COURSE REQUIREMENTS FOR CHEMISTRY SPECIALISATION

Course Code	Course Name
Core Course	
MLS900	Science Communication
Required Courses	
MLS922	Chemistry of Biological Systems
MLS923	Separation and Analytical Chemistry
MLS924	Materials Chemistry
Specialisation Elective Courses *(Select 2 for those on the dissertation route; 3 for those on the complete coursework route)*	
MLS925	Asymmetric Synthesis
MLS926	Bioactive Natural Products and Their Derivatives
MLS927	Current Topics in Environmental Chemistry
MLS928	Green Chemistry
MLS929	Medicinal Chemistry
MLS930	Physical Methods in Structural Elucidation
MLS931	Metallomics
MLS946	Physical Methods for the Analysis of Energy Materials
MLS948	Molecular Spectroscopy
MLS962	Environmental Health and Toxicology
MLS963	Conservation and Management
MLS964	Global Environmental Change and Vulnerable Ecosystems
MLS985	Chemical Ecology
Plus Either:	
-	Dissertation (6AU); or
MLS921	Critical Inquiry (Chemistry) (2AU)

Description of courses

MLS900 Science Communication

It is important for Science to be communicated effectively across all levels, given its large impact on society and vice versa. All science professionals, whether they are in education, research or industry, will need to engage different audiences in science communication at various points in their career. This course aims to equip participants with the knowledge and skills to evaluate scientific information and to communicate it effectively to both expert and lay audiences. The following broad topics will be covered: mutual roles and influence of Science and society, principles of effective science communication, evaluating the quality of scientific evidence, and current science-related issues affecting society. Opportunities for practice in science communication will be provided.

MLS921 Critical Inquiry (Chemistry)

Chemistry discipline is an experimental science and this is a compulsory experimental course offered to MLS (Chemistry) participants to enable them to solve real life problems. This course will enable participants to enhance their higher order thinking skills like critical thinking and problem solving; and apply chemistry knowledge through the use of the scientific inquiry approach to solve related chemical problems. Experimental techniques and relevant instrumentation related to different areas of chemistry will be introduced. This course will be taught by a team of chemists with different backgrounds and participants will benefit from the diverse range of topics and ideas presented.

MLS922 Chemistry of Biological Systems

The role of metals in biological systems is an area of great interest to chemists and biologists alike. Life in its present form would not be possible without the involvement of the metallic elements. This course covers the key ways in which metals participate in biochemical processes, focusing on biomolecules that incorporate metal atoms in their molecular structures. The ways in which the chemical properties of selected metals define the biological function of the systems they are found in will be discussed. Topics covered will include the roles of proteins in metal management, oxygen carrier proteins, electron-transfer proteins and metalloenzymes as well as relevant topics in recent literature. Quantitative analysis of biological samples based on classical techniques and modern instrumental methods will also be discussed.

MLS923 Separation and Analytical Chemistry

The discovery of new functional compounds often starts from the key step in the separation, purification, and qualitative/quantitative detection of the active component(s).This course is devoted to familiarise participants with state-of-the-art separation methodologies, and development and applications of (bio)sensing/analytical instrumentations. The course topics include concept and trends in modern chemical analysis; various chromatographic and spectrometric methods; case study on separation of biomolecules and environmental samples; and fundamentals of (bio)sensing transducing techniques for the development of biosensors. This course is of importance and relevant to all who rely on the use of instrumental separation and analysis in their field of endeavour.

MLS924 Materials Chemistry

Materials chemistry involves studying the relationship between structures and properties of materials. The following important major materials will be discussed in-depth in this course: metals, ceramics, glass, polymers and composites. The structure, physicochemical property, application relationship of these materials will be discussed and highlighted in the context of material properties and structural elements. Cross-disciplinary aspects of materials chemistry will be emphasized throughout this course by linking other scientific disciplines such as nanotechnology, colloidal science, material characterization, biomedicine and engineering. This course will be taught by a team of chemists with different backgrounds and students will benefit from the diverse range of topics and ideas presented. Practical sessions will be conducted to reinforce the concepts taught in the classroom.

MLS925 Asymmetric Synthesis

Asymmetric catalysts not only accelerate chemical reactions but can also exert remarkable control of the absolute and relative stereochemistry through the three-dimensional interaction of the asymmetric catalysts with the reacting substrates. This course covers the design, discovery, and study of asymmetric catalytic systems that catalyze fundamentally interesting and important organic transformation reactions. The application of physical-organic chemistry tools to gain insight into the transition structure geometries and molecular recognition events that control the origin of stereoselectivity will be included. The topics are taught with special emphasis on the current emerging tools in organic synthetic methodology. Topics covered will include enolate chemistry and carbonyl reactions with emphasis on disconnection approach to organic synthesis. The application of the various asymmetric strategies for the control of absolute stereochemistry in C-H, C-C and C-O bond formation reactions, olefin metathesis and fragment coupling reactions will also be discussed also be discussed.

MLS926 Bioactive Natural Products and their Derivatives

Natural products play an essential role in the drug discovery and development process. A high proportion of drugs currently in use, particularly in treatment of cancer and infectious diseases, are derived from natural products and their synthetic derivatives. The purpose of the course is to provide participants with fundamental knowledge of natural product chemistry and the role natural products play in drug discovery and development. Topics such as the distribution and biosynthesis of natural products and their ecological function within biological systems, as well as knowledge of drugs, drug extracts and bioactive natural products from plants and microbes that are used for production of medicine and herbal remedies, will be covered. In addition, innovative analytical techniques used in natural products research will be emphasized.

MLS927 Current Topics in Environmental Chemistry

Environmental chemistry plays various important roles for human sustainable civilization as it unveils how physicochemical phenomena taking place in our environment and their impact on human lives, as well as the environment itself. This course aims to expose participants to current fundamental and applied research in the field of environmental chemistry. Chemistry principles applied to the study of atmosphere, hydrosphere and lithosphere will be discussed. The importance of the anthrosphere, i.e. part of the environment made and operated by humans will be introduced. In addition, the environmental, health, and economic effects of pollution in a chemical context will be examined through discussion on local and global case studies. Ways of alleviating pollution issues via public education and pollution regulations will be explored.

MLS928 Green Chemistry

Green chemistry, also called sustainable chemistry, encourages the design of products and processes that minimize the use and generation of hazardous substances. This course deals with the fundamental principles of green chemistry and their extensive application potentials in various chemistry and related fields, e.g. Physics, Molecular Biology, and Environmental Science. The course covers topics like waste minimization, atom efficiency, solvent selection, (bio)catalysis, renewable resources and energy efficient processes. Participants will be exposed to various examples of chemical synthetic processes and analytical methodologies that minimize the use and generation of hazardous substances. Relevant green analytical techniques will be introduced.

MLS929 Medicinal Chemistry

Medicinal chemistry is a chemistry-based course and it involves the application of chemical research to the development of new pharmaceuticals. A wide range of topics will be included in the discussion of medicinal chemistry. These topics include drug targets, drug optimization, structure activity relationship studies, synthetic organic chemistry, pharmacology, as well as drug discovery and development. Novel chemical and biological techniques will be highlighted in this course and are introduced in the context of the drug

development process. Interdisciplinary aspect of medicinal chemistry will be emphasized by linking other scientific disciplines, such as biochemistry and molecular biology. This course will be taught by a team of chemists with different backgrounds and participants will benefit from the diverse range of topics and ideas presented.

MLS930 Physical Methods in Structural Elucidation

Structural elucidation is an essential aspect in many areas of Chemistry. This course seeks to provide students with a good understanding of the principles behind the commonly-used physical structural elucidation techniques: infrared, Raman, ultraviolet-visible and nuclear magnetic resonance spectroscopy and X-ray crystallography. It also highlights the strengths and limitations of each technique. Examples of applications of these techniques will also be discussed, to help students appreciate the practical considerations and issues encountered in their use. In particular, this course will equip students for research projects that involve structural elucidation.

MLS931 Metallomics

Metallomics within the cell and in the living organism is an emerging and growing field of research that involves integration of a broad range of research disciplines such as analytical, bioinorganic, environmental and medicinal chemistry. It is basically a study of the metallome (i.e. metal, metalloid or trace element) of an entire system and how the metallome interacts with the organism's genome, proteome or metabolome. In this course, the molecular mechanisms of metals in metal-containing biomolecules in biological system, the roles of metals in disease development, metal-based drugs and the characterization of metallomes in biological systems using various analytical techniques will be covered.

MLS946 Physical Methods for the Analysis of Energy Materials

The amount of information that can be derived from an examination of any material depends ultimately on how fine a probe is used. The wavelength of X-rays in the region of 0.1 nm would be an excellent probe. Modern scanning techniques are able to probe down to the nanometer scale lengths as well. X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy, Raman spectroscopy and X-ray photoelectron Spectroscopy are useful for the studies of molecular structure. The electron microscope is also widely used for high resolution work in studying cellular ultrastructure. Transmission and scanning electron microscopies (TEM and SEM) are normally used to investigate the 3-dimensional pattern of advance nanostructured materials. To identify the various elements especially, the energy dispersive x-ray fluorescence (EDXRF) spectroscopy is an excellent tool. This course will survey a wide range of modern and traditional characterization techniques with emphasis on techniques which are useful in current research laboratories. Participants will have the opportunity to learn to operate selected characterization instruments in this course.

MLS948 Molecular Spectroscopy

The course on Molecular Spectroscopy will provide the students with the theoretical knowledge and the experimental tools in understanding the properties of many different materials especially those used in clean energy technologies e.g. the materials used in solar cells and biofuels. In this course, the students will learn and use the techniques applied in molecular spectroscopy, and they are microwave, infrared, and Raman spectroscopies.

MLS962 Environmental Health and Toxicology

The study of the effect of pollution on natural ecosystems by examining biological responses at all organismal levels (molecular to whole organism) using biomarkers is an increasingly popular tool for managing environmental health by various governmental bodies. Candidates who take this course will have an opportunity to run laboratory experiments using known pollutants. Field sampling will be conducted to examine possible correlations with environmental contamination, allowing candidates to experience a direct application of ecotoxicology techniques as an environmental management tool. This experimental extension allows for a more rigorous assessment of a research-based course.

MLS963 Conservation and Management

In a rapidly changing world where the utilisation of resources is inextricably linked to development, the challenge of ensuring the sustainable use of natural resources has global consequences. This course will deal with issues relating to the sustainable use, protection, conservation and management of the earth's natural resources through relevant case studies. Local, regional and international initiatives, which address the issue of sustainable development and natural resource management, and the role of science in environmental management will be studied.

MLS964 Global Environmental Change and Vulnerable Ecosystems

Accelerated change in the environment on a global scale has been observed in the Anthropocene. The drivers of these global scale changes are attributed to human activities that relate to an unsustainable rate of development. Natural ecosystems (both terrestrial and aquatic) are impacted by environmental change, particularly when the scale and intensity of change exceeds the natural resilience and tolerance states of these ecosystems. It is important to be able to monitor and understand the impacts of environmental change to whole systems, especially vulnerable tropical ecosystems which largely support more than half of the earth’s human populations. This course aims to look at global environmental change and their impacts on vulnerable ecosystems from a scientific perspective, utilising state of the science technologies and newly developing knowledge. The course will be delivered as a practice-based field-orientated programme, which will have a compulsory overseas field component.

MLS985 Chemical Ecology

This course on Chemical Ecology explores the role and function of chemistry in mediating interactions among a variety of organisms, including intraspecific and interspecific interactions. The course will cover the range of compound classes involved in chemical ecology. In addition, we will discuss the diversity of species interactions and chemical compounds in terrestrial and aquatic systems, and methods (e.g. analytical and molecular techniques) used to detect these compounds. We will cover defensive and offensive chemistry mediating antagonistic interactions; the evolution of defenses; chemicals mediating mutualisms, competition, and sociality; the physiology of chemical production and recognition; and how chemical ecology affects humans. The biotechnological applications of chemical ecology will also be discussed. This course will include paper discussions of relevant recent literature.
