ICE-T Modules 2022-2023

Fall 2022

10.492A Electrochemical Engineering, MWF10-11 (Virtual), Fikile Brushett, first half of term

10.492A is a half-semester-long Integrated Chemical Engineering course, where students are exposed to a particular topic within the broad realm of chemical engineering. This course provides an introduction to electrochemical engineering with a focus on highlighting the connection to the chemical engineering discipline and exploring the unique aspects of electrochemical processes. Electrochemical technologies are an integral part of modern life. Methods based on electrochemical phenomena underlie sensors, energy storage and conversion, and microfabrication processes. Moreover, electricity can be used to drive the clean production of chemical and remediation of environmental pollutants. Though chemical engineers have an important role to play in the field, undergraduates are not typically exposed to electrochemistry. Thus, our aim is to provide an introduction to the fundamental principles, to demystify existing electrochemical systems, and, hopefully, to inspire ideas for future products and processes.

10.492B Process Intensification MWF10-11 (Virtual), Klavs Jensen, second half of term

Process intensification invokes new reaction techniques and equipment to improve chemical processes by miniaturizing, combining, controlling, and/or enhancing the underlying chemical and physical transport processes. The ultimate goal of process intensification is achieving higher efficiency, reduced energy consumption, less waste, safer operation, and long-term sustainability. This class explores the principles of process intensification through lectures, demonstrations, homework, and projects based on concepts introduced in transport phenomena (10.301/2), thermodynamics (10.213), kinetics, and reaction engineering (10.37). The current transition in pharmaceutical manufacturing from batch to continuous flow serves one of several examples of process intensification. Microwave, electrochemical, and photochemical reaction processes illustrate alternative, intensified approaches to drive chemical reactions instead of by conventional heating. Membrane reactors exemplify combined reaction and separation unit operations. 3D printing and other modern fabrication techniques serve to realize new, efficient processing equipment. Integration, automation, control and optimization form important elements in achieving further process intensification.

10.01 Ethics for Engineers (full term)
M3-5, 66-144, Prof. Bernhardt Trout, (AI focus)
M3-5, 66-148, Prof. Doug Lauffenburger, Peter Hansen (BE focus)
T3-5, 66-144, Peter Hansen
W3-5, 66-144, Kathryn Hansen
W7-9, 66-144, Peter Hansen

Explores the ethical principles by which an engineer ought to be guided. Integrates foundational texts in ethics with case studies illustrating ethical problems arising in the practice of engineering. Readings from classic sources including Aristotle, Kant, Locke, Bacon, Franklin, Tocqueville, Arendt and King. Case studies include articles and films that address engineering disasters, safety, biotechnology, the internet and AI, and the ultimate scope and aims of engineering. Different sections may focus on themes, such as AI or biotechnology. Students taking independent inquiry version 6.9041 will expand the scope of their term project. Students taking 20.005 focus their term project on a problem in biological engineering in which there are intertwined ethical and technical issues. In person not required. Limited to 18 per section.

IAP 2023

10.493 Electrochemical Energy, Schedule TBD, Javit Drake, IAP

Energy technology plays a critical role on an individual and societal scale. Electrochemical energy conversion systems, such as batteries and fuel cells, find applications in personal power--e.g., handheld electronic devices; stationary home power; vehicles; and large scale power plants. Design, sizing, and choice of operation point are important considerations for appropriately engineering these potentially efficient electrochemical systems. Lectures and assignments address the ways that thermodynamics, electrochemical reaction, and transport factor into power, durability, and efficiency trade-offs. For the project, each group undertakes a detailed analysis of a single or hybrid combination of power sources, leading to design choices targeting a particular device and consumer use.

SPRING 2023 EXPECTED

Expected: 10.494A Design of new processes for reducing GHG emissions in the energy sector, Schedule TBD, Prof. William H. Green, first half of term

Currently the transportation fuel sector is a major source of greenhouse gas emissions, both in the fuel production process (and ancillary processes handling or valorizing byproducts) as well as in direct fuel use by consumers, and the relative importance of this sector to global GHG emissions is expected to increase over the next 20 years. There is therefore great interest in reducing the greenhouse gas emissions associated with fuel production. This half-semester subject will give the students experience designing a new chemical engineering process to reduce GHG emissions from this sector, considering a wide range of technical, practical, economic, ethical, environmental, and societal-impact factors. While most of this subject will be focused on a design project done by a student team, there will also be some lectures and homework focused on specific issues, to help prepare the students to tackle this challenging design problem. Prior experience with ASPEN is helpful for quantitatively evaluating proposed designs.

Expected: 10.494B Therapeutic Nanoparticle Manufacturing, Schedule TBD, Prof. Daniel G. Anderson, second half of term

Lipid nanoparticles are poised to revolutionize the treatment of genetic disease by enabling the therapeutic delivery of nucleic acids that can turn your genes off, turn them on, or even permanently and specifically edit your genome. This class will provide an over view of lipid nanoparticles and drug delivery including what nanoparticles are made of, how they will be used, and in particular how they are made and analyzed. Projects will focus on the application of chemical engineering principles to design a continuous nanoparticle formulation process for pharmaceutical scale production. This will include examination of small scale nanoparticle production procedures based on microfluidics, hands-on construction of nanoparticle formulation chips, and a study of how these devices might be

10.01 Ethics for Engineers
Sections and Instructors TBD, full term

Explores the ethical principles by which an engineer ought to be guided. Integrates foundational texts in ethics with case studies illustrating ethical problems arising in the practice of engineering. Readings from classic sources including Aristotle, Kant, Locke, Bacon, Franklin, Tocqueville, Arendt and King. Case studies include articles and films that address engineering disasters, safety, biotechnology, the internet and AI, and the ultimate scope and aims of engineering. Different sections may focus on themes, such as AI or biotechnology. Students taking independent inquiry version 6.9041 will expand the scope of their term project. Students taking 20.005 focus their term project on a problem in biological engineering in which there are intertwined ethical and technical issues. In person not required. Limited to 18 per section.