**Department of Chemistry Syllabus**

This syllabi is advisory only. For details on a particular instructor's syllabus (including books), consult the instructor's course page. For a list of what courses are being taught each quarter, refer to the Courses page. *Every instructor has prerogative to teach the course as they see fit and ultimately the instructor's syllabus supersedes all others.*

**CHE228D - HOMOGENEOUS AND HETEROGENEOUS CATALYSIS**

Approved:

Suggested Textbook: (actual textbook varies by instructor; check your instructor)

*Industrial Catalysis: A Practical Approach, Second Edition.* Jens Hagen; Copyright \_ 2006 WILEY-VCH Verlag GmbH & Co. KGaA,Weinheim; ISBN: 3-527-31144-0

*Concepts of Modern Catalysis and Kinetics.* I. Chorkendorff, J. W. Niemantsverdriet; Copyright\_ 2003 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim; ISBN: 3-527-30574-2

*The Organometallic Chemistry of the Transition Metals, Fourth Edition*, by Robert H. Crabtree, 2005 John Wiley & Sons, Inc., ISBN 0-471-66256-9

*Organotransition Metal Chemistry: From Bonding to Catalysis 1st Edition*, John Hartwig, 2009 University Science books, ISBN-10: 189138953X

Suggested Schedule:

**1. Introduction**

History of catalysis, Economic importance

**2. Catalysis Fundamentals**

Transition State Theory, Turnover number, Frequency, Selectivity. Hard versus for soft catalysis, heterogeneous versus homogeneous catalysis

**3. Catalysis with Acids and Bases**

Esterification, Amide Hydrolysis

**4. Catalysis with Transition Metals**

Elementary Reactions

**5. Homogeneously Catalyzed Industrial Processes**

Oxo Synthesis, Acetic Acid Process, Wacker Process, Asymmetric Catalysis

**6. Biocatalysis**

Nitrogen Fixation, Photosynthesis

**7. Heterogeneous Catalysis: Fundamentals**

Individual Steps, Adsorption, Kinetics, Energetics, Steric effects, Shape selectivity, Catalyst characterization

**8. Examples of Heterogeneously Catalyzed Processes in Industry**

Ammonia Synthesis, Methanol Synthesis, Polymerization, Hydrogenation

**9. Electrocatalysis**

Comparison with Heterogeneous Catalysis, Fundamentals, Electrocatalytic Oxidation/Reduction, Fuel Cells

**10. Photocatalysis**

Photocatalytic Water Splitting

**11. Environmental Catalysis**

Catalytic Converter

Additional Notes: Evaluation consists of eight homework assignments (not graded), one in-class presentation (powerpoint) with discussion (50 %), and one final exam (50%).

Learning Goals:

This special topics course introduces students to the theory or homoegenous and heterogeneous catalysis. TheAt the end of the class, students will know about the economic importance and history of catalysis, and they will be familiar with performance paramters of catalysts. They will be able to clarify catalysts acceding to their mechanism, and elementary reaction types. They will learn examples of important industrial catalytic processes. They will be able to derive and interpret basic rate laws for heterogeneous and homogeneous catalytic processes. Principles of electrocatalysis and photocatalysis will also be introduced, as well as methods for catalyst characterization.