COURSE REQUIREMENTS FOR
CLEAN ENERGY PHYSICS SPECIALISATION

Course Code	Course Name
Core Course	
MLS900	Science Communication
Required Courses	
MLS942	Global Energy Systems
MLS943	Photovoltaic Physics and Solar Cells
MLS944	Nuclear Physics and Fission Energy
Specialisation Elective Courses *(Select 2 for those on the dissertation route; 3 for those on the complete coursework route)*	
MLS945	Plasma Physics and Fusion Energy
MLS946	Physical Methods for the Analysis of Energy Materials
MLS947	Energy Storage Systems
MLS948	Molecular Spectroscopy
MLS949	Selected Research Topics in Clean Energy Physics
MLS950	Applied Quantum Mechanics
MLS951	Lasers and Photonics
MLS952	Nanotechnology
Plus Either:	
-	Dissertation (6AU); or
MLS941	Critical Inquiry (Clean Energy Physics) (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.

MLS941 Critical Inquiry (Clean Energy Physics)

This course will enable participants to acquire experimental skills/techniques which are specific to Clean Energy Physics Specialisation and enhance their higher order thinking skills like critical thinking, problem solving, and application of knowledge through the use of the science Inquiry approach to solve clean energy related problems.

MLS942 Global Energy Systems

This course is designed for students to understand the global energy sources available for mankind especially for those who are engaged with or planning a career in professional contexts relating to energy management, education, R&D and marketing. It provides both theoretical and practical understanding of how energy and climate policies are distribute and connected across a multitude of cases drawn from global to local arenas.

MLS943 Photovoltaic Physics and Solar Cells

Today the traditional energy sources based on fossil fuels are depleting at an ever fast rate and will be exhausted in the next centuries. Photovoltaic solar energy becomes one of the most feasible alternative energy sources that will provides energy demand for mankind in the future. This course deals with the issues of an alternative sustainable energy source that relies on the direct conversion of sunlight into electrical energy in solar cells based on the photovoltaic effect.

MLS944 Nuclear Physics and Fission Energy

Nuclear Energy presently contributes about 15% of the World's supply of electricity with minimal production of CO2 and other greenhouse gases. This course provides in-depth coverage of the physics related to nuclear energy (basic nuclear physics, fission reactions, neutron physics, reactor physics, radiation interactions) together with a general overview of some important aspects of nuclear energy systems, including: reactor technologies, the nuclear fuel cycle, uranium and thorium resources, nuclear safety, and the human health effects of radiation. The contribution that nuclear energy can make to the security and sustainability of energy supplies is highlighted.

MLS945 Plasma Physics and Fusion Energy

Thermonuclear Fusion science has made great progress and inertial confinement based National Ignition Facility in US and magnetic confinement based International Thermonuclear Experiment Reactor in France are in their advance stage of construction and operation. Their successful operation will pave the way for clean and long term future energy sources. Thermonuclear fusion uses extremely high temperatures with hot dense plasma of fusion fuel being confined for sufficiently long durations for net energy output. The major objectives of this course are: (i) to highlight the advantages of Fusion over other energy resources, (ii) to understand the fundamental concepts related to plasma in terms of single particle motion and that of fusion process, (iii) to understand the role of plasma heating and plasma confinement in achieving controlled thermonuclear fusion, and (iv) to provide in-depth coverage of magnetic fusion and inertial confinement fusion schemes. The major topics included are: World energy scenario; Fusion as clean and long-term energy source; Fundamentals of plasmas; Single particle motion in electric and magnetic fields; Fundamentals of fusion process; Magnetic confinement schemes including magnetic mirror and tokamak; Inertial confinement fusion; and Alternative magnetic fusion device – plasma focus.

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.

MLS947 Energy Storage Systems

Energy storage systems allow the supply and demand of energy to be balanced. This is particularly important with current renewable energy resources such as solar energy where the energy produced during the day can be stored or use at night. Participants in this course will learn various types of energy storage systems and its related technologies. Some examples of energy storage systems are reservoirs and dams for storing gravitational potential energy to run hydroelectric power generators, chemical storage systems, batteries, thermal energy storage. Details of energy storage systems vary in their intended use, for example the energy storage system for a vehicle will have quite different requirements from an energy storage system for a home or grid energy storage system. In addition to the physics of novel energy storage systems, this course will also allow students to discuss the safety, cleanness and economic viability modern energy storage systems.

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.

MLS949 Selected Research Topics in Clean Energy Physics

With population growth, industrial development and technology advancement, the global demand for energy has increased drastically. However, 90 per cent of the primary energy use, nowadays, is from non-renewable sources which include the fossil fuels and nuclear energy. Over-reliance on these non-renewable sources poses grave threats to the sustainable human development such as energy crisis (where the peak of oil production will be reached before year 2020) and environmental debt (including global warming, greenhouse gas emission, nuclear disaster, etc.). As a result, current energy development is moving toward the development of clean energy as sustainable provision of energy to meets the future needs. In this course, students are expect to perform literature review on the latest advances in clean energy research, development and technologies.

MLS950 Applied Quantum Mechanics

Quantum mechanics is widely recognized as the basic law that governs all of nature, including all materials and devices. It has always been essential to the understanding of material properties, and as devices become smaller it is also essential for studying their behavior. This is an introductory course on quantum theory designed for students to understand the rudiments of the physics governing the atoms and molecules. There is an increasing need for professionals in clean energy to delve deeper and deeper into the laws of microscopic regime.

MLS951 Lasers and Photonics

This course is designed for students to understand the science and technology of generating detecting and manipulating light/ photons. Students will expected to propose, carry out, present and review photonics related hands on work. This course allows students to develop both theoretical and practical understanding light. This course is intended to support the students by providing them with the opportunity to study advanced concepts of lasers and light to allow a better understanding of equipment and techniques which they may encounter in their science, technology and engineering related Masters studies or PhD research.

MLS952 Nanotechnology

Students will be able to understand the physics, technology and applications of nanoscaled materials and devices. These include quantum confinements in 0, 1, 2 and 3 D systems, assembly and characterization of nanostructures, nanofabrication and application of various functional devices.
