COMMONWEALTH GRADUATE ENGINEERING PROGRAM
DISTANCE LEARNING COURSE PLANNING SHEET
UNIVERSITY OF VIRGINIA

Course:	MSE 7080 – Advanced Electrochemistry
Semester:	Fall 2009
Instructor:	John R. Scully
Phone No.:	434.982.5786
Office Address:	University of Virginia; Department of Materials Science and Engineering; Wilsdorf Hall, Room 330; 395 McCormick Road; P.O. Box 400745; Charlottesville, VA 22903
E-Mail Address:	jrs8d@virginia.edu

Textbook(s):

None (class notes from over 5 books synthesized into one set of course notes will be provided)

Reference(s):

Selected chapters from:

D.A. Jones, Principles and Prevention of Corrosion
E. Gileadi, Electrode Kinetics for Chemical Engineers and Materials Scientists
Pletcher, Industrial Electrochemistry
Hamann, Electrochemistry
ASM Metals Handbook, Volume 13
Atlas of Electrochemical Equilibria in Aqueous Solutions, NACE Houston, TX
H. Kaesche, Metallic Corrosion

Computer Needs:

Computer Capability:	On-grounds: A network capable Laptop computer (running either Firefox 3+ or IE 7+) with headset & microphone to participate in *Illuminate* session as live participant Access to Collab, ability to download and play streaming video, read pdf, ms word, ms ppt Off-grounds: Access to Collab, ability to play streaming video, read pdf, word, ppt
Software required:	Power point Adobe PDF Microsoft Word Microsoft Excel
Provided?	no
Other:	Plotting Software: Origin Pro, Sigma Plot, Excel Plot, K-graph

NOTE: This will be an asynchronous course for off-grounds students. You will be given information to access the course lectures by video streaming.

MSE 7080
Listed as: Advanced Electrochemistry
Fall, 2009
On-grounds: M,W: 11:00-12:15 pm
WDH RM 101

Instructor:
Dr. John R. Scully
Professor of Materials Science & Engineering
Wilsdorf Hall, Rm 330
Office Phone: 434.982.5786
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Office: Rm 318, Wilsdorf Hall, Univ. of Virginia

Class hours and location:

On-grounds: M,W: 11:00-12:15 pm (live lectures)
Off-grounds: Collab Educational Site
Power Point Lecture Presentations
Streaming video recordings of given lectures posted by T,Th

Make-up on grounds: TBA – Friday; WH 101, 11-12:15 pm

Grading Policy:
Class participation: 5%
Homework (3-4 assignments): 40%
Mid-term (take home) exam: 25%
Final Exam (this will be consist of a written paper review, and an oral exam, oral discussion of written paper review): 30%
HW and Exams are pledged independent efforts. *Please refrain from use of homework and test solutions from previous years.*

Auditing policy: The only auditors permitted are those that would be ineligible to take the class, etc. Eligible customers are expected to

take the class. Auditors eligible for taking the class at a later date should refrain from collecting HW and Test solutions.

Prerequisites: completion of MS 608, its equivalent, or by consent of the instructor. The class requires an introductory knowledge of materials science and engineering and inorganic chemistry.

Class objective: The intent of this class is to provide students with a strong foundation in electrochemical material science. It will emphasize corrosion science with focus on the thermodynamics, electrochemical kinetics, transport phenomena in electrochemistry, and passivity followed by the phenomenological observations, basic theory and latest mechanisms associated with the eight forms of corrosion. The fundamental thermodynamics and kinetics will easily enable discussion of batteries and fuel cells, and to a limited extent plating and industrial electrochemical phenomena.

Therefore, the class objectives are:

- The class provides an understanding of fundamental thermodynamic and kinetic principles of electrochemical phenomena applicable to aqueous corrosion, batteries, fuel cells, and other electrochemical phenomena.

- The class also covers some amount of underlying materials science associated with corrosion processes, as well as modern theories, principles, and mechanisms associated with the various forms of corrosion. The class will build upon the fundamental foundations covered in MS 608 or its equivalent.

- Secondly, the class will provide a few examples of the application of electrochemical thermodynamics and kinetics to batteries, fuel cells, electroplating and industrial electrochemistry.

- The class will be divided into basic (MSE 301/608 review), advanced (MSE 7080), and enrichment areas. Basic and advanced topics should be regarded as required areas of knowledge acquisition while “enrichment areas” are extra and not required areas.

- Lastly, the proposed mechanisms along with some phenomenological observations will be reviewed for each of the forms of corrosion covered. Occasionally, techniques used to probe various corrosion phenomena will be discussed but experimental measurement details will not be a major emphasis of the course.

Textbook: A suitable textbook does not exist for class goals. The class notes have been constructed from different textbooks, review papers and the archival literature papers. Xerox copies of handouts with reference sources will be provided.

The following list of books will be helpful for a Ph.D. student to acquire but not mandatory for class success. Selected chapters may be provided but these are “fair use” only and are not to be distributed or re-sold.

- D.A. Jones, Principles and Prevention of Corrosion
- M. Pourbaix, Atlas of Electrochemical Equilibria in Aqueous Solutions.
- Carl Hammann, Electrochemistry
- Eliezer Gileadi, Electrode Kinetics for Chemical Engineers and Materials Scientists.
- H. Kaesche, Metallic Corrosion
- P. Marcus, J. Oudar, Corrosion Mechanisms in Theory and Practice
- Z. Szklarska-Smialowska, Pitting and Crevice Corrosion
- Corrosion Theory, ASM Metals Handbook, Vol. 13A

Computer Needs:

Computer Capability:

On-grounds: A network capable Laptop computer (running either Firefox 3+ or IE 7+) with headset & microphone to participate in Illuminate session as live participant

Access to Collab, ability to download and play streaming video, read pdf, ms word, ms ppt

Off-grounds: Access to Collab, ability to play streaming video, read pdf, word, ppt

Software required:

Power point
Adobe PDF
Microsoft Word
Microsoft Excel

Other:

Plotting Software: Origin Pro, Sigma Plot, Excel Plot, K-graph

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Software required:

Power point
Adobe PDF
Microsoft Word
Microsoft Excel

Provided: no

MSE 7080
"Advanced Electrochemistry"
Fall 2009
Tentative Course Outline

CLASS BY TOPIC	Time (approx.)	PRIMARY SOURCE	SUGGESTED READING+
Introduction	Week 1	Class presentation	none
Thermodyanmics intro – chemical vs. electrochemical equilibrium	Week 1	Class presentation	Jones, Ch 2.
Thermodyanamics – Chemical Equilibrium and Electrochemical Equilibrium: the Nernst Equation	TBA	Class presentation	Jones, Ch 2.
Thermodynamics- Construction of Pourbaix or E-pH diagrams at room temperature and pressure	TBA	Class presentation	Article by Verink, Pourbaix Atlas, Jones, ch 2
Thermodynamics – Special Topics E-pH with Complexation, Foreign Surfaces and Adsorbate E-pH*	TBA	Class presentation	ASM Metals Handbook Vol. 13A, Chapter by Marcus
Thermodyanmics – Special Topics/High Temperature, alloying, surface curvature*	TBA	Class presentation	Selected articles
Homework #1 (Thermodynamics)	TBA	Collab posted	all
Kinetics – Intro & Faraday's Laws	TBA	Class presentation	Jones, Ch 3.
Kinetics – Driven and Driving Systems	TBA	Class presentation	Gileadi, Ch. E
Kinetics – Absolute reaction rate theory	TBA	Class presentation	Glieadi, Ch. E
Kinetics – overpotentials, symmetry factor	TBA	Class presentation	Jones, Ch. 3, Gileadi Ch. E
Kinetics - Single and Multi-step Charge Transfer Controlled Reactions, Reaction Order and Mechanisms, Adsorbed Intermediates	TBA	Class presentation	Gileadi, Ch F, I
Kinetics - HER and ORR, corrosion ½ cell reactions		Class presentation	Gileadi, Ch D.15
Introduction to Solution Properties I		Class presentation	Hamann Ch. 2
Kinetic limitations – Mass Transport Controlled Reactions – rotating disk, cylinder, pipe	TBA	Class presentation	Hamann Ch. 2
Kinetics – Mixed Potential Theory, Evans Diagrams, Wagner-Traud theory of corrosion	TBA	Class presentation	Jones, Ch. 3, Hamann Ch 4
Kinetics – Electrode arrays and microelectrodes*	TBA	Class presentation	Gileadi, Ch.L.27
Introduction to Solution Properties II			Hamann, Ch. 2
Kinetic Limitations – Ohmic Drop	TBA	Class presentation	Gileadi, Ch. C.8
Homework #2 (Kinetics)	TBA		
Kinetics – Dissolution in single and multi-metal systems, high field and low field governing kinetics			Kaesche, Ch. 5,6,8
Kinetics - Galvanic Corrosion, Batteries and Fuel Cells	TBA	Class presentation	Jones, Ch 6., Gileadi,Ch. M Pletcher, Hamann Ch 9
Kinetics: CVs, LPR, EIS*		Class presentation	Jones, Ch. 5, Gileadi Ch. L
Test One – take home	TBA	Collab posted	
Kinetics – Current and potential distributions	TBA	Class presentation	Various
Kinetics – special topics*	TBA	Class presentation	TBA
Forms of Corrosion – Uniform corrosion	TBA	Class presentation	ASM Metals Handboo Vol. 13, Jones

Forms of Corrosion – Galvanic, Batteries, Fuel Cells	TBA	Class presentation	ASM Metals Handbook, Vol. 13, Pletcher
Homework #3 applications	TBA	Posted on Collab	All
Passivity of metals and alloys		Class presentation	Kaesche,Ch. 10, Jones, Ch. 4
Forms of Corrosion – Localized: Pitting and Crevice Corrosion	TBA	Class presentation	ASM Metals Handbook, Jones Ch 7
Forms of Corrosion – Localized: Intergranular	TBA	Class presentation	ASM Metals Handbook, Jone Ch 7s
Forms of Corrosion – Localized: Dealloying		Class presentation	ASM Metals Handbook, Jones, Ch 7
Forms of Corrosion – Environment assisted cracking: stress corrosion, corrosion fatigue, and hydrogen embrittlement	TBA	Class presentation	ASM Metals Handbook, Jones, Ch 8
Other topics: More on Fuel Cells	TBA	Class presentation	Gileadi, M, Pletcher, Hamann, Ch 9.
Final Exam (Paper review and oral final)	End of class	Posted on Collab	n/a

- * Enrichment topics may not be presented as time allows
- + Suggested reading is optional unless specifically assigned

On-grounds schedule:

M,W 11:00-12:15 pm, WDH 101
Exceptions:
1. Aug. 25th, TV rm Thornton A119, Tuesday August 25th, 8-9:15 pm (First session only)
2. August 26th, first class session in WDF 101 at 11:00-12:15 pm
3. August 28th, this is a make-up session, 101 at 11:00-12:15 pm
4. August 31st, Sept. 2nd, WDF 101 sessions cancelled, Lecture Presentation as PDF and Recorded Illuminate Sessions (PDF + audio) available
5. October 5 and 7; WDF sessions cancelled, Lecture Presentation as PDF and Recorded Illuminate Sessions (PDF + audio) available

Off-grounds schedule:

Official broadcast time: T,TH 8:00-9:15 pm, Thornton Rm A119 (This room and time will be used on August 25th only)
Lecture Presentation as PDF and Recorded Illuminate Sessions (PDF + audio) available by 8 pm, T, Th of each week on Collab UVA Instructional Web Page (no TV broadcast at 8 pm at any time during semester after first session)

Administrative issues should be directed to:
Rita F. Kostoff
University of Virginia
Commonwealth Graduate Engineering Program
351 McCormick Road - Thornton Hall A127
P. O. Box 400235
Charlottesville, VA 22904-4235

Phone: 434-924-4051 - Fax: 434-924-4086
Email: rfk2u@virginia.edu

UVA website: http://cgep.virginia.edu
State-wide website: http:/cgep.virginia.gov

Academic Misconduct

Academic misconduct may occur when a student's actions distort the accurate assessment of any student's individual accomplishments that are evaluated for the purpose of grading or conferring academic credit. Note that a student may be guilty of academic misconduct, for example, by cheating, plagiarizing, or by allowing another student to cheat or plagiarize. Note that the distortion applies, for example, to exams, homework assignments, project assignment and presentations. To the extent that any class activity is used for evaluation for the purpose of grading or conferring academic credit, falsifying, plagiarizing or distorting submitted or presented material or permitting another student to falsify or distort such activity, represents academic misconduct.

Additional guidance about what represents academic integrity and misconduct, and related university-wide policies and procedures are available at the following locations:

http://www.virginia.edu/honor/students.html

http://www.scps.virginia.edu/honor_code.htm

http://plagiarism.phys.virginia.edu/