive vs. exteroceptive sensors; contact vs. non-contact sensing. Sensor characteristics: range, sensitivity, resolution, accuracy, precision, repeatability, linearity, hysteresis, drift, response time, bandwidth, threshold, dead zone and reliability. Measurement errors: systematic and random errors; uncertainty; noise sources; calibration concepts; static and dynamic response. Analog and digital sensor outputs; voltage/current/frequency/PWM/serial outputs; ADC, sampling, quantization and aliasing; basic DAC concepts. Signal conditioning: amplification, attenuation, filtering, isolation, debouncing and level shifting; grounding and shielding; basic sensor interface circuits. Calibration and data acquisition: zero/span calibration, multi-point calibration, sensor characterization and validation.		
Exemplars / Practical Applications and usage: Sensor calibration and characterization in robotic joint modules; analog-to-digital acquisition; noise reduction in encoder/current/force signals.		
Assignments: - Prepare a comparative sensor datasheet matrix covering range, accuracy, resolution, output type, response time and environmental limits for five robotic sensors. - Develop a calibration curve and error/uncertainty report for a selected analog or digital sensor using sample data.		
Unit 2	Position, Orientation, Proximity & Distance Sensing	Week 3 CO2
Position and displacement sensing: potentiometers, encoders, resolvers and linear displacement sensors. Rotary encoders: incremental and absolute encoders; quadrature signals; direction and speed estimation; encoder resolution and counts-per-revolution. Limit and proximity sensing: mechanical limit switches, inductive, capacitive, photoelectric and magnetic/Hall-effect sensors; selection considerations. Distance and ranging: ultrasonic and infrared/ToF sensing; basic LiDAR concept; field of view, blind zone, reflectivity and environmental limitations. Orientation and motion sensing: gyroscope, accelerometer and IMU fundamentals; basic coordinate-frame interpretation. Interfacing and application examples: joint position feedback, end-stop detection, object detection, conveyor tracking, mobile robot odometry and obstacle detection.		
Exemplars / Practical Applications and usage: Joint position feedback, AGV/mobile robot odometry, object detection on conveyors, end-effector limit sensing and obstacle detection		
Assignments: - Select an encoder and proximity sensor set for a 4-DOF manipulator and justify the selection using resolution, speed, environment and interface requirements. - Design a sensor-interfacing concept for a mobile robot that combines wheel encoders and distance		

sensors for odometry and obstacle detection.

Unit 3	Force, Torque, Tactile & Inertial Sensing	Weeks 4-5	CO3
Force and torque sensing in robotics: interaction control requirements; load cells and strain gauges; Wheatstone bridge principle and instrumentation amplification. Six-axis force/torque sensing: force and moment components, mounting considerations, overload protection and calibration concepts. Tactile sensing: contact detection, pressure distribution, tactile arrays, capacitive/resistive/piezoresistive approaches and grasp monitoring. Current/torque estimation: motor-current-based force/torque estimation; advantages, limitations and safety implications. Inertial sensing: accelerometers, gyroscopes and IMUs; bias, scale factor, drift and basic sensor fusion concept. Applications: compliant grasping, collision/contact detection, assembly, surface following, balancing and mobile robot motion estimation.			
Exemplars / Practical Applications and usage: • Robotic grasping, precision assembly, contact detection, force-guided insertion, balancing and collision detection.			
Assignments: 1. Compare strain-gauge load cells, force/torque sensors and motor-current-based torque estimation for a robotic gripping/assembly task. 2. Analyze sample IMU or force-sensor data to identify bias, noise and drift and recommend a suitable conditioning/calibration strategy.			
Unit 4	Robotic Actuators, Transmissions & Drives	Week 6	CO4
Actuation in robotics: actuator requirements; electrical, pneumatic and hydraulic actuation; comparative characteristics and application domains. Electric actuators: DC motors, geared DC motors, BLDC motors, stepper motors and servo motors; operating principles and selection criteria. Motor characteristics: torque–speed curves, rated/peak torque, stall torque, speed, power, efficiency, thermal limits and duty cycle. Mechanical transmission: gearboxes, harmonic drives, planetary gears, belt/chain drives, lead screws, ball screws and rack-and-pinion mechanisms. Motor drives and control interfaces: H-bridge, PWM, current control, servo drives, stepper drivers, feedback loops and basic protection. Actuator sizing: load torque, acceleration torque, gravity/friction effects, transmission ratio, reflected inertia, safety factor and power estimation.			
Exemplars / Practical Applications and usage: • Servo joint design, pick-and-place axes, mobile robot wheel drives, precision positioning and high-torque robotic joints.			
Assignments: 1. Perform actuator sizing for one robot joint from given payload, link dimensions, desired speed/acceleration and transmission ratio; justify the selected motor and safety factor. 2. Prepare a comparison of servo, stepper and BLDC actuation for a pick-and-place robot and recommend a suitable drive architecture.			

Unit 5	Integrated Sensor–Actuator Systems for Robots	Weeks 7-8	CO5
Sensor–actuator architecture: signal flow from sensing to computation to actuation; controller, I/O, drive and feedback paths. Closed-loop robotic systems: feedback concept; position, velocity and torque feedback; sensor placement and observability considerations. Synchronization and interfacing: encoder feedback with motor drives; digital/analog I/O; serial/CAN/Ethernet-based device communication concepts. Sensor fusion and redundancy: combining complementary sensors; plausibility checks; fault detection and basic redundancy strategies. Safety and reliability: limit switches, emergency stop, overload/overcurrent/overtemperature protection, fail-safe states and sensor diagnostics. Integrated case studies: manipulator joint module, mobile robot drive unit, conveyor pick-and-place cell and basic human–robot interaction sensing. Design methodology: requirement specification, component selection, interface definition, calibration plan, testing/validation and documentation.			
Exemplars / Practical Applications and usage: • Closed-loop manipulator joints, mobile robot drive modules, automated inspection/handling cells, safe interaction and actuator fault detection.			
Assignments: 1. Develop a block-level sensor–actuator architecture for a 4-DOF robotic pick-and-place cell, showing sensors, controller, drives, actuators, feedback paths and safety devices. 2. Prepare a mini design note identifying sensor/actuator specifications, interfaces, calibration checks, failure modes and validation tests for the selected robotic subsystem.			
Textbooks: 1. J. J. Craig, Introduction to Robotics: Mechanics and Control, Pearson. 2. Bruno Siciliano and Oussama Khatib (Eds.), Springer Handbook of Robotics, Springer. 3. Mark W. Spong, Seth Hutchinson and M. Vidyasagar, Robot Modeling and Control, Wiley.			
Reference Books: 1. J. Angeles, Fundamentals of Robotic Mechanical Systems, Springer. 2. Kevin M. Lynch and Frank C. Park, Modern Robotics: Mechanics, Planning, and Control, Cambridge University Press. 3. John Iovine, Robots, Androids, and Animatrons / relevant introductory robotics instrumentation references. 4. Robert H. Bishop (Ed.), The Mechatronics Handbook, CRC Press.			
MOOCs Links and additional reading material: • SWAYAM/NPTEL courses on Robotics, Sensors and Actuators, Mechatronics, Industrial Automation and Robot Mechanics. • NPTEL lectures on robot sensors, actuators, instrumentation, kinematics and control. • Manufacturer application notes/datasheets for encoders, IMUs, load cells, servo drives, BLDC motors and proximity sensors.			

Strength of CO-PO-PSO Mapping														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	1	1	1	1	3	2	1
CO2	3	3	3	3	3	1	1	1	1	1	2	3	3	2
CO3	3	3	3	3	3	1	1	2	1	1	2	3	3	2
CO4	3	3	3	2	3	1	1	1	1	1	2	3	3	3
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	3
Avg.	3.0	2.8	2.6	2.6	2.8	1.2	1.2	1.4	1.2	1.2	1.8	3.0	2.8	2.2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern
a) Continuous Comprehensive Evaluation (CCE) – 40 Marks
The Continuous Comprehensive Evaluation shall be carried out by the Department based on the student's performance throughout the duration of the SWAYAM-NPTEL course. · Performance in NPTEL Weekly Assignments: 30 Marks · Course Progress and Participation (completion of video lectures, timely submission of weekly assignments, and periodic progress monitored by the Faculty Mentor): 10 Marks
b) End Semester Evaluation (ESE) – 60 Marks
1. Students shall register for and appear in the SWAYAM-NPTEL Proctored Certification Examination. 2. The marks obtained in the NPTEL Proctored Examination shall be converted proportionally to 60 marks using the following formula: 3. Students who successfully obtain the NPTEL certificate shall have the converted score considered as the End Semester Evaluation (ESE) marks. 4. Students who fail to obtain the NPTEL certificate, fail to appear for the NPTEL certification examination, or fail the certification examination shall appear for the Institute End Semester Examination conducted by the College. 5. If a student appears for both the SWAYAM-NPTEL Certification Examination and the Institute End Semester Examination, the higher of the two ESE scores shall be considered for the award of the final grade. 6. The decision of the Department regarding verification of NPTEL scores and award of

marks shall be final and binding.

BT Level	CCE						ESE
	CT1	CT2	Assignments	Course Project	Field Activity / Case Study	Quiz / present ation etc.	
K1	-	-	✓	-	-	-	✓
K2	-	-	✓	-	-	-	✓
K3	-	-	✓	-	-	-	✓
K4	-	-	✓	-	-	-	✓
K5	-	-	-	-	-	-	-
K6	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:

- Sensors and Vision System
- Robot Kinematics & Dynamics
- Design of Robot Elements
- ROS
- Autonomous Robotic Systems

Job Mapping:

- Robotics Engineer / Robotics Design Engineer
- Automation & Robotics Engineer
- Robot Integration / System Integration Engineer
- Controls and Motion Engineer
- Industrial Automation Engineer
- Mechatronics Engineer
- Robotics Testing, Commissioning & Maintenance Engineer
- Sensor/Actuator Application Engineer