SUSTAINABILITY STUDIES (SENS)

SENS 601 Research Methods and Ethics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course prepares students for performing graduate level research. It introduces students to quantitative and qualitative methods for critical exploration of research, locating and summarizing and critiquing relevant literature, developing a research problem, framing a problem with an appropriate research method, constructing a coherent research designs. Introduction to ethics and ethical misconduct, intellectual property and environmental health and safety. Through the course students will be developing a research proposal.

SENS 611 Sustainability Fundamentals and Tools **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course gives a general introduction to sustainability and how this concept evolved from the environmental movement of the post-World Water 2 era to the present. It outlines the major global issues that sustainability confronts, the major stakeholders involved and the barriers that prevent the wide scale application of sustainability principles. Students will be introduced to the main methods of quantifying sustainability, assessing the strengths and limitations of each method.

SENS 681 Integrated Sustainable Design for the Built Environment **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Students gain principles of sustainable design, and implement, demonstrate and debate them for specific built-environment projects in teams.

SENS 695 Master's Thesis Hours **1-6 Credits**
Grade Mode: Pass/Non Pass

The student formulates and undertakes an independent scientific research project under the supervision of their research adviser. A successful thesis defence leads to a Pass grade.

SENS 698 Industrial/Applied Project **6 Credits**
Grade Mode: Standard Letter, Pass/Non Pass

The student formulates and undertakes an independent scientific research project under the supervision of their research adviser. A successful thesis defence leads to a Pass grade.

SENS 701 Research Seminars **0 Credits**
Grade Mode: Audit/Non Audit, Pass/Non Pass

Research seminars are a regular slot for invited speakers and students to present scientific research and be listen to Sustainability related topics outside their main research focus.

SENS 706 Independent Studies **3 Credits**
Grade Mode: Standard Letter, Pass/Non Pass

Independent studies offer an opportunity for students to perform independent research work in any area related to Sustainable Development under the supervision of a faculty member

SENS 712 Environmental Quality and Health **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course will provide an overview on the relationship between Environmental Quality and health and the link to economic growth and sustainable development. Case studies will demonstrate the importance of growth, expansion of urban population and their impact on land, and water resources quantity and quality. In addition the course will cover the risks, transport and toxicity mechanisms associated with Chemicals of Emerging Concern in daily life, industry, and drinking water.

SENS 714 Sustainability: Energy, Environment and Economics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides an introduction to the interactions between energy, environment, economics and society, and how these impact sustainable development. The course will explore the influence of society through population growth, changing consumption rates and a desire to grow GDP on the extraction and utilization of energy sources and related environmental impacts. In particular the course will focus on the economic and social impacts of renewable energy development and environmental resource management.

SENS 715 Life Cycle Assessment - LCA **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass

The need for sustainable engineering is fueling the development of novel tools and techniques for studying the behavior of industrial systems and their relationship with the biosphere and society. Life Cycle Assessment (LCA) is an environmental modeling method that has become increasingly popular within business and academia for evaluating the environmental impacts of products or systems. LCA considers impacts along the entire life cycle, from production to consumption to disposal, and generally provides quantitative information for a range of different environmental issues to inform decisions. This course enables students to develop a practical understanding of the intellectual foundation and standards of LCA, common databases and software packages used, and their application to products and systems. Process-based analysis models, input-output and hybrid approaches are presented for LCA. This is a research based course and is suitable for students interested in researching in depth a particular topic.

SENS 716 Efficiency: Resource Use and Behavioural Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course explores the various uses of energy and other resources in a variety of human activities, the relative magnitudes of resource consumption and waste and the technological, social and economic factors that impact energy and resource efficiency and conservation.

SENS 718 Sustainable Cities and Urban Mobility **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course offers a multidisciplinary exploration of sustainable urban development by integrating advanced energy systems and smart city frameworks with traditional urban planning and transportation studies. Students will analyze the interplay between urban design, mobility, and public health alongside topics such as energy and sustainability. Building on established smart city frameworks, the course incorporates a smart city matrix that assesses urban progress through seven sub-indexes—Smart Environment, Smart Economy, Smart Society, Smart Governance, Smart Energy, Smart Infrastructure, and Smart Transportation—allowing students to quantify a city's transition toward sustainability.

SENS 719 Energy Water Food (EWF) Nexus **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course investigates the nexus of energy, water and food (EWF) resources and the complex interaction with human behavior and natural systems, in addition to the inter-dependencies that exist between the EWF resources themselves. The social, technical and economic nature of these interdependencies is explored throughout the life cycle of various systems to determine optimal solutions for a sustainable future.

SENS 720 Additive Manufacturing for Sustainability **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on Additive Manufacturing and the relevant issues of materials, design, process, applications, modelling and simulation. It will introduce the fundamental concepts, its relevance, use and importance under the field of sustainability in terms of materials, time, space and resource efficiency; part, process and application flexibility; distributive, on-time and on-demand nature of production capability; and possible intertwining with other disciplines of materials science, design, industry, production, arts and architecture. Then, it will gain knowledge on various emerging types, approaches, applications of Additive Manufacturing in addition to materials, design, modelling and economics for it.

SENS 721 Advanced Materials Synthesis and Characterization **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides an overview and hands on experience on processing and characterization techniques of advanced materials used in energy, water, and electronics applications. Both chemical and physical processes to synthesize and deposit materials in various scales including nanostructures, thin films and bulk are tackled. The course also provides basic training in advanced characterization technics such as AFM, SEM, XPS, TOF-SIMS, XRD, Raman and FTIR. In addition, advanced tools related to PV characterization (e.g. TRPL, PL mapping and micro PCD) will be as well introduced in-depth

SENS 722 Sustainable Chemical Industry - A Green Approach **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course will introduce principles and practices of sustainable chemical process design to reduce industry's impact on the environment. Specific examples will cover the possibilities of running industrial chemical processes in a sustainable manner and provide an up-to-date insight into the main concerns for sustainable process optimization.

SENS 728 Electrochemistry and Environmental Corrosion **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is designed for graduate students who are interested in learning by doing in the area of applied electrochemistry and environmental corrosion. The course specifically focuses on how to make electrode and cells (e.g., battery). Also, the course extends to study corrosion behavior of metallic substrates under a given condition that develop in our living environment. Furthermore, the course teaches advanced techniques used to understand electrode reactions in particular corrosion processes and estimate important parameters, such as corrosion potential and corrosion rates.

SENS 729 Electrochemistry and Electrochemical Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass

This course is about introducing fundamentals and applications of electrochemisty in energy storage

SENS 762 Advanced Transport Phenomena **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course will acquaint the student with important topics in advanced transport phenomena (momentum, heat and mass transport). Topics include laminar and turbulent flow, thermal conductivity and the energy equation, molecular mass transport and diffusion with heterogeneous and homogeneous chemical reactions. Focus will be to develop physical understanding of principles discussed and with emphasis on different field of engineering applications. In addition to the text, the student will be exposed to classic and current literature in the field. Two exams, homework assignments and a student project are required

SENS 780 Green Building: Design, Construction and Operation **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass

The built environment is a major source of environmental impact. This course teaches all major aspects of green building design, construction and operation with life cycle thinking in order to reduce these impacts. All green building categories are covered: location & transportation, sustainable sites, energy and atmosphere, water efficiency, materials & resources, and indoor environmental quality. The United States Green Building Council's LEED rating system is used to demonstrate one possible green rating system.

SENS 785 Innovation Entrepreneurship Leadership I **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course first provides introductory discussions on theories of design innovation, entrepreneurship and leadership. Then, it focuses on experiential learning for design and development of products, processes, systems and business models. Topics include design thinking, system thinking, design process; understanding and developing user/stakeholder needs/input for a sustainable solution; generating technical and marketing specifications; and prototyping methods to reduce development time.

SENS 786 Innovation Entrepreneurship Leadership II **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course first provides introductory discussions on theories of design innovation, entrepreneurship and leadership. Then, it focuses on experiential learning for design and development of products, processes, systems and business models. Topics include design thinking, system thinking, design process; understanding and developing user/stakeholder needs/input for a sustainable solution; generating technical and marketing specifications; and prototyping methods to reduce development time.

SENS 791 Geospatial Information Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is about introducing information system fundamentals for geospatial applications

SENS 890 Dissertation Hours **1-9 Credits**
Grade Mode: Pass/Non Pass

Original and independent doctoral thesis research. A successful defense of the thesis leads to the grade Pass