MASTER PROGRAMS & POSTGRADUATE DIPLOMA IN

Analytical Chemistry

PROSPECTUS

2023 onwards

Department of Chemistry
University of Kelaniya
Kelaniya
Sri Lanka

Telephone : 94 011 2914486
Fax : 94 011 2903203

Postgraduate Programmes in Analytical Chemistry:

M.Sc. Degree in Analytical Chemistry, Master of Analytical Chemistry and Postgraduate Diploma in Analytical Chemistry

1.0 Preamble

The Department of Chemistry at University of Kelaniya presently offers theory and laboratory course units in Analytical Chemistry for undergraduates and postgraduates. Most of the undergraduate and postgraduate research in the Department of Chemistry is focused on analysis of environmental samples, food chemistry and food analysis, nutrition, analysis and assay the reactivity of phytochemicals and molecular biology research. Plant based and earth based natural resources are export items that are mainly exported with not much value addition. Quality analysis, quality control and value addition are important for our nature based export items to be of high quality and competitive in the world market. There is a dearth of properly trained analytical chemists with practical knowledge and experience in the country who can support quality control and research and development. In addition, there is a lack of sufficiently trained scientists competent in analytical diagnostic methods.

Graduates with first degrees in Sri Lanka do not have the opportunity to get exposure to advanced analytical methods and hands-on practical experience to many analytical techniques. In order to address this issue, **three** postgraduate programmes in Analytical Chemistry namely **M.Sc. Degree in Analytical Chemistry Programme** (with course work and a research component, SLQF 10: 2 year duration, 60 credits), **Master of Analytical Chemistry (MAC) Degree Programme** (with course work only, SLQF 9: 1 year duration, 30 credits) and **Postgraduate Diploma in Analytical Chemistry** (SLQF 8: 1 year duration, 25 credits) are introduced by the Department of Chemistry, University of Kelaniya.
(**SLQF:** Sri Lanka Qualification Framework)

2.0 Aims and Objectives of the Postgraduate Programmes

2.1 Aims of the M.Sc. Degree Programme with course work and a research component, MAC Degree Programme with course work only and Postgraduate Diploma

Aims of the Postgraduate Diploma, MAC and M. Sc. Degree Programmes are to produce graduates and professionals with scientific knowledge and laboratory skills required by industries and organizations dealing with quality control, research and development and other laboratory work.

In addition, the M.Sc. Degree Programme with course work and a research component would enable graduates and professionals to develop the ability to carry out research independently, in an area related to Analytical Chemistry.

2.2 Objectives of the M. Sc. and MAC Degree Programmes and Postgraduate Diploma

On the completion of the Postgraduate Diploma, diplomates will gain sufficient theoretical knowledge on basic and advanced analytical techniques and basic practical skills that are important for understanding and interpretation of analytical results.

On the completion of the and the MAC Degree Programme, the postgraduates will gain adequate knowledge and necessary skills to solve chemically related problems in the areas of Analytical Chemistry.

Further, on completion of the M.Sc. Degree Programme with course work and a research component the postgraduates will be able to make a significant contribution to the research and development programmes aimed at quality improvement and product development in industries and other organizations.

3.0 Target Groups

The postgraduate courses (M. Sc. Degree Programme with course work and a research component, MAC Degree Programme with course only and Postgraduate Diploma) are intended for graduates, who are engaged or seeking career opportunities in,

- Industries dealing with quality control
- Academic Institutes
- Organizations dealing with Environmental analysis
- Scientific Services (Government, Corporation and other Statutory bodies)
- Research Institutes ● Medical laboratories and
- University graduates who are seeking more qualifications to apply for Ph.D. degrees abroad.

4.0 Duration and Course Structure of the Postgraduate Programmes

Postgraduate Programmes will be operated in a credit based course unit system.

For a theory course unit, **one** credit is equivalent to **15** contact hours and will consist of interactive lectures, tutorials and assignments. For a laboratory course unit and course units on case studies and industrial training, one credit is equivalent to **45** contact hours involving laboratory work, assignments, report writing and presentations.

Postgraduate Programmes are conducted mainly by the academic staff of the Department of Chemistry, University of Kelaniya and when necessary, visiting lecturers will be drawn from other Departments of the University of Kelaniya, other Universities, research institutes, industries, government departments, corporations and other statutory organizations. Medium of instruction of the postgraduate programmes is **English**. Lectures and most of the laboratory experiments will be conducted during weekends.

4.1 M.Sc. Degree in Analytical Chemistry Programme

M. Sc. Degree in Analytical Chemistry is a full time postgraduate degree programme of **two**-year duration.

This M. Sc. Degree Programme consists of two parts namely **Part I** and **Part II**. (Table 1). Each part is of **one**-year duration and all course units in Part I and the research project to be carried out in Part II of the programme are compulsory. For a candidate to qualify for

the M. Sc. Degree Programme with course work and a research component he/she should accumulate **30** credits in Part I and **30** credits in Part II.

Part I:

- Part I of the programme involves theory courses (ANCH 54713 to ANCH 54782), a laboratory course, industrial training and a case study.

Part II:

- To be eligible to proceed to Part II of the M. Sc Degree programme the candidate should sit for all examination papers at Part I examination.
- Part II of the programme (ANCH6382W) involves a research project.
- A candidate should carry out a research project of 10 to12 month duration on a selected topic and submit a dissertation incorporating the results of the research project. The research project has to be carried out at the University under the supervision of a senior member of the academic staff or at a research institute or an industry or any other organization acceptable to the Department of Chemistry, University of Kelaniya. In the event that the research is carried out at an organization other than the Department of Chemistry, University of Kelaniya a research scientist with postgraduate qualifications above M.Sc. level should act as the supervisor and a senior member of the Department of Chemistry, University of Kelaniya should act as the co-supervisor.
- Before the commencement of the research project, a candidate should make a presentation on the plan of the project and methodology to the Department.
- During the Part II of the programme the candidate should submit quarterly, a brief progress report to the coordinator of the programme. The progress report should be certified by the supervisor. If a candidate fails to submit **two** consecutive progress reports without a valid reason he/she shall be deemed to have voluntarily withdrawn from the M. Sc. Degree Programme.
- The dissertation should be submitted at the end of the second academic year.
- A *Viva voce* examination will be held after evaluating the dissertation.
- A candidate who had submitted quarterly progress reports and has failed to submit the dissertation at the end of the second academic year will be considered as a repeat candidate unless the request for the extension is accepted by the Faculty of Graduate Studies. Extensions up to a maximum of **two** years may be granted under special circumstances on the recommendation of the Faculty of Graduate Studies.

4.2 Master of Analytical Chemistry (MAC) Degree Programme

Master of Analytical Chemistry (MAC) Degree Programme is a full time postgraduate programme of **one-**year duration. Course units (ANCH 54713 to ANCH 54794) in the Part I of the M.Sc. Degree in Analytical Chemistry Programme will be offered for the MAC Degree Programme. To complete the MAC Degree Programme with coursework a candidate should accumulate **30 credits from Part I.** (Table 1)

4.3 Postgraduate Diploma in Analytical Chemistry

Postgraduate Diploma in Analytical Chemistry is a full time postgraduate programme of **one-**year duration. Core Course units and necessary Optional course units of candidates' choice to complete 25 credits in the Part I of the M.Sc. Degree in Analytical Chemistry Programme will be offered for the Postgraduate Diploma. To complete the Postgraduate Diploma a candidate should accumulate **25 credits** from **Part I including all core courses.** (Table 1)

All course units offered in the Postgraduate Programmes are summarized in Table I.

Table I: Course Units Offered for the Postgraduate Programmes

Code No.	Course Unit	No. of Credits	M.Sc. with course work and a research component (2 years)	MAC with course work only (I year)	Diploma
Part I					
ANCH 54713	Basic Analytical Concepts	3	Core	Core	Core
ANCH 54723	Quality Management, Ethics and Safety in in process of chemical analysis, Chemometrics	3	Core	Core	Core
ANCH 54734	Separation and Chromatographic Analysis	4	Core	Core	Core
ANCH 54743	Electroanalytical Techniques	3	Core	Core	Optional
ANCH 54753	Modern Instrumental analysis methods for characterization of matter	3	Core	Core	Optional
ANCH 54763	Spectroscopic Methods in Chemical Analysis	3	Core	Core	Optional
ANCH 54773	Applied Analytical Chemistry I	3	Core	Core	Core
ANCH 54782	Applied Analytical Chemistry II	2	Core	Core	Core
ANCH 54801	Case Study	1	Core	Core	Optional
ANCH 54811	Industrial Training	1	Core	Core	Optional
ANCH 54794	Analytical Chemistry Laboratory	4	Core	Core	Core
Part II					
ANCH6382W	Research Project	30	Core	**	**
Total number of credits to be accumulated			60	30	25

** course not offered for the particular programme

Syllabi

Type/Status **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
Course Code **:** ANCH 54713
Title **:** Basic Analytical Concepts

Learning outcomes:
At the completion of this course candidate will be able to

- apply basic concepts of analytical chemistry such as solubility, precipitation, and titrations in chemical analysis
- design methods to quantify analytes in aqueous media using concepts of titrimetry and gravimetry.

Course content:
Introduction:
Classification of analytical methods, an overview of analytical methods, types of instrumental methods, instruments for analysis, data domains, electrical and non-electrical domains, detectors, transducers and sensors, selection of an analytical method, accuracy, precision, selectivity, sensitivity, detection limit and dynamic range, classification of techniques: calibration curve, standard addition and internal standard methods. Significant figures, scientific notation, and uncertainty calculations.

Acid-Base Theory and Solvent Systems
General concept of acid-base equilibria in water and in non-aqueous solvent, definition of pH and pH scale (Sörenson and operational definitions), and its significance, Hammett acidity function, pH calculation for aqueous solutions of very weak acid and very weak base, salts of weak acid and weak bases, mixture of weak acid and its salts, mixture of weak base and its salts, polybasic acids and their salts, polyamines and amino acid, comparison of solution of polybasic acid as a function of pH, protolysis curves. Acid-base theories: Bronsted-Lowry, Lux-Flood, Usanovich, Lewis and solvent system definitions, measures of acid-base strength, acid-base interactions, hard and soft acids and bases, classification, HSAB (hard-soft acid base) principle, levelling effect, symbiosis, proton sponges. Nonaqueous solvents: classification of protic and aprotic solvents, super acids, molten salts as solvents, and ionic liquids.

Buffer Solutions:
Theory of buffer solution, dilution and salts effects on the pH of a buffer, buffer index, criteria and expression of maximum buffer capacity, application of pH buffers, preparation of buffer solutions of known ionic strength (typical examples). Practical limitations in use of buffers, metal ion buffers and their applications, biological buffers and their applications.

Introduction to Titrimetric Analysis:
Principles, reactions used for titrations, concentration systems, and stoichiometric calculations involving acid base and redox systems.

Neutralization Titrations:
Neutralization curves for strong acid-strong base, weak acid-strong base titrations, indicators, determining the colour change range of an indicator choice of indicator, feasibility of acid base titrations, factors affecting Ph at the equivalence point. Importance of conditional equilibrium constants and non-ideal systems, activity and activity

coefficients, conditional solubility product and its application in non-ideal systems, acidbase equilibria in polyprotic systems. Titration curves of a weak dibasic acid versus strong base.

Complexation Titrations:
Stability of complexes – stepwise formation constants, titration curves, feasibility of complexation titration, equilibria involved in EDTA titration, effect of pH on the concentration of completely dissociated form of EDTA, absolute and conditional stability constant for metal-EDTA complex. Factors affecting the equivalence point, metallochrome indicators – determination of percentage composition in alloys or mixtures using masking and de-masking agents.

Precipitation Titrations:
Solubility equilibria, titration curves and feasibility of titration. Theory of indicators. Mohr method and Fajans method of estimation of halides.

Oxidative-Reductive Titration:
Nernst equation, usage of standard reduction potential and formal potential in titrations. Application in natural and industrial systems.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.

Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman.
- Skoog, D.A., Donald M. W., James, F.H., (2013) *Fundamentals of Analytical Chemistry,* Saunders College Publishing.

Skoog, D.A., James F.H., Nieman. T. A., (1998) *Principles of Instrumental Analysis,,* Harcourt Brace College Publishers.

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Type/Status : Core Course (M.Sc. and MAC Degree Programmes and Postgraduate Diploma)
Course Code : ANCH 54723
Title : Quality Management, Ethics and Safety in in process of chemical analysis, Chemometrics

Learning outcomes:
At the completion of this course candidate will be able to

- apply use statistical methods for reporting analytical results with required levels of confidence.
- validate analytical methods
- apply concepts of good laboratory practice in the laboratory

Course content:

Ethics and Safety:
The four principles of safety, fostering a safety culture, safety laws and regulations, hazardous waste regulations, radioactive materials regulations, emergency planning, responding to laboratory emergencies, mitigating the emergency, non-laboratory related emergencies, fire emergencies, chemical spills on you and the lab, containment and cleanup of chemical spills, physical hazards, gas cylinders and cryogenic liquids.

Quality in analytical chemistry and quality management:
First aid in the lab, signs, symbols, and labels, material safety data sheets(MSDS), interpreting MSDS information, information resources about laboratory hazards and safety, chemical hygiene plans, the dangers of messy labs, safety, storage, shelf life, handling & disposal. Risk assessment, working or visiting a new lab, safety planning for new experiments, making decisions about safety, safety for common lab operations, protective clothing and respirators, laboratory eye protection, introduction to GLP and GMP, quality laboratory management systems, quality control practices for laboratory tests, validation of laboratory methods and technology, quality planning for laboratory testing processes, quality systems in chemical laboratories, cost and benefits of a quality system, types of quality standards for laboratories, total quality management, quality audits and quality reviews, responsibility of laboratory staff for quality.

Sampling and sample preparation in analysis:
Definition, theory and techniques of sampling, sampling of gas, liquids and solids, criteria of good sampling, minimization of variables, transmission and storage of samples, high pressure ashing techniques (HPAT), particulate matter, its separation in gas stream, filtering and gravity separation. Analysis of particulate matter like asbestos, mica, dust and aerosols etc. Preparing the sample for analysis: the effect of sampling uncertainties, gross sample, determination of the size of the sample, analytical sample. Sampling of solids – preparation of laboratory sample from gross sample, moisture in the sample, sampling of gases and liquids. Decomposition and dissolving the sample – decomposition of sample by fluxes, wet digestion, dry ashing, combustion with oxygen, microwave decomposition.

Chemometrics:
An introduction to analysis of data. Basic statistics and probability. Regression methods, variance. Introduction to the "concept of chemometrics", use of chemometrics in planning of experiments, the creation of information-rich data, modelling and evaluation, validation and prediction. Various types of experimental designs, and analyses and optimization methods. Multivariate data analysis: similarities and differences between tests, calibration, multivariate classification.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.

Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman.
- Mendham, J; Denney, R.C.; Barnes, J.D.; (2002) *Vogel's Textbook of Quantitative Chemical Analysis*. Prentice Hall.

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Type/Status **:** Core Course (M.Sc. and MAC Degree Programmes and Postgraduate) Diploma)
Course Code **:** ANCH 54734
Title **:** Separation and Chromatographic Analysis

Learning outcomes:

At the completion of this course candidate will be able to

- understand basic principle of separation techniques
- use and modify separation technique for analysis of complex systems.
- design new separation methods for sample analysis

Course content:

Introduction to separation methods in analytical chemistry:

Precipitation, filtration, distillation, extraction and chromatography, modes of separation in chromatography: adsorption, partition, ion exchange, size exclusion and electro chromatography.

Solvent extraction:

Recapitulation, factors affecting the solvent extraction, separation of metal ions as chelates, concept of $[pH]_{1/2}$ and its significance, ion association, solvation with suitable examples, Craig's counter current extraction: principles, apparatus and applications, use of crown ethers in solvent extraction.

Solid phase extraction:

Principle, process and applications.

Ion Exchange Chromatography:

Cation exchange resin, anion exchange resin, cross-linkage, separation of metal ions on anions exchange columns, applications of ion exchange chromatography. Fundamental properties of ion exchangers, theories of ion exchange, exchange capacity, screening effect, penetration of electrolytes into the ion exchange resins, sorption of complex ions, ion exchanges equilibrium, column operation, theory of break through curves, elution steps, use of non-aqueous solvents in ion exchange separation, application of ion exchange separation in determination of total salt concentration, removal of interfering ions, separation of anions and metals.

General classification of chromatographic methods:

Column efficiency, plate and rate theories, resolution, selectivity and separation capability, Van Deemter equation.

Planner Chromatography:
Thin layer chromatography (TLC), paper chromatography (ascending, descending, circular and two-dimension), high performance thin layer chromatography (HPTLC).

Gas Chromatography (GC):
Gas chromatography theory and instrumentation, column types, solid/liquid stationary phases, column switching techniques, sample introduction systems, basic and specialized detectors, elemental detection, chiral separations, pyrolysis gas chromatography, temperature programming, applications in various fields**.**

High Performance Liquid Chromatography (HPLC):
HPLC theory and instrumentation, column efficiency in liquid chromatography (LC), mobile phase reservoirs, solvent treatment systems pumping systems, sample introduction systems, types of columns, detectors. Adsorption chromatography, liquid-liquid partition chromatography, microbore and capillary chromatography, affinity techniques, size exclusion, ion pair separations, chiral and isotope separations, ion-chromatography, applications in various fields**.**

Capillary Electrophoresis:
Principle, instrumentation of capillary electrophoresis and detector, applications in various fields. Capillary zone electrophoresis, capillary iso-electric focusing, micellar electrokinetic capillary chromatography, capillary gel electrophoresis, capillary electrochromatography

Supercritical Fluid Chromatography (SCFC):
Characteristics, instrumentation and applications. Comparison of HPLC and GC with SCFC. Applications in various fields.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.

Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman.
- Mendham, J; Denney, R.C.; Barnes, J.D.; (2002) *Vogel's Textbook of Quantitative Chemical Analysis*. Prentice Hall.
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Type/Status **:** Core Course (M.Sc. and MAC Degree Programmes)
Optional Course (Postgraduate Diploma)
Course Code **:** ANCH 54743
Title **:** Electroanalytical Techniques

Learning outcomes:
At the completion of this course candidate will be able to

- understand principle of electroanalytical techniques

- use and modify electroanalytical technique for analysis of complex systems. ➢ design new electroanalytical methods for sample analysis

Course content:

Introduction and overview of electrochemical processes: Electrochemical cell and reactions, Faradic and non-Faradiac processes, electrochemical Experiments and variables in electrochemical cells, Basic electrochemical thermodynamics, free energy and cell EMF, half reaction and reduction potentials, formal potentials, reference electrodes, measurements of potential differences, Electrochemical potentials, Fermi level and absolute potentials, liquid junction potential.

Conductometry and potentiometry: Reference electrodes, indicator electrodes, direct potentiometry, potentiometric titrations, ion selective electrodes, solid state chemical sensors. Electrogravimetry, constant current and controlled potential coulometry.

Kinetics of electrode reactions: Essentials of electrode reactions, Butler Volmmer Model for electrode kinetics, one step, one electron process through potential energy diagram, standard rate constants and transfer coefficients, equilibrium condition and exchange current, current over potential equation, current-over potential equation, **Electrogravimetry**: Introduction, factors affecting the nature of the deposit, instrumentation and applications.

Coulometry: Coulometry at controlled potential and controlled current.

Polarography: Principles, Factors affecting polarographic wave, pulse polarography, and differential pulse polarography,

Voltammetry: Voltammetric principles, Hydrodynamic voltammetry, Stripping voltammetry, Cyclic voltammetry, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes, qualitative and quantitative analysis by these techniques.

Bi-amperometric Titrations: Principle, instrumentation, titration curves and detection of endpoint, Karl Fischer method: principle, process and instrumentation

Chemically Modified /Ion Selective Electrodes
Principle, instrumentation and application
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Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.

Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman
- Skoog, D.A., Donald M. W., James, F.H., (2013) *Fundamentals of Analytical Chemistry,* Saunders College Publishing.
- Paul, M.S. Monk., (2001) *Fundamentals of Electroanalytical Chemistry,* Wiley.
- Skoog, D.A., James F.H., Nieman. T. A., (1998) *Principles of Instrumental Analysis,*Harcourt Brace College Publishers

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Type/Status **:** Core Course (M.Sc. and MAC Degree Programmes)
Optional Course (Postgraduate Diploma)
Course Code **:** ANCH 54753
Title **:** Modern Instrumental analysis methods for characterization of matter

Learning outcomes:

At the completion of this course candidate will be able to

- apply advanced spectroscopic techniques to structure elucidation of organic compounds.
- explain theoretical basis of advanced techniques in NMR and MS spectroscopy
- use x-ray diffraction techniques to analyze inorganic material and thereby extract structural information of compounds

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Course content:

Thermal Analysis:

General principles of thermal, instrumentation, types of measurements; TGA (thermogravimetric analysis), DTA (differential thermal analysis), DSC (differential scanning calorimetry), TT (thermometric titrations) and EGD (evolved gas detection), principles, instrumentation and applications of the techniques, thermogravmetry (TGA), derivative thermogravimetry (DTG), differential thermal analysis (DTA), differential scanning calorimetry (DSC).

X-ray Diffraction:

X-ray powder diffraction (XRD), Single crystal X-ray diffraction, X-ray Photoelectron spectroscopy(XPS), X-ray Fluorescence spectroscopy (XRF)

Electron Microscopy:

Scanning Probe Microscopy: Scanning Tunneling Microscopy (STM); Atomic Force Microscopy (AFM), Electron Microscopy: Scanning Electron Microscopy (SEM); Transmission Electron Microscopy (TEM).

Nuclear Magnetic Resonance Spectroscopy:

Introduction to ^{1}H NMR, ^{13}C NMR, Two dimensional (2D) NMR and their application in various field.

Mass Spectrometry:

Principle of mass spectrometry; Intel system, ionization, acceleration, Drift Chamber, Detection systems; Advancements in equipment; Analytical uses of mass spectrometry,

quadrupole mass spectrometry; Interpretation of mass spectra. Correlation of mass spectra with Molecular structure.

Electron Spin Resonance (ESR):
Principles of ESR, hyperfine splitting in simple systems, Instrumentation, factors affecting G values, applications to inorganic complexes.

Nuclear Quadrapole Resonance Spectroscopy [NQR]:
Introduction, effects of magnetic field on the spectra, relation between electric field gradient and structure, application of NQR.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.

Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading;

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman
- Rouessac, F., Rouessac, A., Chemical Analysis: Modern Instrumentation Methods and Techniques.
- Skoog, D.A., James F.H., Nieman. T. A., (1998) *Principles of Instrumental Analysis,*Harcourt Brace College Publishers.
- Ladd, M. F. C. and Palmer, R. A., (2003) *Structure Determination by X-ray Crystallography,* Kluwer.
- Firebolin, H., (2004) Basic *One – and two – dimentional NMR spectroscopy,* VCH.

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Type/Status **:** Core Course (M.Sc. and MAC Degree Programmes)
Optional Course (Postgraduate Diploma)
Course Code **:** ANCH 54763
Title **:** Spectroscopic Methods in Chemical Analysis

Learning outcomes:
At the completion of this course candidate will be able to

- explain the function of the components of different type spectrophotometers and capabilities and limitations in their analytical applications
- explain the importance of the effects of the experimental conditions in analysis and modify the method used or correct the data accumulated using their knowledge of conditional constants.
- use the knowledge in fundamentals to design analytical methodologies for analyzing of samples with complex matrices
- explain theoretical basis of advanced techniques in spectroscopy

Course content:

Introduction to spectroscopic methods: recapitulation of basic concepts, general instrumentation: sources, wavelength selectors, sample containers, radiation transducers,

signal processors and read out system, fiber optics, types of optical instruments, Fourier transform optical instruments, Beer-Lambert's law; Deviations; UV-Visible spectroscopy, IR spectroscopy

Atomic Spectroscopy:
Atomic fluorescent spectrometry (AFS), Atomic Emission Spectrometry (AES): Inductively coupled plasma – ICP / AES and Flame emission spectroscopy (FES), Atomic Absorption Spectrophotometry (AAS): flames and furnaces, ICP-MS

X-ray fluorescence spectroscopy:
Principles instrumentation and applications of X-ray fluorescence, absorption and diffraction spectroscopy**.**

Nephlometry and Turbidometry:
Principle, instrumentation and Applications

Fluorimetry:
Principle, relationship between excitation spectra and fluorescence spectra, factors affecting fluorescence emission, instrumentation.

Raman Spectroscopy:
Raman Spectra-idea of Raman scattering, Rayleigh scattering Molecular polarizability. Rotational Raman Spectra of linear Molecules, Symmetric top molecules and spherical top molecules Vibrational Raman spectra.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.
Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman
- Rouessac, F., Rouessac, A., Chemical Analysis: Modern Instrumentation Methods and Techniques.
- Williams, D.H., (1989) Spectroscopic methods in Organic chemistry, McGraw and Hill.
- Pavia, D. L., Lapman G M and Kriz G S (1979) Introduction to Spectroscopy, Saunders.
- Skoog, D.A., James F.H., Nieman. T. A., (1998) *Principles of Instrumental Analysis,*Harcourt Brace College Publishers.

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Type/Status **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
Course Code **:** ANCH 54773
Title **:** Applied Analytical Chemistry I

Learning outcomes:
At the completion of this course candidate will be able to

- analysis industrial and environmental samples

- develop and validates various analytical methods for industrial and environmental samples

Course content:

Analysis of dyes and paints:

Types of dyes and their analysis. Composition and analysis of paints, determination of volatile and non-volatile constituents, flash points, separation of pigments, estimation of binders and thinners

Environmental Analysis:

pH, Moister, total nitrogen, phosphorous, silica, lime, magnesia, manganese, sulfur, alkali salts, fertilizers and pesticides. Analysis of pollutants in air, water and soil.

Analytical Chemistry of polymers

Chemical and Physical analysis, IR, UV, Raman and NMR spectroscopic analysis, X-ray diffraction analysis. Differential thermal analysis, thermo gravimetric analysis, Studies of optical properties.

Fuel analysis:

Solid, liquid and gas, ultimate and proximate analysis heating values, grading of cool, liquid fuels, flasks points, aniline point, octane number and carbon residue, gaseous fuels – producer gas and water gas – calorific value.

Analytical Organic Chemistry:

Chemical analysis of Bio-pesticides and natural cosmoceuticals, essential oil industry, natural polymers, application of separation methods in industrial organic chemistry

Food Product Analysis:

Moisture content, ash, fiber, nutrients, anti-nutrients, toxicants, microorganism-spoilage (rancid taste), color, preservatives, Analysis of amino acids, proteins, carbohydrates, lipids and fats, Analysis of edible oils, dairy products, pickles etc., fruit and vegetable products, Food additives and food colors, Food adulteration; common adulteration in food, contamination of food stuffs, microscopic examination of foods for adulterants, Pesticide analysis in food products, Extraction and purification of sample, HPLC, gas chromatography for organo–phosphates, thin layer chromatography for identification of chlorinated pesticides in food products.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.

Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman ➢ Manahan, S. (2010) *Environmental Chemistry*, Lewis.
- McBride, M. B. (1994) *Environmental Chemistry of soils*, Oxford.
- Evangelou, V. P. (1998) *Environmental soil & water Chemistry. Principle and Applications*, John Wiley.
- Potter, N. N. and Hotchkiss, J. H., (1997) *Food Science*, Aspen.
- Eskim, N.A., (1990) *Biochemsitry of foods*, Academic press.

- Garrow, J.S. and thames W.P.J, (1997) *Human Nutrition*, Churchil living stone.
- Odham, G. Larsson, L. and Mardh, P., (1984) Gas Chromatography / Mass Spectrometry, Plenum Press.
- Handbook of Biopolymers and Biodegradable Plastics Properties, Processing and Applications, (2012) Edited by SinaEbnesajjad, Fluoroconsultants Group, Chadds Ford, Pennsylvania, USA; formerly DuPont.

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Type/Status **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
Course Code **:** ANCH 54782
Title **:** Applied Analytical Chemistry II

Learning outcomes:
At the completion of this course candidate will be able to

- analysis industrial and environmental samples
- develop and validates various analytical methods for industrial and environmental samples

Course content:

Clinical Chemistry:
Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulin, barbiturates, acidic and alkaline phosphates, Immunoassay, principals of radioimmuno assay, and applications. The blood gas analysis – trace elements in the body. Drug analysis: Narcotics and dangerous drugs, classification of drugs, screening by gas and thin layer chromatography and spectrophotometric analysis.

Forensic Analysis:
Special features of Forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD 50 and LC 50.

Analytical Microbiology:
Morphological structure and characteristics nutrition and physiology, classification of microorganisms, Taxonomy and nomenclature nutritional requirements phathoseas and spoilage organics microscopy, staining techniques, Aspatic Techniques, isolation and use of differential media, sterilization and disinfection.

Pharmaceutical Analysis:
Introduction to drugs, their classification, sources of impurities in pharmaceutical raw materials such as chemical, atmospheric and microbial contaminants etc. Limit tests, limit tests for impurities like, Pb, As, Fe, moisture, chlorides, sulfates, Boron, free halogen, selenium etc. Analysis of some commonly used drugs likes sulfa-drugs, antihistamines, barbiturates, vitamins (A, B6, C, E, K) etc.

Bioanalytical chemistry:
Biomolecular recognition methods; immune assays and its applications, use of biosensors in the analysis of biological samples, chromatography of biomolecules, kinetic study of protein-ligand interaction, enzyme kinetics and inhibitions, applications of Polymerase

Chain Reaction (PCR) in biometric evaluations, Validation of bioanalytical procedures methods and challenges.

Method of teaching and learning: A combination of lectures, tutorials, assignments and discussions.
Assessments: In-course assessments through evaluation of assignments and end of course written examination.

Recommended reading:

- Rouessac, F., Rouessac, A., Chemical Analysis: Modern Instrumentation Methods and Technique.
- Potter, N. N. and Hotchkiss, J. H., (1997) *Food Science*, Aspen.
- Eskim, N.A., (1990) *Biochemsitry of foods*, Academic press.
- Voelter, W. and Daves, D. G., (1984) Biologically active principles of natural products. Georg ThiemeVerlag.
- Szantay, C. S., (1984) Chemistry and biotechnology of biologically active natural products, Elsevier.
- Handbook of Biopolymers and Biodegradable Plastics Properties, Processing and Applications, (2012) Edited by Sina Ebnesajjad, Fluoroconsultants Group, Chadds Ford, Pennsylvania, USA; formerly DuPont.

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Type/Status **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
Course Code **:** ANCH 54794
Title **:** Analytical Chemistry Laboratory

Learning outcomes:
At the completion of this course candidate will be able to

- operate common analytical instruments properly and optimize experimental conditions to achieve high sensitivity, selectivity, accuracy and reproducibility in chemical analysis
- demonstrate skills in sampling, processing, preservation of environmental samples, quality assurance and quality control procedures in performance of analytical instruments
- use of analytical instruments in chemical analysis and in the field of selected industries
- critically analyze and interpret scientific data

Course content:
Sampling, handling and preservation of samples. calibration and performance check of analytical systems, quality management of laboratory equipment and supplies, selection of approved analytical methods, method development and their validation, data evaluation, statistical analysis, transformation of data and report presentation. Use of flame photometry, atomic absorption spectrometry, gas and liquid chromatography, high performance liquid chromatography, ion exchange chromatography, ultra violet–visible spectroscopy, potentiometry, voltammetry, coulometry, food chemistry, mineral chemistry and petroleum chemistry.

Method of teaching and learning:
A combination of lectures, assignments, laboratory experiments and mini projects.

Assessments: In-course assessments through evaluation of assignments

Recommended reading;

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman
- Mendham, J; Denney, R.C.; Barnes, J.D.; (2002) *Vogel's Textbook of Quantitative Chemical Analysis*. Prentice Hall.
- Svehal, G; (2001) *Vogel's Qualitative Inorganic Analysis,* Longmans.

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Type/Status **:** Core Course (M.Sc. and MAC Degree Programmes)
Optional Course (Postgraduate Diploma)
Course Code **:** ANCH 54801
Title **:** Case Study

Learning outcomes:
At the completion of this course candidate will be able to,
candidates will be able to demonstrate skills to analyse a real world environmental and industrial problem in a scientific manner

Course content:

Literature survey, field study, discussions, data analysis, problem solving and report writing.

Method of teaching and learning: Report, presentation and oral examination.

Assessments: In-course assessments through evaluation of assignments and end of course

Recommended reading:

- Harris, D.C. (2010) *Quantitative Chemical Analysis,* Freeman
- Manahan, S. (2010) *Environmental Chemistry*, Lewis.
- Mendham, J; Denney, R.C.; Barnes, J.D.; (2002) *Vogel's Textbook of Quantitative Chemical Analysis*. Prentice Hall.

  Svehal, G; (2001) *Vogel's Qualitative Inorganic Analysis,* Longmans.

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Type/Status **:** Core Course (M.Sc. and MAC Degree Programmes) Optional Course (Postgraduate Diploma)
Course Code **:** ANCH 54811
Title : Industrial Training

Learning outcomes:
At the completion of this course candidate will be able to

- To discuss the functions of an industry, its management and suggest improvements by SWOT **(**strengths, weaknesses, opportunities and threats**)** analysis.

Course content:
Candidates are expected to visit at least **three** industries acceptable to the Department of Chemistry and submit a report and a presentation on **one** such visit. The report should contain the manufacturing process including the chemistry involved, energy balance, waste management process, safety factors, and suggestions for improvement by SWOT analysis, application of quality management and environmental management systems and process diagrams.

Method of teaching and learning: Laboratory experiments, field visits, assignments and laboratory reports

Assessments: Self-study, discussions, industrial visits

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Type/Status **:** Core Course (M.Sc. Degree Programmes)

Course Code **:** ANCH 6382W
Title **:** Research Project

Learning outcomes:
At the completion of this course candidate will be able to

- demonstrate skills to plan and carry out a research project independently according to the scientific method, analyse the experimental data, interpret and report the data in a scientific manner in the form of a dissertation.

Course content:
The research project in an area related to analytical is assigned to the candidate. Research should be carried out on full time basis for at least 10 months.

Method of teaching and learning: Literature survey, laboratory and/or field work, data analysis and interpretation, dissertation, presentations

Recommended reading: Reference material relevant to the case study

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