ISyE 4501 Energy, Efficiency and Sustainability

Category Toward Degree: ISyE Concentration Breadth Elective

Credit: 3-0-3

Proposed: Andy Sun, Valerie Thomas

Prerequisites: ISyE 3025 Eng Economy, ISyE 3133 Engineering Optimization (with concurrence), Physics 2211, Chem 1301 or Chem 1211 K.

Catalog Description: Analysis and modeling of energy production and use, material and energy efficiency, sustainability, and cost for systems, products, and services.

Text and readings: Lecture notes will be posted, supplemented by articles.

Content:
Methods:
• Environmental lifecycle assessment (LCA) – Green supply chains. Lifecycle environmental impact including production, distribution, use, and recycling or disposal.
• Economic approaches to environmental management - Cost-benefit analysis. Taxes and subsidies. Supply curves. Environmental externalities, tradable permits, markets.
• Material flow accounting and industrial ecology – Efficiency assessment.
• Resource constraints and availability – Calculations with population, technology, consumption and emissions.

Topics: (At least 4 topics below)
• Energy - Energy calculations for mass, fuel energy value, energy efficiency, and applying energy knowledge to calculate energy resources and constraints.
• Water - Water mass balances, water needed for electricity generation; combined energy/water analysis for industrial systems.
• Greenhouse gas emissions - Greenhouse gas accounting, global warming potential calculations, and greenhouse gas emission inventories.
• Transportation energy - Energy use by transport mode. Supply chain energy use and environmental impacts.
• Electricity – Generation, transmissions, distribution.
• Air Pollution – Human health impacts, monetization.

Grading:
Homework – 10%. Midterm 1 – 20%. Midterm 2 – 20%. Projects – 25%. Final Exam – 25%

Sample schedule, each topic is 1 week

Topic	Weeks
Efficiency	1
Energy	1
Life cycle assessment	1
Cost benefit analysis	1
Material analysis, Midterm 1	1
Greenhouse gas accounting	1
Economic input output life cycle assessment	1
Energy, efficiency and sustainability in freight transport	1
Electricity; water	1
Levelized cost, Midterm 2	1
Metrics of impact	1
Box Models	1
Air pollution: monetization of impact	1
Sustainability in product supply chain	1
Project presentations	1
Integrated assessment models	1
Total	16

Attendance
The only acceptable excuses are the Institute Approved Absences http://www.registrar.gatech.edu/students/formlanding/iaabsences.phpor, or from Dean's Office.

Rules
- Honor Code: http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code
- Student-Faculty Expectations: http://www.catalog.gatech.edu/rules/22/
- If you have GT approved official excuse http://www.registrar.gatech.edu/students/formlanding/iaabsences.phpor or excuse from Dean's office for assignments, tests or presentations, you must arrange for the resolutions with the instructor before the test.

Learning Outcomes: At the end of the course, students will be able to:
1. Evaluate lifecycle environmental impacts of a product or service (by exams)
2. Use knowledge of industrial systems to scope and develop environmental assessments (by project)
3. Evaluate monetary and environmental costs and benefits of technology choices (by exams)

Student Outcome Assessment Plan

Course outcome \ Program Outcomes	1. identify, formulate solve engg prob by engg, sci & Math	2. produce solutions consider public health, safety, welfare, global, cultural, social, environ & economic	3 communicate with a range of audience	4 recognize ethical & professional responsibilities, make informed judgement consider resolutions in global, economic, environ and societal context.	5. effective on a team provide leadership, collaborative and inclusive envirn, plan tasks & meet objectives	6. develop and conduct experiment, analyze and interpret data & use engineering judgement to draw conclusions.	7. acquire and apply new knowledge using appropriate learning strategies
1. Evaluate Lifecycle environmental impacts of a product or service		H		H			
2. Use knowledge of industrial and systems engineering to cope and develop environmental assessment		H		H			M
3. Evaluate monetary and environmental costs and benefits of technology choices (by exam)		H		H			

Evaluation of the important course outcomes

The course outcomes 1 and 3 will be assessed by final exam and2 will be assessed by course projects.

The approximate relationship from prior ABET a – k to new ABET 1 – 7.

OLD Criterion 3. Student Outcomes The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.	NEW Criterion 3: Student Outcomes The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.
(a) an ability to apply knowledge of mathematics, science, & engineering (e) an ability to identify, formulate, and solve engineering problems	(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health & safety, manufacturable, & sustainable	(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(d) an ability to function on multidisciplinary teams	(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative & inclusive environment, establish goals, plan tasks, and meet objectives.
(f) an understanding of professional and ethical responsibility (h) the broad education necessary to understand the impact of engg solutions in a global, economic, environmental, & societal context (j) a knowledge of contemporary issues	(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(g) An ability to communicate effectively.	(3) An ability to communicate effectively with a range of audiences.
(i) a recognition of the need for, and an ability to engage in life-long learning	(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	Implied in 1, 2 and 6