

**UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
Fall 2020**

1. COURSE: CHEMISTRY 409, Applied Chemistry and Chemical Pathways for Engineers

| LEC | DAYS | TIME | ROOM | INSTRUCTOR | EMAIL | OFFICE HOURS |
|-----|------|-----------|-----------|----------------------|--|-----------------------|
| L01 | TR | 8:00-9:15 | WEB-BASED | Dr. Maryam Izadifard | maryam.izadifard@ucalgary.ca | Fridays: 3:00-5:00 pm |

To avoid IT problems, it is recommended that the students use their U of C account for all course correspondence. **Please use "CHEM 409" in the Subject of your e-mail.**

Desire2Learn (D2L) Site: CHEM409L01 - (Fall2020) - ApplChem & ChemPath For Engg

Departmental Office: Room SA 229, Tel: (403) 220-5341, e-mail: chem.undergrad@ucalgary.ca

2. Course Description: Analysis of industrial chemical processes based on reaction pathways to infer system performance including co-product formation and the role of catalysts. Examples from oil, gas, coal and petrochemical processing.

3. Recommended Textbook:

Jacob A. Moulijn, Michiel Makkee, Annelies E. van Diepen, Chemical Process Technology, 2nd Edition: Wiley.
Andreas Jess & Peter Wasserscheid. Chemical Technology: An Integral Textbook: Wiley.

4. Topics Covered:

Introduction to the Chemical Industry

Sources of raw materials:

- Application of phase and phase change to purify/separate raw materials
 - e.g. Frasch process for mining sulfur
 - e.g. Claude process for distillation of air to produce nitrogen, oxygen and argon

Processes in the Oil Refinery

- Petroleum Refining:
 - Simple purification
 - H₂S removal from crude oil (Acid-Base Chemistry)
 - Distillation (purification by phase change)
 - Pyrolysis – bond strength and understanding radical reactions
 - Catalytic Cracking – understanding carbocationic reactions
 - Elimination
 - Substitution (and polymerization)
 - Rearrangement

Production of Light Alkenes

- Thermodynamics and kinetics

Production of Synthesis Gas

Bulk Chemicals and Synthetic Fuels Derived from Synthesis Gas

Inorganic Bulk Chemicals

- General Considerations in the Design of an Industrial Chemical Process:
 - Green Chemistry
 - Reaction Thermodynamics (equilibria – application of LeChatelier's principle in industry)
 - Reaction Kinetics (activation energy)
 - The Contact Process for sulfuric acid production
 - Synthesis of ammonia
 - Synthesis of nitric acid
- Electrochemistry:
 - Definitions of oxidation and reduction
 - Direct and indirect redox processes
 - Basic electrochemical cell
 - Corrosion
 - Balancing redox equations
 - Standard cell potential
 - Electrolysis (active and passive electrodes)
 - Production of Cl_2 , NaOH (and H_2) from NaCl(aq.)
- Acid-Base Chemistry:
 - Three definitions of acid and base
 - Fundamental concepts (on an atomic level) that determine acid-base properties of compounds
 - Ammonium Nitrate and Ammonium Sulfate

Catalysts:

- General Introduction – Activity / Selectivity / Stability
- Heterogeneous – Mechanisms, Physical adsorption, chemisorption
 - Hydrogenation
 - Zeolites (uses as water softeners and catalytic cracking)
- Homogenous – Mechanisms, 16/18 electron rule
 - Monsanto Acetic Acid Process

Polymer Chemistry:

- Nucleophilic alkyl and acyl substitution (and potential side reactions)
 - Polyurethane
 - Epoxy resins
- Thermoplastics and thermosets
- Chain growth and step growth polymerization
- How chemical structure of a polymer relates to its bulk properties
 - Kevlar versus Nylon

Selected Topics

- Reactions of Arenes:
 - Benzene structure
 - Electrophilic Aromatic Substitution (and ways of generating the carbocation)
 - The Cumene Process (and a mechanistic explanation of the associated side reactions)
 - BHT synthesis
 - Bisphenol A synthesis
- Corrosion and Corrosion Control
- Fouling and fouling control
- Biotechnology
- Process Development

Department Approval: