



**UNIVERSITY OF  
BIRMINGHAM**

Centre for Hydrogen and Fuel Cell Research  
[www.fuelcells.bham.ac.uk](http://www.fuelcells.bham.ac.uk)

## **L5 Train-the-Trainer course in fuel cells and hydrogen fuel.**

The training programme includes lecturing hours will be delivered online via the University of Birmingham online Learning Management System (CANVAS) and a practical session (Hydrogen Fuel Cell Skills Training Lab) will be delivered at Birmingham Energy Innovation Centre (BEIC) in Tyseley Energy Park, B25 8FJ, Birmingham.

The course will be organised and offered at the first instance to technical staff, teachers, and those in industry (training the trainers) over a total duration of 4 weeks for 40-50 hours. Within this period, participants will have the opportunity to work with the course material at their own pace, take part in group tutorials and discussions on content updates.

The workload should be tailored to the needs of part-time participation, alongside regular working hours. The timetable should allow the participants to manage their workload individually, supported by the tutorials. The course flow plan should make suggestions and recommendations regarding the timing within which specific content should be covered. The learning outcomes will be tested through regular quizzes, and a lab session at the end of the course.

### **Course Structure**

The course delivery should be divided into lectures, which are organised into thematic teaching units. One Teaching Unit should comprise of what a student would be expected to cover in one day. The timing for online learning is more flexible, but these units should give the participants some orientation on how much time to spend on the material.

- Lectures consist of video recordings of material, offered in the format of, for instance, MP4 recordings. The lecture page in the course also gives the student a short summary of what is important about the lecture (learning outcomes), access to the slide set of the presentation, and a number of further reading web links and pdf-files for those students who want to go deeper into the lecture content. All lectures are delivered with an English language audio track. English subtitles are provided for ease of understanding. Students can stop, rewind, back-step, fast-forward, or interrupt lectures any time, and resume watching whenever they please. Lectures are often divided into shorter parts, simply for ease of handling.

- A Teaching Unit contains 3 to 6 lectures, and one or several quizzes that allow the students to check on their progress. All the above is implemented as a fully online supported course.
- Tutorials serve as the contact points between participants and lecturers and are delivered in real time (synchronous). We use Zoom meetings to take on board participant questions and queries, offer additional exercise material, and/or deepen key teaching subjects. The nature of tutorials partly depends on the participant involvement, interest, and respective backgrounds, which have a decisive influence on the way participants wish to interact with the lecturers. They can thus be more or less interactive, practical problem, or teaching oriented. A tutorial of 2 hours is offered within each week the course runs at a specified time.

## **Syllabus**

The following is the structure of the module, teaching units and lectures.

### **Module: Fuel Cells Basics and Hydrogen Safety**

- Introduction to Fuel Cells and Hydrogen
  - Fuel cell background and history
  - Fuel cell basics and types
  - Introductions to applications of fuel cells
- Hydrogen Safety
  - What is Hydrogen
  - Methods of storing and infrastructure
  - Handling hydrogen and design standards
  - Introduction to detonation & deflagration

### **Module: Hydrogen generation and storage**

- Introduction to tools, rules of thumb and applications
  - Overview of fuel cell stack design and components
  - Introduction to tools
  - Normal operating conditions
  - Fuel cell control
  - Rules of thumb
- Installation, maintenance and troubleshooting
  - Overview of fuel cell systems
  - Technical drawings
  - Safety aspects linked to installation
  - Maintenance and service
  - Diagnostics
  - Common problems and solutions

### **Module: Specialist Module Overview (from one of the following topics)**

- Fuel Cell Generators (APU and Backup Power)
- Fuel Cells for Combined Heat and Power Applications
- H<sub>2</sub> Fuel Cell for Transport
- H<sub>2</sub> Production and Handling
- Micro Fuel Cells

### **Module: Practical Training**

- Hydrogen bottles handling, pressure regulators.
- Testing 1.2 kW air-cooled PEM fuel cell system
- Testing DC-DC converter integration to fuel cells
- Overview of Balance-of-Plant components of water-cooled PEM fuel cell system.
- Overview of 150 kW fuel cell packaging for transport applications.

### **Certification and Accreditation**

Participants who successfully complete the Technical Staff Training (Train the Trainer) will receive a completion certificate issued by the University of Birmingham.

### **Technical Aspects**

In addition to the above, the following aspects are also included:

- Provision of delivering the material using University of Birmingham canvas Learning Management System (LMS). The material will include a recorded lecture, slide set and a pdf file with a summary of the content covered.
- Registration and access control.
- 2 hours weekly online tutorials in the duration of the course.
- Online quizzes for self-monitoring of student progress.
- Online discussion board for exchange between students, provide feedback and ask questions.
- Provision of slide sets and background material for self-study and further information.
- Final feedback and discussion session.