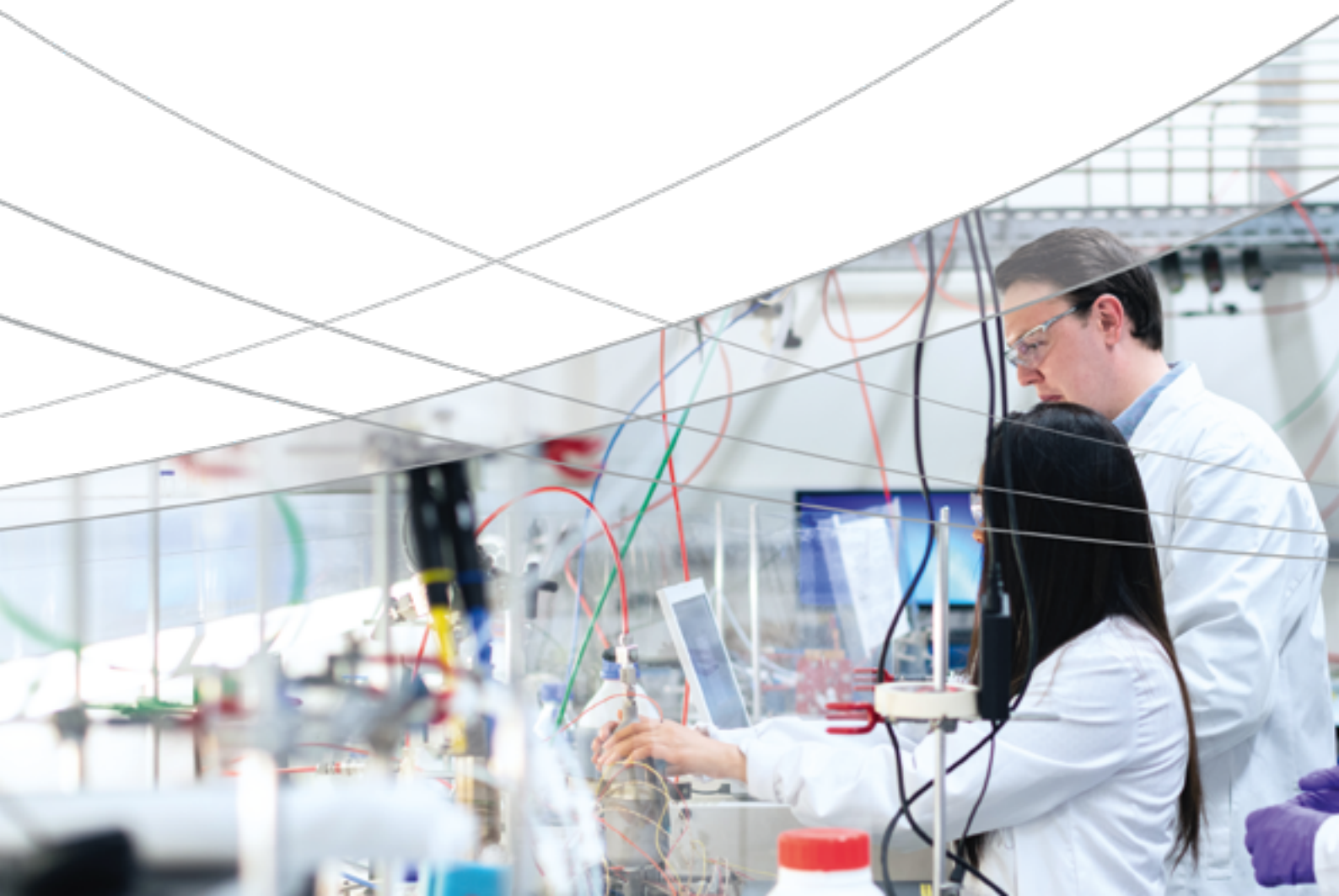


# Teaching Analytical Sciences

In partnership with Shimadzu



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**Pharmaceuticals**



**Medical Care**



**Chemicals**



**Foods Safety**



**Environmental**

## Shimadzu's Commitment to Furthering Education

The corporate philosophy of the Shimadzu Group, to 'Contribute to Society Through Science And Technology', underpins our efforts and determination to raise the level of quality and understanding in Practical Analytical Chemistry in schools, colleges and universities across the United Kingdom.

As a top-tier sponsor of the Royal Society of Chemistry's CAMS (Community for Analytical Measurement Science), our continuous commitment to furthering education in analytical sciences field is clearly demonstrated.

Technological shifts in scientific analysis have seen the use of analytical instrumentation increasingly employed for measurement and testing purposes. This increase has coincided, with the use of analytical instrumentations broadening use within commercial fields including industry and research.

Improving the quality and skills of tomorrow's Analytical Scientists will enhance the efficiency and productivity of commercial laboratories and further the boundaries in research, in less time. We will work with you to spark interest and inspiration in students, with exciting instrumentation and interesting, relevant experimental challenges.

Our team of industry experts and skilled application scientists with over 100 years combined experience are ready to work with you, tailored to your requirements and aspirations.



## Uses of Chromatography in Everyday Life

Chromatography may not be the most well known scientific field but is steeped in history. Decades of scientific advances led us to today's uses of chromatography. Uses that include industry sectors such as forensic science, pharmaceutical, chemical, food and healthcare. Chromatography allows all these industries and more to separate each component within a mixture to accurately identify and quantitate the amounts within varying types of samples.

Let's have a closer look at few sectors:



### Forensic testing

Crime dramas such as CSI have brought criminal investigations to mainstream television. You may have heard of Major Mass Spec in NCIS; this Shimadzu gas chromatography mass spectrometer is not only used on this drama series but also in reality. Crime scene samples can all be processed for various compounds, including analysis of chemicals within arson cases, soil analysis from shoes or carpet, or identification of unknown particles found on clothing. These tests can also be used during post mortems to determine conditions such as heart attacks or perhaps drug overdose that may have caused death.



## Biological sample analysis

Due to the precision with which chromatography can identify substances in blood and urine, it is widely used not only within hospitals, but also by the police and authorities such as the **World Anti-Doping Agency (WADA)**. No matter if you are having a routine blood test for health reasons, being investigated for taking illegal drugs or an athlete being checked for banned substances, the same chromatography principles are utilised.



## Food analysis

Have you ever wondered how manufacturers maintain the quality and consistency of their products? Continuous monitoring of levels of **sugar** going into final products or **alcohol content in spirits** are basic chromatography tests. Chromatography can even determine how “bitter” your beer will taste. However, it can also detect the substances that should not be there! News stories have reported the scandal where **horse meat** replaced beef in processed foods, high heavy metal levels in rice and melamine, a carcinogen within baby milk formula in China. It can also show you what colourants are used in your food and drink – even blue smarties!



## Household products

Have you ever picked up a face cream, shampoo or kitchen cleaner and read the ingredients? All these ingredients are individually tested for a variety of reasons. This also includes products we store in sheds and garages. Pesticides, herbicides and insecticides are all tested for their environmental impact and efficacy of their active ingredient, to ensure that product simply does the job effectively and is **not dangerous** to us or the environment.



## Pharmaceutical

2020 saw the start of a worldwide pandemic and development of new vaccinations. Chromatography was used to not only analyse **COVID-19 detection test components**, but also run vigorous testing on vaccinations. As well as the vaccines, there were many other medications tested in hope to reduce symptoms. Chromatography has led the way in testing and developing **new drugs and vaccinations** for decades. Who knows what chromatography will help discover next?

We have seen that chromatography is used across a wide variety of compound types and industries. Teaching the fundamentals of chromatography can open avenues across multiple sectors and product types. Who knows what the next generation of scientist will discover?





# Analytical Teaching Lab Instrument Portfolio



Liquid Chromatography



Gas Chromatography



Gas Chromatography - Mass Spectrometry



UV-Vis Spectrophotometer



FTIR - Fourier Transform Infra-Red Spectrophotometer



Engineering Lab Instrumentation

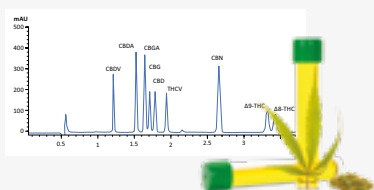
## *i*-Series HPLC System



Liquid Chromatography is the Gold Standard for the Pharmaceutical Industry. The *i*-Series is a COMPACT, ROBUST, and RELIABLE Liquid Chromatography Analyser commonly employed in QA/QC laboratories globally. Ideal for teaching and research where the versatility to handle a broad range of compounds is required. Easy to use common software platform.

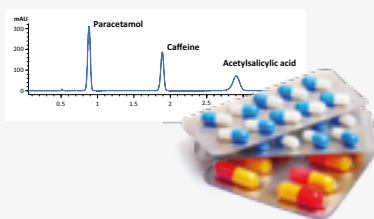
- Easy to use
- Modern touchpad visual display
- High sample capacity
- Common software platform

### Laboratory experiments



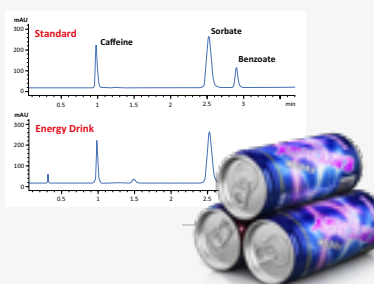
#### Cannabinoid testing

Cannabinoid plant extracts, such as CBD, have gained significant media interest in recent years. There are many variants of cannabinoids with similar structures, making them difficult to analyse. However, modern analytical techniques can differentiate these compounds and identify each moiety. Using this package students can analyse various samples, similar to the U.K. Food Standards Agency (FSA), to confirm the stated concentration as well as check for the legality of the samples.



#### Pharmaceutical drug testing

The pharmaceutical industry has to ensure that their drugs, vaccines, and ointments have not only the correct active ingredients but also at the correct dosage level. HPLC is “the gold standard” for analysing the concentration of the active compounds within the pharmaceutical industry. In this package, students will learn to interpret and draw conclusions from chromatograms from standards and over-the-counter drugs, such as aspirin, paracetamol or caffeine. Utilising calibration curves to cover a wide range of concentrations students can answer the questions of: Which compounds are present and quantify how much? Do the amounts match the stated concentrations?



#### Consumer drinks analysis

The food and beverage industry uses chromatography testing to ensure products are safe for the consumer. Typical tests within the beverage industry are sugar or caffeine analysis. These simple tests on widely available products show students both sample pre-treatment and testing for common ingredients. Students will learn to identify peaks using retention times of standards, in addition to using library compounds. It is also commonplace to utilise this technique to analyse colourants in drinks, what exactly does give Irn Bru its distinct colouring?



# GC-2010 Pro Academic Teaching Lab System



The GC-2010 Pro has been designed with academic and teaching facilities in mind. The new GC system comes fitted with a host of features geared towards ease of use, flexibility, and long-term robustness. These include:

- Easy maintenance: Toolless septum, liner exchange
- Upgrade to toolless column exchange using Click Tek
- Gas saver functions to reduce consumption
- Fast oven heating and cooling to reduce analysis time
- Flexibility to allow installation of up to 4 injectors and 4 detectors
- Wide range of sensitive detectors available
- Compatible with the complete range of Shimadzu sample introductory autosamplers

## Laboratory experiments



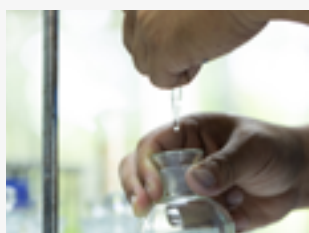
### Analysis of commercial hand sanitizer

Application allows students to analyse commercially available hand sanitizers, looking at the different base alcohol products used (IPA or EtOH). GC-FID method can be further developed to analyse for impurities and test to see if products comply with government guidelines as stipulated in EN 12791. Exercise teaches basic GC method setup and quantification results.



### Engine oil/fuel analysis

Application requires students to analyse various petroleum and diesel products. Analysis by GC-FID. The focus is on data interpretation, identifying different hydrocarbon bands based on retention time and drawing conclusions on the different types of fuel being assessed.



### Solvent impurities

Application involves the analysis of various laboratory solvent mixes, and comparison to commercially available spirits from hardware stores. Analysts learn to separate solvents on different phase columns and develop knowledge on boiling point versus polarity separation. Exercise teaches method setup and basic GC maintenance.

## GCMS-QP2010 SE System



The GCMS-QP2010 SE has been designed to combine simple operation and versatile functionality in a cost-effective GCMS option – perfect for academic and teaching facilities. Benefits of the GCMS-QP2010 SE include:

- High sensitivity for ppm level analysis
- Gas saver and ecology shutdown functions to reduce gas and energy consumption
- Easy and fast injection port maintenance using the Easy sTop feature
- Easily maintained ion source
- Automated tune procedure, providing a “Pass” or “Fail” statement to demonstrate the system suitability
- Ability to perform simultaneous SIM and Scan analysis
- Flexibility to allow installation of up to 4 injectors and 4 analogue detectors alongside the MS
- Compatible with a wide range of sample introduction autosamplers

### Laboratory experiments



#### Fragrance analysis

Application on GCMS looking at the various fragrance chemicals used in perfumes and personal care products. Analysis focuses on organic aromatic compounds, and the various “smells” they contribute to commercial products. Exercise teaches library searching and spectral breakdown in basic Mass Spectrometry.



#### Caffeine detection

Exercise focuses on human testing for drugs, but using a legal and easily available component. Caffeine analysis in urine (or synthetic serum). Exercise uses GCMS to identify caffeine in a difficult matrix and the preparation of analytical standards to provide accurate quantification in a human sample.



#### Solvent analysis by GCMS

This application builds on the solvent impurities application available for GC-FID. Having now identified the best separation using GC-FID, the students can switch their sample over to GCMS to confirm the correct identification of all impurities. Exercise teaches compound identification without the reliance of automated library searching, instead focussing on  $m/z$  ratios of particular function groups and fragments.

# UV-1900i UV-Vis Spectrophotometer



Very fast scanning, true double beam dual detector, touchpad interface, full research grade performance in a compact affordable design. Easy to use common software platform.

- 6 measurement modes – choose between: Spectrum, Quantitation, Kinetics, Photometric, Time Course and Bio Method
- Dual beam optic system including patented low-ray-light diffraction grating
- Lowest stray light for extended linearity range (up to 4 Abs.)
- High resolution of 1 nm
- Ultra-fast scan function: 29,000 nm/min
- Integrated instrument validation functions

## Laboratory experiments



### Analysis of soft and alcoholic drinks for caffeine content

Following a solvent extraction of caffeine from various sources, the samples are measured in the UV-1900i against a calibration curve created from a set of weight/volume standards using the 'Concentration' software module within the instrument software or Labsolutions UV software.

The experiment requires accuracy in creating the standards and precision when making the extractions and will show the relative caffeine content of beverages.



### Analysis of proteins by dye-reaction method

Protein is present in many food products and it can be quantitated in an aqueous extract. Materials like egg-white and milk can be used as sources. Following extraction in buffer, the protein can be reacted with a commercial product such as the Coomassie-blue based Bradford Assay, (the dye develops to a bright blue with maximum absorbance at approx. 595 nm in the presence of protein) which can then be measured directly against a calibration curve in the spectrophotometer. Other sources such as homogenised meat and vegetable products, filtered, can also be measured.



### Determination of DNA in extracts

DNA can be recovered from a wide variety of sources and can be measured directly in a UV spectrophotometer. The very high absorbance of DNA (from lysed bacterial cultures, saliva, etc) allows direct determination at low concentrations at the absorbance maximum of 260 nm. Measurements are usually made at 260, (DNA peak Absorbance) 280 (protein peak absorbance for contaminating protein), and 320nm which should be a baseline position for both biomolecules, though with the high-speed scanning UV-1900i measurements can be made in scanning mode with a digital selection of 260nm, 280nm and 320nm in the software.



## IRSpirit - FTIR Spectrophotometer



Powerful, space-efficient design with unmatched functionality – for stable, reliable performance. Easy to use Windows 10 common software platform.

- Easy and quick analysis
- Large choice of accessories
- High sensitivity: S/N ratio up to 30000:1 (KBr)
- Easy macro function for routine analysis
- Space-efficient with high expandability
- IRPilot program
  - 23 pre-set application programs
  - Analysis of multiple samples with only one click

### Laboratory experiments



#### Alcohol and base emulsifier/conditioner in commercial hand sanitisers

This experiment shows the power of FTIR analysis by testing both the alcohol content and the emulsifier base of commercial hand sanitisers. A sample is directly applied to the FTIR ATR crystal and scans made at fixed time intervals. The experiment can be sped up by using a hand-held hairdryer or similar to encourage the evaporation of both the ethanol and water from the sample. The initial scans will show the alcohol content, which should be greater than 70% of the formulation, whilst evaporation to dryness will allow a scan of the emulsifier or skin conditioner left behind, and this can be identified from the spectrum library match.



#### Identification of microplastics

Plastics should be collected from the environment. The plastics can be large samples or very small amounts recovered from soil or (for instance) the fluff from tumble-drier filters. These should be separated by visually identified type and then transferred to the ATR crystal. Even tiny flakes of plastics which are more than approx. 100-micron microspheres can be placed individually on the ATR, the spectrum determined, and then the plastic identified by comparison to the library files, or from first principles by establishing the bonds present.



#### Identification of environmental plastics

The challenge of identifying plastics recovered from the environment can be illustrated so that the challenge of automated sorting in waste recovery systems can be understood. Students should collect small fragments of plastic from everyday locations, their own gardens, or from the grounds of the institute. These can then be directly measured using the FTIR-ATR before and after the samples are cleaned with a mild acid, mild alkali, and mechanical cleaning. The results of each approach can be compared. This experiment also gives an opportunity to discuss the 'working depth' of the ATR approach to Infrared spectroscopy and the physical principles behind total internal reflectance measurement and the nature of the photon.



## Engineering Solutions

Shimadzu offers a range of materials testing instrumentation to suit academic requirements. The EZ Test is a compact solution for performing a wide variety of tests up to a maximum of 5kN, while the AGS-X table top universal testing machines series offers practical testing solutions for a variety of tests requiring force of up to 50kN.

Shimadzu's material testing solutions are supported by Trapezium X operating software allowing for user friendly programming and set up. Safety features are at the core of our machine development, with multiple levels of safety triggers built into both the machine and software.



### High-precision testing system

Test Force Measurements Guaranteed with a High-Precision Load Cell with a Capacity of 5 kN Max.

The system uses a high-precision load cell that guarantees accuracy to within  $\pm 0.5\%$  of the indicated value (high-precision type) over a wide range from 1/500 to 1/1 of the rated capacity.

This helps ensure highly reliable evaluation tests over a wide range of loads.

### COMPLIANCE

JIS B7721 Class 1

ISO 7500-1 Class 1

EN 10002-2 Grade 1

ASTM E4

*Note: Shimadzu recommends validation at an installation site that meets the requirements specified in these standards.*



### AGS-X:

- ✓ Real-time auto tuning of control parameters
- ✓ Easy comparisons to unknown samples without the need for preliminary tests
- ✓ Quick stress control test to an ISO 6892-2009
- ✓ Achieve an accurate S-S curve with high-precision load cells

**$\pm 0.5$**

Load Cell  
Precision

**FROM  
1/500  
TO 1/1**

Load Cell  
Precision  
Range

**1msec  
(1000Hz)**

High-Speed  
Sampling



# Materials Testing Experiments



## Tensile test: What is it?

A Shimadzu material testing system is ideal for measuring tensile properties. Tensile tests are used to determine how materials will behave under tension load. In a simple tensile test, a sample is typically pulled to its breaking point to determine the ultimate tensile strength of the material. The amount of force (F) applied to the sample and the elongation ( $\Delta L$ ) of the sample are measured throughout the test. Material properties are often expressed in terms of stress (force per unit area,  $\sigma$ ) and strain (percent change in length,  $\epsilon$ ). To obtain stress, the force measurements are divided by the sample's cross-sectional area ( $\sigma = F/A$ ). Strain measurements are obtained by dividing the change in length by the initial length of the sample ( $\epsilon = \Delta L/L$ ). These values are then presented on an XY plot called a stress-strain curve. Testing and measuring procedures vary based on the material being tested and its intended application.



## 3-point bend test

A Shimadzu material testing system is ideal for 3-point bend testing. This test measures the flexural strength and flexural modulus of materials, usually **reinforced and unreinforced plastics**.

These calculations allow you to choose materials that do not bend when supporting the loads you require for your application.

The test uses an EZ-Test universal testing machine and a three-point bend fixture to bend **plastic test bars** to acquire the data needed to make the calculations.



## Peel test

A Shimadzu material testing system is ideal for measuring the **peel, tear, and friction** properties of **elastomers, adhesives, glues, cements, laminates, packaging, fabrics, coatings, labels, tapes, medical devices, and other products, materials, and components**.

With the Shimadzu UTM, you can accurately calculate average peel strength load over a specified distance and strength per unit width of adhesive. All adhesive testing systems feature constant-rate-of-extension (CRE) and constant-rate-of-load (CRL) control which allows you to perform a **wide variety of adhesive tests with only one testing machine**.

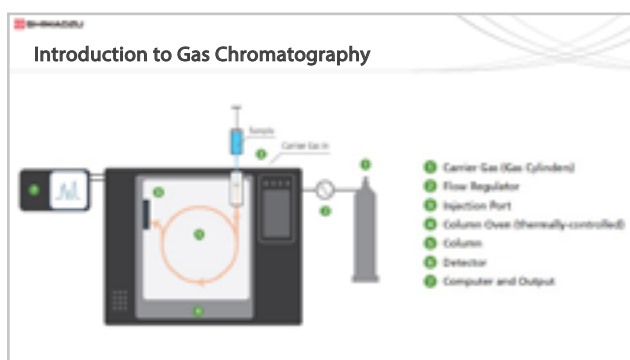


## e-Learning Resources

All college students and personnel will gain access to Shimadzu e-learning resources.

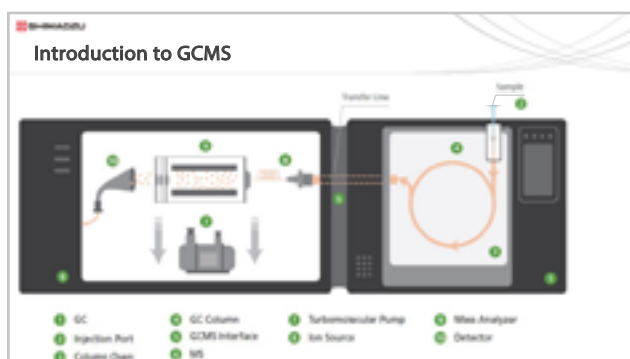
The resources are geared towards students and young scientist. These cover the theory and key principles of chromatography and mass spectrometry techniques.

There are numerous e-learning videos available including such topics as:



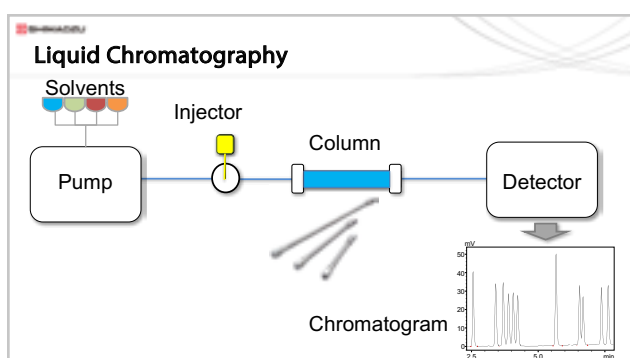
### Gas Chromatography (GC)

- Introduction to gas chromatography
- GC columns
- GC injection techniques
- GC detectors
- Processing GC data
- Maintenance and troubleshooting
- Method development



### Gas Chromatography – Mass Spectrometry (GCMS)

- Introduction to GCMS
- Single Quadrupole (SQ) vs Triple Quadrupole (TQ) GCMS
- GCMS operation and maintenance
- Introduction to GCMS method development



### High Performance Liquid Chromatography (HPLC)

- Introduction to liquid chromatography
- Types of liquid chromatography and separation techniques
- Separation process
- Method development



## Maintenance, Service and On-going Support



**Shimadzu UK is dedicated to providing the best possible service to enable our customers to make the most of their equipment. With our team of Factory Trained & Certified Field Service Engineers and Product Applications Specialists, we are easily accessible to support and answer any questions that might arise.**

Maintenance and support of analytical instrumentation is a vital part of laboratory operation. For our customer's peace of mind, Shimadzu instrumentation is supplied with 12 months warranty, commencing on the installation of the equipment.

In addition, we offer an academic maintenance plan, specifically developed to meet the needs of teaching laboratories. This plan includes an annual preventive maintenance visit to keep instrumentation running smoothly, as well as a 35% discount on emergency labour and travel charges.

The training sessions tailored to end user's needs and requirements will also be provided as a part of the package. In addition, we pride ourselves on providing continuous technical support for the lifetime of the instrument at no extra cost. Our customers have full online access to the Shimadzu online support portal and direct contact details of your key technical specialist.

## Additional Value Offerings

In line with Shimadzu's ethos of Excellence in Science, we highly value the importance of investing in the next generation of talent. The students of today will be the driving force for the future of science and technological advances.

As part of the purchase of new analytical instrumentation, Shimadzu's proposal could extend to the following areas:

- Supporting the implementation of the teaching laboratory with the latest instrumentation at a collaborative subsidised rate
- Supporting guest teaching seminars by Shimadzu Application Specialists at the University site
- Shimadzu to invite key students/personnel to their Centre of Excellence HQ in Milton Keynes, providing access to the latest industry-standard analytical equipment
- Access to annual training courses at the Shimadzu Centre of Excellence HQ in Milton Keynes
- Shimadzu to create and support co-promotional activities, focusing on science teaching capabilities of the University
- Supporting teaching via e-learning platforms

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**Shimadzu Products**

LC | GC | LCMS | GCMS | Consumables | Molecular Spectroscopy | Elemental Analysis  
| Life Sciences | TOC | Material Testing | Software