

Unit 4068:

Industrial Robots

Unit code **L/617/3940**

Unit level **4**

Credit **15**

Introduction

Industrial robotics is the present and future of automated manufacturing and is an unstoppable reality. With the emergence of lighter, smarter and safer industrial robot models that are increasingly easy to interface, the demand has never been so high and is expected to grow year on year. Popular applications for industrial robots include welding, painting, assembly and materials handling. Modern industrial robots are now an integral part of cyber-physical mechatronic systems contributing to Industry 4.0 manufacturing.

The aim of this unit is for students to investigate the range, operation and benefits of industrial robots within manufacturing applications. Among the topics included are industrial robot selection, and programming and safety protocols that anticipate future developments in industrial robot technology.

On successful completion of this unit students will have an understanding of the electrical, mechanical, hydraulic and pneumatic operation of common industrial robots, how to select and program an industrial robot for a given requirement, taking account of safety considerations, and how to assess the economic future of robot technologies in manufacturing.

Learning Outcomes

By the end of this unit students will be able to:

- LO1 Describe the operational characteristics, selection criteria and applications of industrial robots within manufacturing industries
- LO2 Explain the safety standards associated with industrial robots
- LO3 Program an industrial robot for automated process application
- LO4 Investigate the global economic scope of industrial robots and integration into smart factories.

Essential Content

LO1 Describe the operational characteristics, selection criteria and applications of industrial robots within manufacturing industries

Types and selection:

Operational characteristics: Cartesian, cylindrical, spherical, toroidal, SCARA

Selection: number of axes; load, orientation, speed, travel, precision, environment and duty cycle parameters (LOSTPED); anthropomorphic robots

Common Brands: e.g. Fanuc, Yaskawa and ABB.

Applications:

Welding, painting, material handling, packaging, assembly, inspection, dangerous and robust working environments, repetitive tasks.

Operation and characteristics of 6-axis industrial robots:

Controller: motion controller, motor drives, power supplies, human-machine interface (HMI)

Manipulator: sensing, brakes, axis motor, effector motor, environment sensing

Tooling: grippers, types, interfaces

Axis operation: purpose of each axis, work area, reach, wrist roll, pitch and yaw motion, rotation, home position and calibration

End effectors: types of gripper tools and hands, two-jaw, vacuum and magnetic.

LO2 Explain the safety standards associated with industrial robots

Safety standards:

Functional Safety: IEC61508, Hazard and Risk Assessment

Robot and robot system safety: ANSI/RIA R15.06-2012, BS EN ISO 10218:2011

Cell safety features: operating envelope, space restrictions; operating safeguards, emergency stops, guarding, barriers, interlocks, light curtains, laser, two-hand controls, scanners, floor mats; barrier sizing – around, under, through, over (AUTO)

Operational modes, user interfaces

Safety first culture within the context: health and safety policies, procedures and regulations, compliance, risk management and mitigation.

LO3 Program an industrial robot for automated process application

Software:

Latest tools and technologies to aid programming of industrial robots.
For example: data objects, instruction lists, BASIC, MATLAB, Python, Yaskawa, MotoSim Enhanced Graphic Virtual Robot Control, ABB, RobotStudio, Fanuc Roboguide, Denso Wincaps III.

Robot application programming:

Types: joint-level, robot-level and high-level programming
Command and control: graphical user interfaces, point-n-click, scheduling software
Tasking software: drag-n-drop, specific application deployment, scripted language, lead by the nose
Online: joysticks, pendants, jogging, modifying existing positions
Computer simulation offline programming
Controlling robots with programmable logic controllers (PLCs; see *Unit 18*)
Robot commands: motion, interlock and sensor
Manufacturers' languages: ABB Rapid, Kuka KRL, Yaskawa Inform
Case studies: Team programming projects, peer evaluations and professional discussions.

LO4 Investigate the global economic scope of industrial robots and integration into smart factories.

Economic scope:

Major markets: Japan, USA, China, South Korea, Germany
Application demand: automotive, electrical and electronics, metal
Robot density; impact on workforce; training of workforce.

Advances in robot technology:

Machine vision, artificial intelligence (AI), collaborative robots (cobots), Internet of Things (IoT), edge computing, simplified integration, networked robots, cloud robotics, virtual reality robots; training of robots; role of robotics in Industry 4.0.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Describe the operational characteristics, selection criteria and applications of industrial robots within manufacturing industries		LO1 and LO2
P1 Review the types of industrial robots and their applications within manufacturing industries. P2 Describe selection criteria for industrial robot applications.	M1 Analyse the features and operation of six axis robots within manufacturing applications.	D1 Evaluate the selection of a safety-compliant industrial robot system for a given manufacturing application.
LO2 Explain the safety standards associated with industrial robots		
P3 Outline the principles and methods of functional safety analysis within automated manufacturing. P4 Explain the safety criteria for robot cells within manufacturing applications.	M2 Develop hazard and risk assessment for an industrial robot manufacturing system.	
LO3 Program an industrial robot for automated process application		
P5 Investigate the range of programming languages and methods available for industrial robots. P6 Program an industrial robot to perform a simple task.	M3 Analyse offline and online programming methods for industrial robots.	D2 Design, develop and test a robot program for a series of automated industrial tasks.
LO4 Investigate the global economic scope of industrial robots and integration into smart factories.		
P7 Assess the advantages and scope of collaborative robots over traditional methods. P8 Investigate advances in industrial robot technology.	M4 Analyse the benefits of artificial intelligence within industrial robotics and contribution to Industry 4.0.	D3 Evaluate the global economics of increased robot density in smart factories and the impact on the human workforce.

Recommended Resources

Note: See HN Global for guidance on additional resources.

Print Resources

- Blume C., K. Selke and Jakob W. (2011) *Programming Languages for Industrial Robots – Artificial Intelligence (Paperback)*. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG.
- Calinon S. (2021) *Robot Programming by Demonstration (Hardback)*. Taylor & Francis Inc.
- Doulgeri Z. and Dimeas F. (Editors) (2023) *Human-Robot Collaboration: Unlocking the potential for industrial applications – Control, Robotics and Sensors (Hardback)*. Institution of Engineering and Technology.
- Dum B. (2021) *The Complete Guide to Programming a Robotics for Dummies: Build, Analysis, Control, Applications, Autonomous, Defending Human Expertise, Machine Learning, And Virtual (Paperback)*.
- Eteokleous N. and Nisiforou E. (Editors) (2021) *Designing, Constructing, and Programming Robots for Learning (Hardback)*. IGI Global.
- Engelberger J.F. (2012) *Robotics in Practice: Management and Applications of Industrial Robots*. Berlin: Springer.
- Grau A. and Wang Z. (Editor) (2020) *Industrial Robotics: New Paradigms (Hardback)*. IntechOpen.
- Lazarescu M., Biradar R.C., Geetha D., Tabassum N. and Hegde N. (Editors) (2023) *AI and Blockchain Applications in Industrial Robotics (Hardback)*. IGI Global.
- Nagat F. and Watanabe, K. (2013) *Controller Design for Industrial Robots and Machine Tools: Applications to Manufacturing Processes*. Cambridge: Woodhead Publishing in Mechanical Engineering.
- perlberg J. (2016) *Industrial Robotics*. Boston: Cengage Learning.
- Petrič T., Ude A. and Leon Žlajpah L. (Editors) (2023) *Advances in Service and Industrial Robotics: RAAD 2023 – Mechanisms and Machine Science 135 (Hardback)*. Springer.

Journals

Note: Example journals listed below provide a broad range of articles related to unit content and those relevant for the qualification. Staff and students are encouraged to explore these journals and any other suitable journals to support the development of academic study skills, and subject specific knowledge and skills as part of unit level delivery.

[Automation and Remote Control](#)

[Automation](#)

[IFAC Journal of Systems and Control](#)

[IEEE Journal on Robotics and Automation](#)

[International Journal of Automation and Control \(IJAAC\)](#)

[Journal of AI, Robotics and Workplace Automation](#)

[Journal of Automation and Intelligence](#)

[Programmable Logic Controllers \(Special issue\)](#)

[Robotics](#)

Links

This unit links to the following related units:

Unit 4015: Automation, Robotics and Programmable Logic Controllers (PLCs)

Unit 4016: Instrumentation and Control Systems

Unit 4030: Industry 4.0

Unit 4033: Programmable Logic Controllers (PLCs)

Unit 5009: Further Programmable Logic Controllers (PLCs)

Unit 5021: Further Control Systems Engineering.