

IMPERIAL

AI & Autonomous Industrial Systems Summer School

Explore the cutting-edge science and technologies driving the transformation of industrial production towards greater efficiency and sustainability

21st July to 1st August 2025 at Imperial College London



IMPERIAL COLLEGE LONDON

Consistently rated amongst the world's best universities (1st in Europe and 2nd in World, QS World University Rankings 2025), Imperial College London is a science-based institution with an international reputation for excellence in teaching and research. Imperial attracts over 22,000 students and 8,000 staff of the highest international quality from over 126 different countries.

Since its foundation in 1907, Imperial's contributions to society have included the discovery of penicillin, the development of holography and the foundations of fibre optics. This commitment to the application of research for the benefit of all continues today, with current areas of focus including interdisciplinary collaborations to improve global health, tackle climate change, develop sustainable sources of energy, address security challenges, develop data management and analysis technologies for supporting data driven research, and tackling problems at molecular scale.

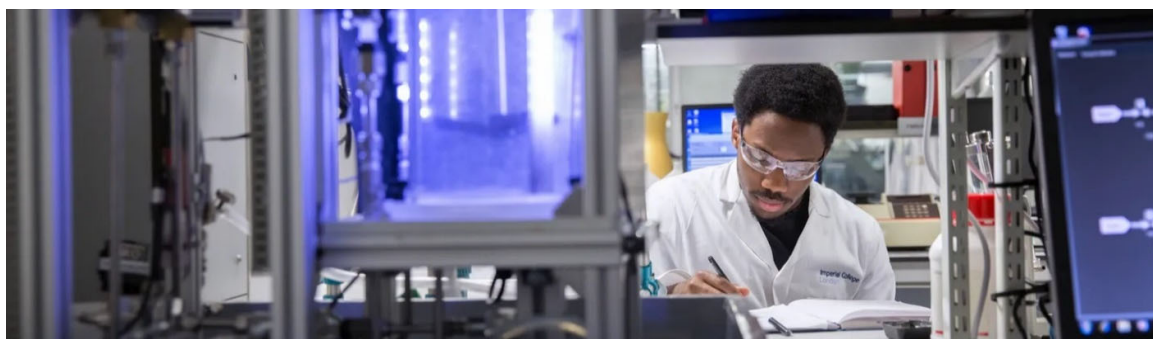


ABB AUTONOMOUS INDUSTRIAL SYSTEMS LAB

The ABB Autonomous Industrial Systems Lab (AISL) is a leading research group hosted by the Department of Chemical Engineering at Imperial College London and the Sargent Centre for Process Systems Engineering. The Lab brings together Imperial's expertise in process modelling, optimization, and artificial intelligence to redefine how industrial systems operate, advancing towards safer, more reliable, and more sustainable production processes. AISL provides a focal point for innovation, serving as a catalyst for addressing some of the most pressing challenges facing industries today. The Lab is supported by ABB – a global engineering company providing automation and electrification solutions.

Industrial systems are at the heart of modern society, but they also face critical challenges, including rising energy demands, the need to reduce greenhouse gas emissions, and the increasing complexity of interconnected operations. These issues demand transformative solutions that balance economic viability with environmental responsibility. The Lab's mission is to develop and deploy intelligent, autonomous systems that operate with minimal human intervention, guided by cutting-edge science and technology – a hallmark of Imperial College London.

As the industrial landscape grows more dynamic, traditional approaches to process design and control must evolve to embrace predictive models, adaptability, and continuous optimization. In this context, AISL combines advancements in machine learning, model predictive control, and real-time optimization with an emphasis on zero-emission technologies. By aligning its research with global goals such as those outlined in the UN Sustainable Development Goals, the Lab strives to enable industries to transition toward a low-carbon, resilient future.

In a world increasingly shaped by digitalization and sustainability imperatives, AISL is committed to collaborating with academia, industry, and government to harness the potential of intelligent systems. By doing so, it aims to ensure that industrial production not only meets the demands of today but also anticipates and solves the challenges of tomorrow, delivering transformative impact on a global scale.

SUMMER SCHOOL OVERVIEW

The AI & Autonomous Industrial Systems Summer School offers a unique opportunity to delve into the transformative role of artificial intelligence and machine learning in advancing industrial systems toward autonomy, efficiency, and sustainability. In an era defined by rapid technological advancements, understanding the core principles of data-driven decision-making and intelligent system design is essential for tackling the challenges of modern industrial processes.

The remarkable progress in AI and machine learning over the past decades has fundamentally reshaped industries, from manufacturing and energy systems to healthcare and transportation. With growing demands for efficiency, resilience, and environmental responsibility, the integration of intelligent systems into industrial processes is no longer a vision of the future—it is a necessity.

This summer school programme has been meticulously designed to align with the cutting-edge research and educational expertise of the Autonomous Industrial Systems Lab (AISL) at

Imperial College London. The programme will equip participants with the foundational skills and hands-on experience required to address real-world industrial challenges through intelligent, data-driven approaches.

This intensive two-week programme is open to undergraduate and early postgraduate students across a range of disciplines who are keen to explore the science and technologies underpinning autonomous systems. Participants will gain exposure to the fundamentals of AI and machine learning, engage with real-world industrial problems, and collaborate on projects that simulate the challenges faced by today's industries.

Topics covered include:

Introduction to Statistics and Linear Algebra: Building the mathematical foundation for data science and machine learning.

Machine Learning Fundamentals: Exploring the key concepts and techniques that drive AI applications.

Optimization Fundamentals: Understanding the role of optimization in decision-making and intelligent system design.

Supervised and Unsupervised Learning: Applying models to tasks such as prediction, classification, and clustering.

Active Learning: Advanced topics in Bayesian Optimization and Reinforcement Learning for decision-making under uncertainty.

Project-Based Learning:

Participants will apply their knowledge through engaging, hands-on projects in three key areas:

Team learning through group projects on industry relevant applications:

Participants will apply the foundational knowledge gained during the summer school to real-world scenarios through a series of carefully designed, hands-on projects. These projects provide an opportunity to bridge theory and practice, empowering students to tackle industrial challenges using state-of-the-art AI and machine learning techniques. The projects focus on three key areas, each reflecting a critical aspect of modern industrial systems:

Image Recognition-Based Anomaly Detection:

Participants will explore how machine learning models can be employed to detect irregularities in visual data, a crucial capability in manufacturing for quality control, assembly line monitoring, and packaging inspection. Through this project, students will:

- Work with image datasets to identify patterns and classify anomalies.
- Learn to preprocess, augment, and analyse image data for model training.
- Understand the importance of anomaly detection in ensuring operational safety, reducing downtime, and improving system reliability.

Time Series Forecasting:

This project emphasizes the development of predictive models to anticipate trends and patterns in industrial operations. Time series data is ubiquitous in industrial systems, capturing critical information such as equipment performance, energy usage, and production rates. Students will:

- Apply statistical and machine learning methods to forecast future values based on historical data.

- Address challenges such as noise and process disturbances in datasets.
- Discuss the implications of accurate forecasting for proactive maintenance, resource planning, and energy optimization.

Reinforcement Learning:

Participants will dive into the world of reinforcement learning, designing intelligent agents capable of making optimal decisions in dynamic and complex environments. Reinforcement learning has transformative potential in areas like process control, robotics, and supply chain optimization. In this project, students will:

- Define reward functions and explore how agents learn to maximize performance.
- Experiment with training models in simulated environments to achieve desired outcomes.
- Understand the role of reinforcement learning in autonomous system design, enabling adaptability and resilience in uncertain conditions.

Learning objectives:

On completion of this summer school, students will be able to understand, define and place in the wider context:

- Grasp the fundamental concepts of statistics, linear algebra, and machine learning as they apply to industrial systems.
- Define and address optimization problems in real-world scenarios.
- Understand and apply key machine learning techniques, including supervised and unsupervised learning.
- Explore advanced AI topics, such as Bayesian Optimization and Reinforcement Learning, for decision-making under uncertainty.
- Develop data visualization and presentation skills, communicating findings to expert panels.
- Collaborate effectively within a team to address complex, multidisciplinary challenges.

In addition, students will have an opportunity to make new friends, get to know student ambassadors from Imperial College London through social activities and discuss opportunities for future study and experience what it is like to study in a world class university.

Visit to the Imperial College London Carbon Capture Pilot Plant



As part of this summer school, students will have a unique opportunity to visit the state-of-the-art carbon capture pilot plant at Imperial College London's Department of Chemical Engineering. The pilot plant visit offers a real-world glimpse into how intelligent systems are

transforming industries to address pressing challenges such as reducing carbon emissions and achieving net-zero targets. It's a chance to see first-hand how theoretical principles translate into practical solutions with a significant global impact.

PROGRAMME STRUCTURE AND FORMAT

60 contact hours spread over 2 weeks covering lectures, workshops, tutorials, project work, social activities and relevant visit. Classes will be delivered on weekdays.

Students will be allocated in small groups for Project work which will be done through team-based learning with supervision. Final project will be presented in groups to a panel of experts on the last day of the programme. A prize will be awarded to the team with the best project.

The entire programme will be taught in English.

SESSIONS DESCRIPTION

Days 1 to 5: Foundations and Skill Development

Each day will include lectures, interactive discussions, and practical sessions to ensure participants develop a comprehensive understanding of key topics.

Day 1: Foundations of AI and Machine Learning

Introduction to statistics and linear algebra as the mathematical foundation of AI.

Day 2: Optimisation and Machine Learning

What is optimization? Key concepts and applications in industrial systems. Solving optimisation problems.

Day 3: Supervised Learning

Concepts and models. Introduction to neural networks. Applications: Dynamic modelling of industrial systems.

Day 4: Unsupervised Learning

Principal component analysis and dimensionality reduction techniques. Clustering methods
Applications: Anomaly detection and pattern recognition.

Day 5: Active Learning

Bayesian Optimization: Using probabilistic models for decision-making under uncertainty.
Reinforcement Learning: Training agents to learn policies through interaction with the environment.

Days 6 to 10: Project-Based Learning

Day 6: Students will form groups based on their interests and begin project work, selecting from themes such as image recognition-based anomaly detection, time series forecasting, or reinforcement learning.

Days 7 to 9: Teams will focus on developing solutions, incorporating a hands-on component that utilizes experimental apparatus or actual industrial data to ensure practical relevance. Throughout these days, teaching assistants will supervise the students, providing guidance, answering questions, and assisting with technical challenges as needed.

Day 10: The programme culminates with project presentations to a panel of experts, where teams will showcase their findings, methodologies, and insights, receiving feedback and recognition for their efforts.

Social activities will include:

- Welcome lunch and campus tour with Imperial student ambassadors.
- Thames River Cruise.
- British Cultural Quiz.
- Visit to Bletchley Park.
- Tour of the Royal Albert Hall

ENTRY REQUIREMENTS

All students are expected to be studying an undergraduate degree in engineering, chemistry or physics preferably in the final two years of their undergraduate studies. Proficiency with Python programming is a prerequisite.

English requirements:

All students are required to have a good command of English, and if it is not their first language, they will need to satisfy the College requirement as follows:

- a minimum score of IELTS (Academic Test) 6.5 overall (with no less than 6.0 in any element) or equivalent.
- TOEFL (iBT) 92 overall (minimum 20 in all elements)

Students will be asked to bring along a laptop computer for project work.

TEACHING FACULTY

The summer school is Academic Director is Dr Mehmet Mercangöz.



Dr Mehmet Mercangöz, Director of the ABB Autonomous Industrial Systems Lab

Dr Mehmet Mercangöz is a faculty member at Imperial College London Department of Chemical Engineering. He is also associated with the Sargent Centre for Process Systems Engineering.

The programme will be taught by a multi-disciplinary teaching team from the Department of Chemical Engineering of Imperial College London.

CERTIFICATION

Students will receive an Imperial College London certificate on successful completion of the summer school and a prize will be awarded to the best project team. Each student will also receive a document stating their project marks.

LOCATION

The summer school will take place at Imperial College London's South Kensington Campus, located amongst many famous [attractions](#) in London.

The culture triangle: neighbour to three of London's most prestigious (and free) museums. Right next door, the Science Museum. Across the road, the Victoria & Albert Museum, and around the corner? The Natural History Museum. From Neolithic to the latest scientific breakthroughs, experience it all just minutes from Imperial's doorstep.

The campus is also next to the famous Royal Albert Hall, one of London's most iconic music venues, established in 1871, host to the BBC Proms and countless world-famous international artists.

In addition, the beautiful Hyde Park and the famous Harrods Department Store are just a short walk from the campus.



Organised by the Institute of Extended Learning, Professional Development & Summer Programmes unit, in collaboration with the Department of Chemical Engineering at Imperial College London.