

# Metrology for Productivity

Learning and development opportunities covering industrial metrology and dimensional measurement

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# Metrology for productivity

Coventry University's metrology for productivity team offers you learning and development opportunities covering industrial metrology and dimensional measurement.

## About Coventry University

Coventry University is a leading university with an innovative approach to teaching and learning, a focus on impactful research and strong links to industry. It is the country's top modern university in the Guardian University Guide 2018 - in which it ranks 12th overall - and is one of the UK's top ten universities for employment rates\*. Coventry also received a Gold rating in the Government's new Teaching Excellence Framework (TEF), which ranks how well students are taught across UK universities.

### Our Approach

Metrology can make the difference between customer satisfaction and the business wide cost penalties of part rejection and failures. Good application of metrology can ensure your product is right, your waste is reduced and your productivity enhanced. In addition, it can provide vital business intelligence that can empower decision making.

The Metrology for Productivity Team at Coventry University are passionate about Metrology's place in modern manufacturing, we understand the linkages between good measurement and good manufacturing. Our approach combines the core knowledge of a leading mechanical engineering University, with the experience of metrology experts who have practical industry experience.

Our mission is to use good metrology to unlock the benefits and reduce the waste, often masked in a company. We do this through practical and relevant training and education, offering metrology thought leadership with the independence of knowledge and the learning excellence associated with a top university.

### Our philosophy

Effective metrology has always been one of the key foundations of successful manufacturing. Historically it was a background activity that almost looked after itself. But with today's demands for more advanced manufacturing techniques, lean and agile business structures, ever tighter specifications and a boom in new measuring equipment and technologies, we think it's time to update old knowledge and make your metrology add value, cutting out the waste often hidden across multiple business budgets and cost centres especially time. Stop the confusion of measurement variation, firefighting scrap and rework, distractions of resources, inappropriate technology investment and unnecessary box ticking. Reduce costs and make metrology work for you and your business.

\* DHLE 2015/2016

## What we do

At Coventry University, our Metrology for Productivity team offer a range of learning and development options to from a foundation of basic knowledge through to higher education qualifications. All our programmes combine our academic knowledge with industrial expertise. We upskill, educate and maintain professional development in manufacturing and industrial engineering metrology practices and their resultant measurement activities.

Our metrology short courses cover measurement best practice, tools and techniques, and importantly realistic industrial applications. Our programmes have been developed to cover the issues we know businesses regularly face and are designed to help you resolve real metrology challenges. If one of our standard courses does not fit your exact needs we are able to quickly tailor a programme from our basic library of knowledge that will cover specific company requirements.

We are proud to be part of a university consistently rated as a leading teaching organisation and ranked highly for its mechanical engineering capabilities and our programmes all draw on this expertise in teaching and engineering.

## How we deliver

We deliver courses from one day to one-week as well as a part time foundation degree over two years.

Our open programmes run regularly at our Coventry campus and include all materials and equipment as well as refreshments and lunch each day. The open courses offer excellent facilities and access to equipment with the flexibility of booking single places on any of our open courses.

Customer dedicated courses are offered on our campus or at a customer site subject to adequate training facilities and a minimum number of candidates. We have dedicated portable teaching equipment for metrology training and so our trainers can deliver anywhere in the UK and beyond.

All candidates receive a certificate of Continued Professional Development (CPD) from Coventry University in recognition of course completion.

## Metrology for productivity within Coventry University covers three principal areas:

- Learning and Development (short training courses, Continual Professional Development and university education)
- Consultancy (from single issue resolution to long term metrology support and development)
- Research (from the application of technology to system and process conception)

### Within Learning and Development, we can offer:

- One-day modular measurement and metrology courses
- Speciality metrology short courses
- Degree qualifications
- Bespoke measurement and metrology courses

### Our delivery can be:

- On Coventry University campus
- At a customer's site (subject to numbers)

### Course fees:

Our courses start at £195 per person



# One-day modular courses

## The fundamentals of measurement

### First principle measurement

An introduction to basic measurement principles using first principle measuring equipment and first principle techniques. This includes the best practice use of handtools such as Calipers, Micrometers and Bore micrometers. Covering an introduction into how measurement variation occurs during any measurement and the key steps you can take to improve repeatability and accuracy.

#### Details

- Improving how we measure to increase efficiency and confidence in right first time
- An introduction to common hand tool and first principle measurement techniques
- Understanding good practice in measurement techniques and procedures
- An appreciation of how measurement variation occurs and how to mitigate it

#### Who should attend?:

Machine tool operators and shop floor inspectors. Those new to measurement but with a basic understanding of manufacturing. New Coordinate Measuring System operators or production manufacturing engineers who apply production and investigative measurement.

### Geometrical Dimensioning and Tolerancing (GD&T)

The aim of this course is to provide an appreciation of Geometric Product Specification (GPS) and the key standards that exist within GPS. The course focuses on the application and definition of Geometric Dimensioning and Tolerancing (GD&T) in relation to datum strategies and the application of tolerances in a variety of common applied scenarios.

The course will familiarise the learner with the feature frame definition system and discuss symbols, tolerance and alignment strategies, and the application of suitable part geometries to the respective elements.

#### Details

- Summarise the GPS system and highlight the six primary chain links within it
- Explain dimensional tolerancing and Geometric tolerancing common practices
- Illustrate the application of GD&T within the context of engineering component definition.
- Understand the commonly used symbols within feature control frames
- Summarise a range of practical measurement strategies and techniques which would be suitable to verify physical geometry against the GD&T standards
- Practice a range of measurement exercises and appreciate relationships between design demand and component verification.

#### Who should attend?:

Any individual whose role includes interpretation of engineering drawings and determine their design intent turning that design intent into an effective, appropriate and trusted measurement result, regardless of the equipment used from hand tools to coordinate measuring systems.

### Principles of coordinate metrology systems

This course will cover all the key aspects of coordinate metrology. These include understanding coordinates in a measurement process, giving a good appreciation of the suitability of measurement technologies as well as in depth best practice strategies for traditional coordinate measuring systems. It will help you understand how to get the best out of your measuring system as you use it.

#### Details

- What are coordinates and their units and application?
- Measurement strategies including setting datums and tolerancing
- Six degrees of freedom and part holding and fixturing
- Strategies for laser, optical and tactile systems
- Geometry construction and manipulation
- Standards for traceability and validation

#### Who should attend?:

Coordinate measuring system users and programmers, including CMM, optical / vision systems, laser trackers, scanning systems and photogrammetry. This course is also ideal for inspectors prior to undertaking vendor-specific training.



## Applied metrology

### Gauge capability

An important tool in the metrology armoury to be able to test measurement process capability. Modern digital devices regularly report dimensions to the micrometre (0.001mm) but the actual capability of the system remains unknown, introducing uncertainty in how that ties into process variation and the tolerances applied. This course will look at Gauge Repeatability and Reproducibility (GR&R) and other gauge capability tools.

#### Details:

- Why do we need to understand capability of a measurement process?
- An explanation of process stability and understanding the data required
- Which tool to use, GR&R, Gauge R (type 1 study), Cg/CgK
- Interpreting the results and effecting improvement where required
- An introduction to Measuring Systems Analysis (MSA)

#### Who should attend?:

Measurement specialists who have responsibility to assure the confidence in any given measurement system capability. Quality engineers, production / manufacturing engineers who plan or organise measurement and supplier quality engineers.

### Process control

An understanding of the key concepts concerning the use of statistical process control relating to metrology as the course explains normal distribution and how this can help understand measurement variation and builds a picture that contributes to process control.

#### Details:

- An explanation of probability and normal distribution
- Attributes and variables analysis
- Standard deviation (sigma) and how it impacts measurement
- Histograms and process control charts (average and range)
- CP/CPk explained

#### Who should attend?:

Measurement specialists or metrologists who are involved in volume production and are required to understand the application of statistical analysis. You will not become an SPC expert but will readily understand common practices applied to measurement results to achieve process control.

## Metrology for non-metrologists

### Metrology for designers

The cost of poor quality often starts with the lack of consideration in design for manufacture. Bad datum placement or ineffective tolerancing can often lead to expensive over engineering or reworking taking place at the manufacturing stages. This professional development course is aimed specifically at designers to give them an understanding of measurement practices to a level that will help them effectively communicate design intent whilst recognising the implications of datum and tolerance decisions on measurement and production costs.

#### Details

- Understanding applied use of GD&T, datum placement and tolerancing
- A basic awareness of common practice measurement technologies and techniques
- Impact of metrology in the design stage on manufacturing costs

#### Who should attend?:

Designers and manufacturing services connected to design.

### Metrology for managers

The aim of this course is to provide an appreciation of the overall management and control of measurement. The course provides the foundation for best practice in dimensional measurement explaining which tools and techniques within the metrology philosophy are appropriate to you and your company. We will help you to understand what helps create successful measurement and the key tools and techniques to deliver cost effective measurement as a value added tool.

#### Details:

- An understanding of equipment types and characteristics, including cost over benefit
- How environmental issues and other factors can create confusion and scrap
- Skills associated with measurement specialists and metrologists
- Manufacturing process influences on the measurement system and tools
- The importance of standards, traceability and process

#### Who should attend?:

Quality managers, manufacturing managers with a responsibility for quality, company directors and small business owners.



# Specialist metrology courses

## Industrial applied measurement uncertainty

A two-day course covering the scoping, calculation and application of industrial measurement uncertainty.

If you are involved in calibration, planning a new measuring process, buying new equipment, looking to move to a new site or considering introducing other change to the process, then measurement uncertainty will contribute greatly to improve that decision-making process prior to change and help mitigate the inevitable problems and workarounds that then occur. Examples will be given and interpretation and common practice covered both in applying uncertainty budgets and what next.

### Details:

- Understanding the measurement model in accordance with the international standards including the Guide to Uncertainty in Measurement (GUM), BS EN ISO/IEC 17025, ISO TS 14253, M3003 and others
- How to interpret and apply the measurement uncertainty results including statistical and probability models
- Designing the measurement process and understanding of static and dynamic characteristics of systems
- Identifying and quantifying the inputs including imported uncertainties, including probability density functions  $f(x)$ , and assess sampling methods
- Calculating sensitivity coefficients and combining them mathematically in accordance with the GUM and other standards
- Construction of the uncertainty budget to expanded uncertainty
- Analysis and improvement or selection of the measurement process through analysis of the uncertainty model constructed

### Who should attend?:

This course is suitable for measuring system champions. Production / Manufacturing / Quality / Design Engineers who wish to gain an appreciation of uncertainty. Any individual who is the technical lead on the purchase of new measuring systems or involved in new part introduction. As a CPD activity for those with a requirement to plan measurement or understand the results from measurement systems.

## Measurement systems analysis

Measurement Systems Analysis (MSA) is a core tool in understanding the amount of variation there is within a measurement process and what contribution that has to the total variation of the manufacturing process. From this you can decide on the suitability of the measurement process and develop improvements if required.

This three-day course combines an overview of statistical theory and test design with hands on group and individual exercises. This will equip candidates in industrial and scientific environments, with the analytical tools, application and understanding of a complete MSA project.

### Details:

- Understanding of Type 1 and Type 2 MSA's
- Process observation, test design and test management
- Statistical tools used such as Range and Mean R&R, ANOVA R&R, EMP and attribute gauge studies, consistency tests, control charts, bias, and linearity capability indices
- Collation and process of measurement system outputs including analysis and recognition of the gauge resolution impact leading to interpretation and making clear, reasoned and traceable decisions on the capability of measurement processes
- Recommend and appropriate courses of action
- You will through activities undertake three full MSA example studies, applying both the practical and analytical techniques introduced

### Who should attend?:

Measurement specialists who have responsibility to assure the confidence in any given measurement system capability, quality managers and metrology project champions. Quality engineers, production / manufacturing engineers who plan or organise measurement and supplier quality engineers.

## Metrology masterclass

This five-day course is designed to be ran only at Coventry University campus as a summer school in late June / early July\*. Candidate numbers are limited so that everyone gets the appropriate time on equipment and to engage with the teaching team.

The basis of the course is industrial dimensional measurement and covers four core knowledge areas:

- The application of metrology principles using a variety of typical equipment looking at good practice and pitfalls
- Measurement and metrology assessment, management tools, related metrology organisations and international standards
- Continuous improvement and waste reduction in metrology systems and processes
- The scientific principles behind measurement equipment technologies, sensors and measurement techniques

The course is taught through various sessions:

- Lectures, presentations with some group interaction and minor activities
- Activity sessions, hands on user experience of a variety of measuring equipment and metrology tools
- Discussions, led by the lecturer these sessions draw out examples from the group and then discuss them

### Additional details:

- A broad and proficient level of understanding of the core underpinning principles of effective measurement and metrology
- How to achieve confidence and sustainability in the measurement result
- Selecting appropriate equipment and strategies for measurement
- Learning good practice and getting hands on use of a variety of first principle and coordinate measuring systems related to various industrial sectors

### Who should attend?:

This course is designed for roles relating to quality / production / manufacturing engineers with responsibility for facilitating and managing measurement processes and metrology tools and technical input into the purchasing of metrology equipment. It also meets the needs of metrology equipment technical sales / applications and measurement contract services providers.

\*Due to the logistics required for this course, the running date is once per year and early registration of sufficient numbers are required to make the planning of the course and its commerciality viable. Please register any interest as early as possible.



# National Physical Laboratory accredited courses

Backed by one of the UK's national measurement institutes, the National Physical Laboratory (NPL), these courses are blanket metrology courses giving introductory insight into good measurement practice and metrology tools. All materials supplied are managed by NPL with Coventry University providing the teaching. Coventry University is proud to have been teaching this course since 2007 and adding our own teaching excellence to the NPL courses.

## Dimensional measurement

### Level 1

A three-day training course that introduces dimensional metrology and some of the key elements involved in good practice, focusing on the right measurement behaviours.

Benefits to the learner

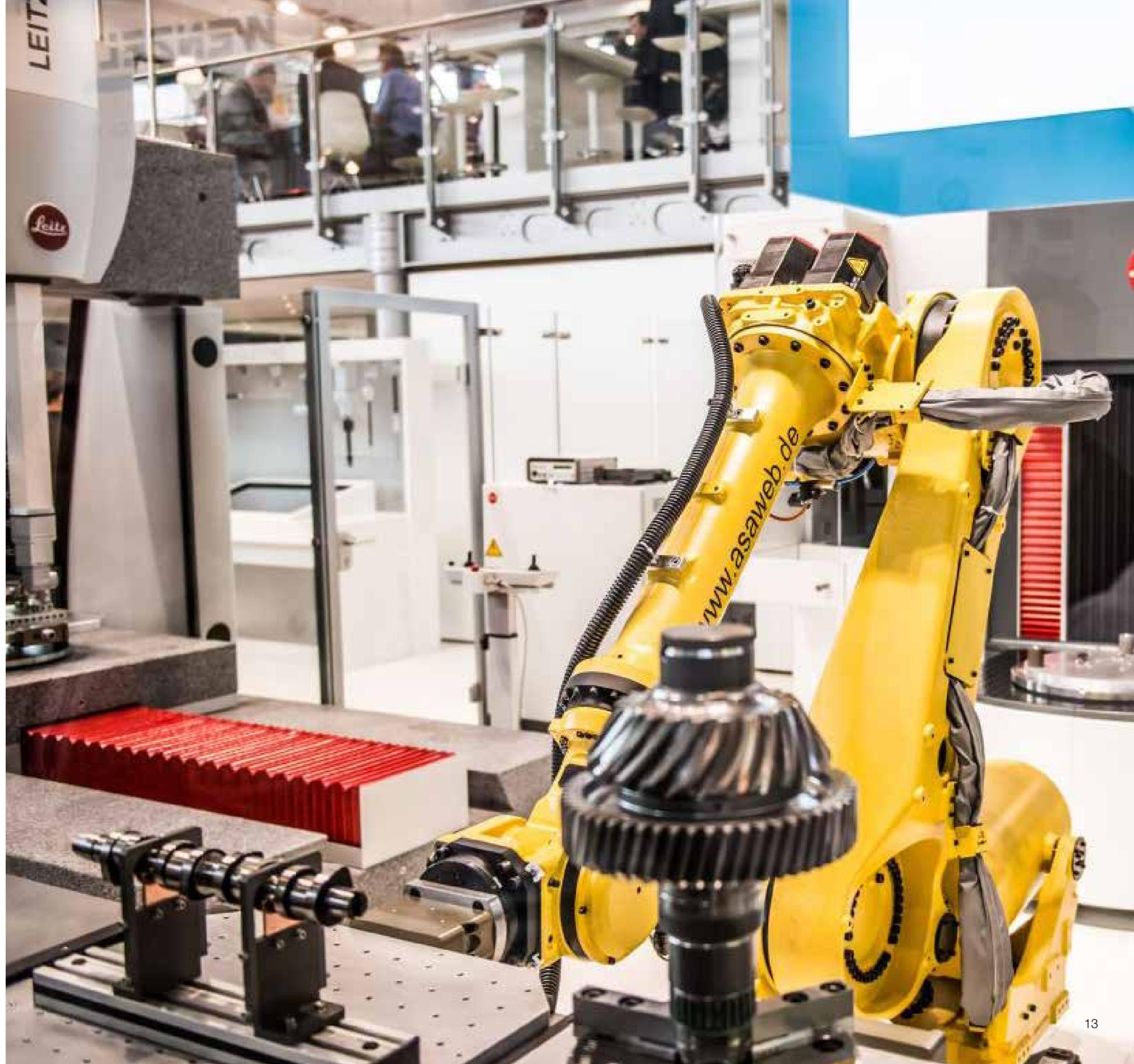
- To understand the importance of using the correct measurement tools for varying applications
- Give delegates a sense of responsibility for the measurement process and its practical application
- Hands-on experience of why measurement is critical to the entire manufacturing engineering process
- To encourage learners to develop a measurement strategy in the workplace

### Level 2

A four-day training course that builds on the basic knowledge and measurement principles achieved in Level 1. You must have completed level 1 to undertake level 2.

Benefits to the learner

- Application of the fundamental principles of geometrical product specification and measurement tools
- To understand the fundamental principles of calibration
- To apply fundamental measurement calculations
- Respond to measurement results and related uncertainty
- Communicate, question and plan the measurement process



# Degree courses

## Foundation Degree (Eng.) Metrology

The Foundation Degree (Eng.) in Metrology (FDeM) is an employer-led Higher Education qualification in Metrology. Learn metrology tool techniques and the decision making that is essential in a quality manufacturing business. Entry is via two routes:

- Academic credits, for example a HNC or engineering degree or
- Vocational experience, where work experience in measurement can qualify your acceptance onto this course

It is critical for any entry route that the student has the support of an employer who can give them access to measurement systems and the support they require to complete the work-related project element of their learning.

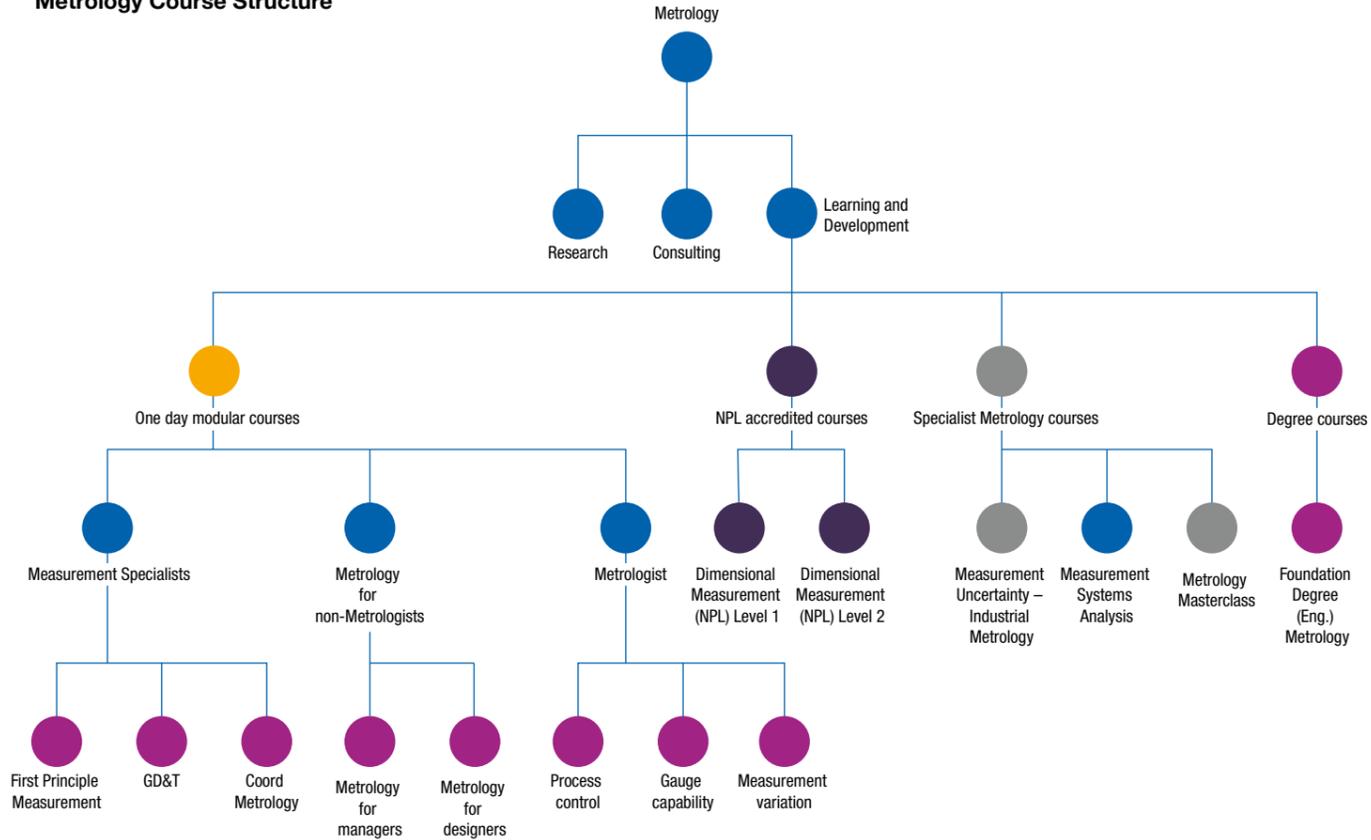
This specialist course is totally focused on measurement and metrology for predominantly the manufacturing, industrial or industrial services sectors. It is a block release course where the student attends the University for two-day blocks per module, completing 6 modules per year for two years. The student will follow up on the lecture with work related tasks and self-learning to complete a project or assessment of working practices and measurement systems. Thus, the company itself can benefit from potential recommended improvements and information the student creates throughout the two years of the course.

The modules cover the breadth of applied dimensional metrology as practised in manufacturing engineering and its support services. Key areas include:

- A good overview of measurement technology and best practice in measurement
- Causes of measurement variation
- Understanding sensor technology involved in measurement and their positives and negatives
- Traceability and standards that underpin metrology practice
- Uncertainty and its quantification in a measurement process
- Measuring system analysis, the full breakdown and verification of a measurement process, people and equipment to deliver valid measurement results and data (Includes GR&P).
- External best practice with a visit to an exemplar site to see how others apply excellence in measurement

The FDeM sits firmly in the UK's qualification framework at 240 credits and is formally recognised throughout the UK and the rest of the world as a formal qualification in metrology. After completion and subject to the awarded pass level the student can choose to continue education and complete to a full engineering degree subject to course entry criteria.

## Metrology Course Structure



Each course is listed in detail in this brochure.



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