Chemistry 505/Chemical and Biological Engineering 505: Aspects of Industrial Chemistry and Business Fundamentals Spring 2016 – Ive Hermans, William Banholzer

The objective of this course will be to educate students in the chemistry and chemical engineering that defines societies' standard of living. Commercial chemical processes will be reviewed. Practical realities of how a discovery moves from research to a commercial product will be taught through examples and case studies. Financial concepts that guild investment will be reviewed including market adoption, the "technology "S" curve, venture capital vs. corporate models, and intellectual property.

Professors: Ive Hermans (608-262-4996, hermans@chem.wisc.edu)
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Credits: 3 – 150 minutes/week
Time: TBD
Location: TBD

Prerequisites: Junior standing or higher and Chem 345, or consent of instructor

Learning Objectives:

This course will:

(1) Provide students with a sound overview of the most important value-chains in the chemical industry.
(2) Connect the fundamental chemistry and chemical engineering principles that the students have learned in other courses with real-world applications.
(3) Teach students how laboratory discoveries can be protected (Intellectual Property) and successfully commercialized.
(4) Teach students how to assess alternative technologies against the available state-of-the-art benchmark.

Topics

Topics covered include the following:

1. Chemical industry integration, feedstock, product flow.
2. Industrial important inorganic chemistry (e.g., Chlor-alkali, nitric, sulfuric, and phosphoric acid)

3. Industrial important organic chemistry including:
    a. Organic Feedstocks (petroleum, natural gas, bio-derived)
    b. C1-chemistry (methane, syn-gas, methanol and formaldehyde)
    c. C2-chemistry (ethane, ethene, ethylene oxide, ethylene glycol and key derivatives)
    d. C3-chemistry (propane, propene, propylene oxide, propylene glycol)
    e. C4-chemistry (butane, butenes and butadiene)
    f. C6 – aliphatic (from cyclohexane to nylon)
    g. Aromatics (benzene, toluene and xylenes (BTX) and their key-derivatives like phenol, benzoic acid and therephtahlic acid)
    h. Long chain linear acids, alcohols and surfactants
    i. Plastics (overview of the most important crystalline and amorphous polymers and their applications)
4. Industrial Business fundamentals including:
    a. Financial fundamentals (NPV, IRR, Cash Flow)
    b. Source of Competitive Advantage (IP)
    c. Large Corporations, Small Company, Start-up VC
5. business simulation, and a variety of case studies

Lecture notes and Preliminary Schedule of Readings

Based on their own experience and available literature, the professors (IH and WFB) will compose lecture notes on every topic that will be covered.

WEEK	LECTURE 1	LECTURE 2
Week Jan 19	**(WFB)** Introduction to commercial chemistry. Why chemistry matters in society. Chemical feedstock integration- envelopes Scale of Fossil fuels, *vs*. chemical industry.	**(WFB)** Inorganic Chemistry, Chlor-Alkali, N, S, P Case study on sulfuric acid
Week Jan 25	**(IH)** Organic Feedstocks Sources: Petroleum, Natural Gas, Bio-derived feedstock	**(IH)** C1 Chemistry: Methane, syngas, methanol and derivatives
Week Feb 1	**(WFB)** Business Fundamentals: What constitutes a successful commercial entity, key performance metrics. difference between cash &	**(WFB)** Case Study Start Up: Cool Planet-New process development addressing climate change

	earnings.	
Week Feb 8	**(IH)** C2 Chemistry: Ethane, EO, EG, Ethylene and key Ethylene derivatives	**(IH)** C2 Chemistry Continued.
Week Feb 15	**(WFB)** Industry dynamics technical innovation: Sources of innovation, Types & Patterns of Innovation Standards/ Regulatory Battles, Timing	**(WFB)** Case Study on supply chain
Week Feb 22	**(IH)** C3 Chemistry: Propane, PO, PG	**(IH)** C4 Chemistry: Butane, butadiene
Week Feb 29	**(WFB)** Industrial Guest Lecture	**(WFB)** Case Study
Week March 7	**(IH)** C5 Chemistry & Derivatives, C6 non aromatic	**(IH)** C6 continued: Benzene, Toluene Xylenes (BTX) and acids.
Week March 14	**(WFB**) Polymers- Crystalline	**(WFB)** Polymers Amophous
Week March 21	**(IH)** value-chain integration; what is waste?	**(IH)** Long chain linear acids, alcohols, surfactants
Week March 28	SPRING BREAK	SPRING BREAK
Week April 4	**(IH)** N containing compounds	**(IH)** Industrial Catalysis
Week April 11	**(WFB)-** Intellectual Property	**(WFB)** Case Study Scale Up: Commercialization of Transesterification to Polycarbonate
Week April 18	**(IH)** Oleochemistry: Fats and Oils	**(IH)** Carbohydrates
Week April 25	**(WFB)** 2-6 Xylenol Business Simulations Introduction	**(WFB)** 2-6 Xylenol First Round Budgets Due
Week May 2	**(WFB)** 2-6 Xylenol Round 1 Reviews	**(WFB)** 2-6 Xylenol Round 2 Review.

Reference Texts

K. Weissermel, Hans-Jurgen Arpe, Industrial Organic Chemistry, Third Edition VCH-Wiley, 1997 ISBN-13: 978-3527288380

H. A. Wittcoff, B. G. Reuben, J. S. Plotkin, Industrial Organic Chemicals, Second Edition 2004 John Wiley & Sons, 2004, ISBN 0-471-44385-9

Melissa Schilling, Strategic Management of Technology Innovation Fourth Edition, McGraw-Hill Irwin, 2010, ISBN 978-0-07-802923-3

Grading

Grading will be based upon the evaluation of two research problems (case studies; 30% each), a final exam (30%), and class participation (10%).

Letter grades will be assigned relative to the overall performance of the class using the following intended grading scale:

A	92 – 100%
AB	88 – 91.99%
B	82 – 87.99%
BC	80 – 81.99%
C	72 – 79.99%
D	68 – 71.99%
F	<68%