POSTGRADUATE INSTITUTE OF SCIENCE
UNIVERSITY OF PERADENIYA

Master of Analytical Chemistry Degree Programme (SLQF Level 9)

Master of Science (M.Sc.) in Analytical Chemistry Degree Programme (SLQF Level 10)

1. INTRODUCTION

Analytical chemistry is an integral and essential component in many diverse spheres, such as food & beverage industry, pharmaceutical industry, health care & medical technology, environmental control, electrochemical technology and agriculture. Many principles of Analytical Chemistry are routinely applied in the above areas for quality control, research and development work, and during manufacturing processes in industry, and also at university and other research laboratories.

A large majority of science graduates passing-out from universities find employment which entails applications of Analytical Chemistry in their respective assignments. To efficiently discharge their duties, it is necessary that such graduates possess the ability to understand clearly the nature of a given problem, use a variety of analytical methodologies and techniques – both classical and instrumental – to obtain accurate and precise measurements of chemical systems, operate and maintain analytical instruments, calculate the final result of an experiment together with its associated error and interpret the results to arrive at appropriate conclusions, and also the skills to communicate orally and in writing to convince their superiors. Although undergraduate curricula provide a strong background in chemistry with a basic training in analytical aspects, a sound hands-on experience together with advanced principles of analytical chemistry is often beyond the scope of such curricula, mainly due to time constraints. The dearth of properly trained analytical chemists in Sri Lanka is a major drawback in the realization of our industrial and scientific potential, especially in the current atmosphere of increasing industrialization. The Board of Study in Chemical Sciences of the Postgraduate Institute of Science (PGIS) has regularly updated the M.Sc. Programme in Analytical Chemistry introducing new courses to suit national needs.

The Masters Programme (by Course work - SLQF Level 9) will provide necessary knowledge in Analytical Chemistry through course work (theory and laboratory work), and a five-credit independent study, which prepares the student to initiate a research project. The Masters Programme (by Course work & Research - SLQF Level 10) will train the student to gain research experience through a one-year research project, in addition to the knowledge gained by completing the requirements of SLQF Level 9. Thus, both the Masters programmes will prepare a student to take the challenge of meeting not only national needs in diverse areas as stated above, but also to continue towards a higher degree anywhere in the world.

2. OBJECTIVES OF THE PROGRAMME

To provide

- a sound theoretical foundation on the principles of analytical methods and important techniques of classical and instrumental analysis.
- the training in using, troubleshooting and maintenance of analytical instruments.
- skills on measurements and errors in chemical analysis, calculation, and interpretation of results, leading to appropriate conclusions.
- effective presentation and communication skills.

3. PROGRAMME ELIGIBILITY

Candidates having a bachelor's degree with 30 credits in relevant modules of Chemistry or equivalent accredited prior learning experience are eligible to follow the programmes. Eligible applicants shall face an aptitude test and a subject test, followed by an interview, conducted by the PGIS. Employed candidates eligible for admission should produce documentary evidence of leave granted to follow the programme and a letter of release from the Head of the Department/Institution.

4. PROGRAMME FEE

Category	Programme Fee	
	Master of Analytical Chemistry degree programme	**M.Sc. in Analytical Chemistry degree programme**
Local candidates	Rs. 175,000/-	Rs. 300,000/-
Foreign candidates	Rs. 350,000/-	Rs. 600,000/-

Students registered for the Master of Analytical Chemistry degree programme shall pay the Programme fee in full or in two *(1/2 at the registration and the balance at the end of the first semester)* installments. An additional payment of Rs. 125,000/- (or Rs. 250,000/- form foreign students) should be made at the end of the first year to continue for the M.Sc. in Analytical Chemistry degree programme. Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS. (N.B. The Programme fees given above may be revised as per recommendation of the Board of Management of the PGIS.)

5. THE PROGRAMME STRUCTURE AND DURATION

5.1 Masters Degree by Course Work (SLQF Level 9)

The Master of Analytical Chemistry degree can be obtained by completing only the course work component.

Course work, comprising of theory courses, laboratory and/or fieldwork and an independent study, shall be conducted over a period of two semesters of 15 weeks each. The total duration of the degree, including examinations, shall be about 12 months.

Satisfactory completion of a minimum of 30 credits of course work with a GPA of not less than 3.00 is required for the successful completion of the degree (Students who do not satisfy the above criteria but obtain a GPA in the range 2.75 to 2.99 for course work of 25 credits are eligible for the Postgraduate Diploma in Analytical Chemistry, and those who obtain a GPA in the range 2.75 to 2.99 for course work of 20 credits are eligible for Postgraduate Certificate).

5.2 Masters Degree (SLQF Level 10)

Completion of 30 credits of Course work as stated in 5.1 with a GPA of not less than 3.00 is a prerequisite for the Masters Degree by Course work and Research. The research project for the degree should be conducted on full-time basis, and completed during the second year. The research component is allocated 30 credits, totaling 60 credits for the entire programme. Therefore, duration of the entire programme shall be 24 months. After successful completion of the research project, the student shall be eligible for the award of the M.Sc. in Analytical Chemistry degree - SLQF Level 10 (Students who do not complete the research project within the stipulated time period shall be awarded the Master of Analytical Chemistry degree - SLQF Level 9).

5.3 Extension of the programme for M.Phil. or Ph.D.

After conducting research for a period of six months in the M.Sc. degree programme under 5.2, students who have demonstrated exceptional progress may apply for upgrading the degree status to M.Phil. The student should continue the research project and any additional research work/assignments recommended by the PGIS for a total of two years (60 credits of research) to qualify for the award of the M.Phil. degree.

During the second year of research, students who have demonstrated exceptional and continuous progress may apply for upgrading the degree status from M.Phil. to Ph.D. The student should continue the research project and any additional research work/assignments recommended by the PGIS for another year on full-time basis (to complete 90 credits of research in total) to qualify for the award of the Ph.D. degree.

Master of Analytical Chemistry Degree Programme (SLQF Level 9)
Master of Science (M.Sc.) in Analytical Chemistry Degree Programme (SLQF Level 10)

Programme Summary

Course Code	Course Title	Lecture hrs	Practical hrs	No. of Credits
CH 501	Fundamentals of Analytical Methods	45	--	3
CH 502	Instrumental Analysis	30	30	3
CH 503	Spectroscopic Methods	45	--	3
CH 504	Environmental Analytical Chemistry	15	--	1
CH 511	Analytical Chemistry Laboratory I – Classical Methods	---	60	2
CH 516	Analytical Separations	30	--	2
CH 517	Electroanalytical Chemistry	30	--	2
CH 518	Special Topics in Analytical Chemistry I*	45		3
CH 519	Special Topics in Analytical Chemistry II*	45		3
CH 526	Analytical Chemistry Laboratory II – Instrumental Methods	---	90	3
CH 596	Research Methodology and Scientific Writing			1
CHN 519	Nanobiotechnology and nanotechnology in Healthcare*			3*
CH 599	Independent Study**[1]	500 notional hours		5
CH 699	Research Project (one year)**[2]	3000 notional hours		30

* *Optional courses. Students are required to obtain 6 credits from among CH 518, CH 519 and CHN 519.*
**[1] *Compulsory for Master of Analytical Chemistry* (*SLQF Level 9*).
**[2] *Compulsory for M.Sc. in Analytical Chemistry* (*SLQF Level 10*).

6. PROGRAMME CONTENTS FOR CH 599 AND CH 699

Course code	CH 599
Course title	Independent Study
Credits	05
Compulsory/ optional	Compulsory
Prerequisites	CH 501, which can be taken concurrently
Time allocation	500 notional hours
Aims	Aims: The overall aim is to familiarize the student with concepts and methods involved in scientific research **Specific aims:** 1. To learn the scientific process in the conduct of research. 2. To develop skills to write a review paper and a scientific research proposal. 3. To develop skills to make a presentation. 4. To master the application of statistical methods on quantitative scientific data.
Intended learning outcomes	At the end of the successful completion of the course module, students will be able to, 1. Conduct an independent review of literature on a selected topic in the area of Analytical Chemistry. 2. Write a formal scientific report conforming to the guidelines provided. 3. Transfer the knowledge gained through (2) and (3) above in the form of a presentation. 4. Complete a research proposal conforming to the guidelines provided. 5. Perform statistical analysis of quantitative data.
Content	*Review paper*: Review of literature; Development of the review paper in concise and professional manner and logical presentation of results that have been reported, writing the abstract, compilation of the list of references. *Proposal writing*: Interpretation and critical evaluation of results of published research; Formulation of a research problem: Concise literature review, justification, time frame, identification of resources, budgeting, etc. *Project*: Collection and statistical analysis of data on a topic associated with the review paper. *Seminar*: Presentation of literature and data collected on a given topic; Preparation of an abstract, preparation of slides.

Assessment criteria: Continuous Assessment

Component	Review paper	Proposal writing	Project	Seminar
% marks	20	10	40	30

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis
3. Priyantha, N. (2015) Measurements and Errors in Chemical Analysis, Science Education Unit, University of Peradeniya.

Course code	CH 699
Course title	Research Project
Credits	30
Compulsory/optional	Compulsory
Prerequisites	GPA of 3.00 at M.Sc. (Course work)
Time allocation	One year (3000 notional hours)
Aims	Aims: The overall aim is to prepare the student to conduct a research independently. **Specific aims:** 1. To train students to apply scientific method in scientific research. 2. To train students to generate researchable hypotheses. 3. To train students to plan, design and conduct scientific research. 4. To gather reliable scientific data, analyse and interpret. 5. To develop skills in scientific writing.
Intended learning outcomes	At the end of the successful completion of the course module, students will be able to, 1. Apply the scientific method. 2. Design a research project. 3. Complete a research project. 4. Understand ethical issues in scientific research (There are no formal lectures related to this aspect. However, ethical issues are taught and discussed in workshops conducted by the PGIS for which participation is required). 5. Understand the patenting process in research (There are no formal lectures related to this aspect. However, patenting process is taught and discussed in workshops conducted by the PGIS for which participation is required). 6. Make presentations at national/international conferences. 7. Produce a thesis conforming to the requirements of the PGIS. 8. Write manuscripts for publication in refereed journals.
Content	The students will conduct sufficient amount of laboratory/field work on a chosen research topic under the guidance provided by an assigned supervisor/s, make a presentation of research findings at a national/international conference, and produce a thesis.

Assessment criteria

Continuous assessment	End-semester examination
30%	Oral examination (20%) Thesis (40%) Conference presentation (10%)

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis
3. Priyantha, N. (2015) Measurements and Errors in Chemical Analysis, Science Education Unit, University of Peradeniya.

Note: The format of the Thesis is available in the PGIS website.

Contents of Other Courses

CH 501: Fundamentals of Analytical Methods (3 Cr, 45 h)

Statistics and chemometrics: statistical calculations, confidence limits, tests of significance, correlation coefficient, propagation of error; sampling methods: representative samples, automation of sampling and sample treatment; experimental design; quality control and assurance, interlaboratory testing; Fourier transformation methods in data analysis. (15 h)
Method of analysis: working curve, standard addition and internal standard methods; volumetric and gravimetric methods; quantitative aspects of colorimetry; theory of different types of titrations: acid-base, precipitation, redox, complexometric, nonaqueous, etc.; use of analytical and quality control methods in industry. (20 h)
Introduction to analytical sensors; automated method of analysis; continuous flow methods; flow injection analysis; kinetic methods of analysis; miscellaneous methods: turbidimetry, refractometry, polarimetry, optical rotatory dispersion and circular dichroism. (10 h)

CH 502: Instrumental Analysis (3 Cr, 30 h lec + 30 h lab)

Elementary electronics: semiconductors, semiconductor diodes and transistors, power supplies and regulators, operational amplifiers, amplification and measurement of transducer signals, digital electronics, digital and analogue signals, readout devices, experiments on the above topics. Spectroscopic instrumentation: components and materials for spectroscopic instrumentation, radiation sources, laser action, wavelength selectors, monochromators, sample containers, radiation detectors, signal processors and readout devices, fibre optics, experiments on the above topics. Computer applications in chemistry: theory and applications of computer technology as applied to chemical analysis, experiments on the above topics.

CH 503: Spectroscopic Methods (3 Cr, 45 h)

A broad treatment of the interaction of electromagnetic radiation with matter, emphasizing atomic, molecular, rotational, vibrational &electronic spectra, selection rules, and relevant analytical applications. Atomic absorption, emission & fluorescence spectroscopy: Principles of atomic spectroscopy; instrumentation of flame and electro-thermal atomization; atomic emission based on plasma, arc and spark atomization, and their analytical applications. (10 h)
Molecular spectroscopy: ultraviolet and visible spectroscopy; fluorescence, phosphorescence, and chemiluminescence spectroscopy;vibrational (IR and Raman) spectroscopy; analytical applications. (10 h)
X-ray methods: Principles of x-ray powder/single crystal diffraction (XRD). Reciprocal lattice constructions, and the rotating crystal method. JCPDS and other databases, and their applications; Principles of X ray fluorescence spectroscopy (XRF), wave dispersive and energy dispersive x-ray fluorescence spectroscopy, treatment of matrix effects and quantitative methods of XRF analysis. (10 h)
Electron-matter interactions: scanning electron microscopy (SEM), magnetic electron lenses, electron optical systems, sample preparation, thin foil techniques, and photography. Electron probe microanalyzer; introduction to next generation x-ray analytical methods. (5 h)
Nuclear magnetic resonance (NMR) and mass spectroscopy in chemical analysis. (10 h)

CH 504: Environmental Analytical Chemistry (1 Cr, 15 h)

Global environmental problems; air pollution; sampling of air, water and soil for chemical analysis;monitoring techniques of air pollutants, air quality standards, pollutants standards index (PSI), monitoring of volatile organic compounds; water pollution: water quality parameters and their determination, algal blooms and algal toxins, monitoring pesticide residues in water and soil, water treatment: municipal water treatment, waste water treatment methods.

CH 511: Advanced Analytical Chemistry Laboratory I - Classical Methods (2 Cr, 60 h)

Experiments on measurements and errors, sampling, chemometry, and classical analytical methods (volumetry, gravimetry, etc.); classical methods in environmental analysis.

CH 516: Analytical Separations (2 Cr, 30 h)

Theory of solvent extraction and phase equilibria, as applied to analytical separations; thermodynamic and kinetic aspects of separation; theory, instrumentation and analytical applications of gas chromatography, planar chromatography, liquid chromatography, size exclusion chromatography, ion chromatography, supercritical fluid chromatography; hyphenated methods; capillary electrophoresis.

CH 517: Electroanalytical Chemistry (2 Cr, 30 h)

Analytical applications of two-electrode systems: conductometry and potentiometry; controlled potential techniques: constant potential (e.g., amperometry), potential step (e.g., pulse techniques), and potential sweep methods (e.g., cyclic voltammetry); hydrodynamic methods; AC methods; bulk electrolysis methods: electrogravimetry, electrophoresis, electrosynthesis, coulometry, flow electrolysis, thin-layer electrochemistry; stripping analysis; hyphenated methods; electrochemical sensors; electrochemical technology

CH 518: Special Topics in Analytical Chemistry I (3 Cr, 45 h)

Surface Analysis (15 h): Theory, instrumentation and applications of modern surface spectroscopic techniques such as X-ray photoelectrion spectroscopy (XPS), Ultraviolet photoelectron spectroscopy (UPS), Auger electron spectroscopy (AES), Low-energy electron diffraction (LEED) and Electron energy loss spectroscopy (EELS).
Nanotechnology (15 h): Chemistry of nanosystems; preparation and characterization of nanosystems; analytical applications; sensors based on nanotechnology.
Forensic Chemistry and Toxicology (15 h): Forensic significance of physical evidence, analysis of contact traces, DNA fingerprinting, marks, impressions and fingerprints, basics of forensic/analytical toxicology, alcohol intoxication, drugs of abuse, agrochemical poisoning, plant poisoning & microbial toxins.

CH 519: Special Topics in Analytical Chemistry II (3 Cr, 45 h)

Pharmaceutical preparations and analysis (15 h): Preparation and characterization of pharmaceuticals; chemical analysis of drugs; quality control of drugs.
Food analysis (15 h): Quality control techniques; analytical techniques as applied to food industry.
Pesticide and pesticide residue analysis (15 h): Chemistry and classification of pesticides, degradation patterns, analytical methods for the detection of pesticides and their residues in the environment.

CH 526: Advanced Analytical Chemistry Laboratory II – Instrumental Methods (3 Cr, 90 hrs)
Experiments on instrumental methods of analysis, including spectroscopy, electrochemistry and separation; instrumental methods in environmental analysis

CH 596: Research Methodology and Scientific Writing (1 Cr)

The nature and concepts of research, types of research and tools of research, research design and conceptualization, operationalization measurement and causality, survey of research and data collection techniques, strategies for data analysis and their applications, scientific and technical writing, writing research reports/thesis and scientific papers, compilation of bibiliography, information gathering through internet and use of electronic resources.

CHN 519: Nanobiotechnology and Nanotechnology in Healthcare (3 Cr, 45 h)

Doctor-Patient Interface: Testing Devices in the Doctor's Office; Underpinning Electronic and Optical Techniques: Amperometric sensors, Potentiometric sensors including chemically sensitive field effect transistors, Optical sensors including evanescent field sensors and optical waveguide sensors, Surface Plasmon Resonance sensors, Resonant Mirror sensors, Capillary Fill Devices, Electro-mechanical Devices such as cantilever bridge sensors; Underpinning Biological

Techniques: Enzyme-based assays, Antibody-based assays, Nucleic acid-based techniques e.g., Polymerase chain reaction (PCR), Lab-on-a-chip.
Applications in the Pharmaceutical Industry: Adaptation of above techniques for large analyte panel testing e.g., Lab-on-a-chip in screening in drug development, Development of techniques for process control in pharmaceutical industry. Applications in Medical Research Laboratories: Development of instrumentation for understanding bioprocesses. Applications in the Hospital Environment: Implantation of large scale integrated circuits; Novel nanoscale imaging agents at the research level.Bionanomachines in action:Biomolecules; Structure and function of Proteins, Polysaccharides, Lipids, Nucleic acids; DNA and RNA.Biomolecular design and Biotechnology: Recombinant DNA technology, Biomolecular structure determination, Molecular Modeling; Structural principles of Bionanotechnology:The raw materials; biomolecular structure and stability, Protein folding, Self assembly, Self-organization, Molecular recognition, FlexibilityFunctional principles of Bionanotechnology:Information driven nano-assembly, Energetics, Chemical transformation, Regulation, Biomaterials, Biomolecular motors, Traffic across membranes, Biomolecular sensing, Self replication, Machine-Phase bionanotechnology. Bionanotechnology today: Basic capabilities, Nanomedicine, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors. The future of Bionanotechnology: Ethical considerations, Case studies.

7. PROGRAMME EVALUATION

Evaluation of course work is done as per guidelines stipulated in the PGIS Handbook. Scheme of evaluation of the five-credit independent study (CH 599) and the Research Project (CH 699) is given in Section 6 above.

8. PROGRAMME COORDINATORS

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9. PANEL OF TEACHERS

	Name, qualifications and affiliation/Address	Area of Specialization
1.	Dr. W.M.A.T. Bandara *B.Sc.(Perad.), Ph.D. (TIT)* Dept. of Chemistry, UOP	Surface Science & Spectroscopy
2.	Dr. N.C. Bandara *B.Sc.(Perad.), M.Sc. (New Orleans), Ph.D. (New Orleans)* PGIS,UOP	Organic Chemistry & Forensic Science
3.	Prof. H.M.N. Bandara *B.Sc.(Cey.), M.Sc.(Ast.), Ph.D. (Ast.)* Dept of Chemistry, UOP	Inorganic Chemistry & Instrumentation
4.	Dr. S.S. Gunathilaka *B.Sc. (Perad.). Ph.D. (Texas at Dallas)* Dept. of Chemistry, UOP	Polymer Chemistry
5.	Dr. C.V. Hettiarachchi *B.Sc.(Perad.), Ph.D. (TIT)* Dept. of Chemistry, UOP	Crystallography
6.	Dr. K.B. Jayasundera *B.Sc. (Perad.), M.S. (Minnesota), Ph.D. (Purdue)* Dept of Chemistry, UOP	Analytical Chemistry & Chromatography
7.	Dr. A.C.A.J. Jayasundera *B.Sc. (SJP), M.Phil.(Cadiff), Ph.D.(St. Andrew)* Dept. of Chemistry, UOP	Solid State Chemistry & Environmental Chemistry
8.	Mr. S. Malavipathirana *B.Sc. (Perad.), M.Phil. (Perad.), Reading for Ph.D. (Perad.)* Sabaragamuwa University of Sri Lanka, Belihuloya	Environmental Analytical Chemistry
9.	Prof. M.M.A.N. Navaratne *B.Sc.(Perad.), M.S. (Hawaii), Ph.D. (Hawaii)* Dept. of Chemistry, UOP	Analytical Chemistry & Bioinorganic Chemistry
10.	Prof. H.M.D.N. Priyantha *B.Sc.(Perad.), Ph.D. (Hawaii)* Dept. of Chemistry, UOP	Electrochemistry & Analytical Chemistry
11.	Dr. U. Ranathunga *B.Sc. (Perad.), Ph.D. (Texas at Dallas)* Dept. of Chemistry, UOP	Computational Chemistry & Instrumentation
12.	Dr. D. Samaraweera *B.Sc.(Perad.), Ph.D.(Texas at Dallas)* No. 80, Lower Gampola Road, Peradeniya	Analytical Chemistry

13.	Prof. K.M.S. Wimalasiri *B.Sc.(Perad.), Ph.D. (Perad.)* Dept. of Food Science and Technology, UOP	Food Science & Technology