

EST/MS/ME 199. Special Topics in Energy Science and Technology
Membrane Science and Engineering for Sustainable Energy. 9 units (3-0-6); second term

Winter Term 2013

Prerequisite: Ph 12C or APh 17a or ChE 63, or instructor's permission

Instructor: Prof. Mamadou S. Diallo (KAIST and Caltech)

Guest Lecturers: Prof. John Brady (Caltech), Prof. William Goddard (Caltech), Prof. Sossina Haile (Caltech), Prof. Julie Kornfield (Caltech), Prof. Rachel A. Segalman (UC Berkeley) and Prof. Zhen-Gang Wang (Caltech)

Course Description:

Synthetic membranes are increasingly becoming critical components of a broad range of applications and technologies relating to the energy, environmental, water and sustainability (EEWS) challenges of society. This course will discuss the science, engineering and applications of membrane processes, materials, modules and systems to energy generation, conversion and storage. The course will cover the fundamentals of membrane science and engineering. It will also discuss membrane processes and applications associated with energy conversion, generation, and storage. In addition to weekly lectures by the instructors, the course will also include supplementary lectures and seminars by Caltech and JCAP faculty and scientists investigating energy science and technology for which membranes play an important role. During the final two weeks of class, each student will be asked to utilize the knowledge gained during the course to develop a proposal for utilizing membrane science and engineering to help solve a current and important problem in sustainable energy generation, conversion, or storage.

Textbook: Introduction to Membrane Science and Technology by Henrich Strathmann (ISBN: 978-3-527-32451-4)

Course Organization

- Weekly lectures (Wednesday and Friday from 2:00-3:30 pm)
- Supplementary guest lectures and seminars
- Homework (4 problem sets)
- Term Paper (Presentations and Written Report)

Grading Policy

Homework (60%)
Term paper (40%)

Course Content and Schedule (Winter Term 2013)

Period	Content	Period	Content
Lecture 1: Diallo Date: (Week 1: January 7)	Introduction and Overview of Membrane Science and Engineering	Lecture 12: Diallo Date: (Week 6: February 15)	Membranes for Solar Fuel Generation: Water-Energy Nexus
Lecture 2: Diallo Date: (Week 1: January 11)	Membrane Separation Processes for Sustainable Energy	Lecture 13 (Guest): Segalman Date: (Week 7: February 20)	Membranes for Solar Fuel Generation: Photocatalytic and Proton Conducting Membranes
Lecture 3: Diallo Date: (Week 2: January 16)	Thermodynamics and Electrochemistry in Membrane Systems	Lecture 14: Diallo Date: (Week 7: February 22)	Membranes for Solar Fuel Generation: Water and Gas Separation Membranes
Lecture 4: Diallo Date: (Week 2: January 18)	Mass and Charge Transport in Membrane Systems	Lecture 15 (Guest): Brady Date: (Week 8: February 27)	Energy Generation from Salinity Gradients: Fundamentals and Applications of Osmosis
Lecture 5: Diallo Date: (Week 3: January 23)	Mass and Charge Transport in Membrane Systems (Cont)	Lecture 16: Diallo Date: (Week 8: March 1)	Energy Generation from Salinity Gradients: Pressure Retarded Osmosis and Reverse Electrodialysis Membranes
Lecture 6: Diallo Date: (Week 3: January 25)	Overview of Membrane Materials, Modules and Systems for Energy Conversion, Generation and Storage	Week 9: March 8 and 13 (Diallo and Goddard)	Student Term Project
Lecture 7 (Guest): Kornfield Date: (Week 4: January 30)	Preparation of Polymeric Membranes for Sustainability: Fundamentals of Polymer Science and Engineering	Week 10: March 15 and 20 (Diallo and Goddard)	Student Term Project
Lecture 8 (Guest): Wang Date: (Week 4: February 1)	Preparation of Polymeric Membranes for Sustainability: Phase Equilibrium and Microstructures in Polymer Solutions	Week 10: March 22	Completion of Student Term Projects and Presentations
Lecture 9: Diallo Date: (Week 5: February 6)	Membranes for Fuel Cells: Preparation and Characterization of Polymer Electrolyte Membranes for Fuel Cells		
Lecture 10: Goddard Date: (Week 5: February 8)	Membrane for Fuel Cells: Multiscale Modeling of Polymer Electrolyte Fuel Cell Membranes		
Lecture 11 (Guest): Haile Date: (Week 6: February 13)	Membranes for Fuel Cells: Preparation and Characterization of Solid Oxide Fuel Cell Membranes		