Engineering Faculty Document No. 31-25
May 19, 2022

TO: The Faculty of the College of Engineering
FROM: The Davidson School of Chemical Engineering
RE: New Graduate Course, CHE 57500 Industrial Catalytic Processes

The faculty of the Davidson School of Chemical Engineering have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

Course: CHE 57500 Industrial Catalytic Processes
Fall/Spring, Lecture, Cr. 3
Restrictions: May not be enrolled as the following Classifications:
Freshman: 0 - 14 hours
Freshman: 15 - 29 hours
Sophomore: 30 - 44 hours
Sophomore: 45 - 59 hours
Junior: 60 - 74 hours
Junior: 75 - 89 hours

Description:

A survey course on the process design of major catalytic processes in the refining and petrochemical industries for production of transportation fuels and commodity chemicals.

Reason:
Fall 2015 semester with 26 students, in the fall of 2016 semester with 22 students, during the fall 2017 semester with 16 students, in the fall 2018 semester with 25 students, fall 2019 semester with 17 students, during the Fall 2020 semester with 12 students and the Fall 2021 semester with 16 students.

Sangtae Kim
Jay and Cynthia Ihlenfeld Head of Chemical Engineering

Purdue University
CHE 597 Industrial Chemical Technology
Spring 2024, Tue-Thu 1:30-2:45, FRNY G124

Instructor: Jeff Siirola, FRNY 1029A, 6-2125, jsiirola@purdue.edu or jjsiirola@gmail.com

Office Hours: Almost anytime; best to make appointment by email

Course Description:

This course traces the historical development of the chemical and related process industries and describes the principal products that are made and the evolution of the raw materials, chemistries, and processes by which they have been made. The scope includes natural products, inorganics, fuels, and commodity and specialty organics. The course also covers topics of current interest including the impacts of modern catalysis, computation, and systems engineering on process technology, issues of sustainability, resource conservation, environmental responsibility, product stewardship, and carbon management, and the likely impacts of recently more abundant and less expensive shale gas and oil on the chemical industry.

Course Content:

History and structure of the chemical and allied process industries (1 week)
Natural Products (animal and vegetable products; wood derivatives) (1 week)
Inorganics (dehydration (calcining), reduction (smelting), bases and acids, commodities) (2 weeks)
Fuels (fossil, petroleum refining, synthetic and biofuels) (1.5 weeks)
Organics (wood and coal derivatives, basic building blocks, commodity intermediates and solvents, commodity monomers and polymers, plastics fibers and coatings, fine chemicals, biotechnology) (4 weeks)
Technical Impact Factors (catalysis, computers, innovation) (1.5 weeks)
Current Issues (environmental protection, health and safety, sustainability, carbon dioxide management, shale gas and oil) (3.5 weeks)

Tentative course schedule (subject to change):

Tue 9 Jan	Course introduction; scope of the chemical and allied process industries
Thu 11 Jan	Historical technology development (alchemy, chemistry, processes, unit operations, transport phenomena, process systems); historical milestones (brewing, soap, salt, smelting, soda ash, distillation, electrolysis, high pressure, continuous controlled processes)
Tue 16 Jan	Natural Products 1 - Animal and vegetable fiber, leather, oils, fats, waxes, gelatin, dairy products, food processing
Thu 18 Jan	Natural Products 2 - Pulp and paper, naval stores, resins, turpentine, rosin, rubber (Report 1 Due)
Tue 23 Jan	Inorganics 1 - Chemistry of dehydration/hydration: ceramic pottery, tile, and brick, glass, plaster, cement, mortar, and concrete
Thu 25 Jan	Inorganics 2 - Chemistry of reduction: ore smelting, iron and steel, silicon, copper, brass, bronze, aluminum

Tue 30 Jan	Inorganics 3 - Bases and acids: soda ash, caustic soda, lime, mineral acids (nitric, sulfuric, phosphoric, hydrochloric)
Thu 1 Feb	Inorganics 4 - Commodity inorganics: water, hydrogen, oxygen, nitrogen, chlorine, fertilizers (ammonia, phosphates, potash), titanium dioxide, carbon black, carbon dioxide, phosgene, hydrogen peroxide (Report 2 Due)
Tue 6 Feb	Fuels 1 - Wood, coal, petroleum (gasoline, diesel, jet fuel, fuel oil), LPG, natural gas
Thu 8 Feb	Fuels 2 - Natural gas processing, petroleum refining processes and products
Tue 13 Feb	Fuels 3 - Synthetic fuels: town gas, F-T, SNG, MTG, biofuels
Thu 15 Feb	Organics 1 - Wood and coal chemicals and materials (Report 3 Due)
Tue 20 Feb	Organics 2 - Basic building blocks: acetylene, olefins (ethylene, propylene, butadiene) aromatics (BTX, Styrene), carbon monoxide
Thu 22 Feb	Organics 3 - Commodity intermediates and solvents: alcohols glycols and phenols, aldehydes and ketones, acids, esters, ethers
Tue 27 Feb	Organics 4 - Commodity monomers and polymers (PE, PP, PS, PET, PC, SBR)
Thu 29 Feb	Organics 5 - Adhesives, coatings, films, fibers, plastics (Report 4 Due)
Tue 5 Mar	Possible No Class
Thu 7 Mar	Organics 6 - Fine chemicals: dyes pigments and cosmetics, flavors and fragrances, soap and detergents, explosives, agrichemicals, pharmaceuticals
12-14 Mar	Spring Break
Tue 19	Organics 6 continued
Thu 21 Mar	Organics 7 - Fermentation and biochemical processes; biotechnology (Report 5 Due)
Tue 26 Mar	Technical Impact Factor 1 - Homogeneous and heterogeneous catalysis
Thu 28 Mar	Technical Impact Factor 2 - Engineering and operational digital computation
Tue 2 Apr	Current Issues 1 - Environmental protection: air, wastewater, land; personnel protection: health and safety
Thu 4 Apr	Current Issues 2 - Loss prevention and process safety (Report 6 Due)
Tue 9 Apr	Current Issues 3 - Sustainability: triple bottom line, life cycle analysis, industrial ecology, green chemistry and engineering
Thu 11 Apr	Current Issues 4 - Sustainability: population and economic growth, raw materials; energy and water resources
Tue 16 Apr	No Class
Thu 18 Apr	Current Issues 5 - Climate change
Tue 23 Apr	Current Issues 6 - Carbon dioxide management, capture, and sequestration
Thu 25 Apr	Current Issues 7 - Impact of shale gas and oil (Report 7 Due; Bonus Report Due)

Homework Reports:

Report 1 - Industry Structure and Statistics (Due 18 January)
Report 2 - Reaction Path Synthesis: Solvay Process (Due 1 February)
Report 3 - Block Flow Diagram: Petroleum Refining (Due 15 February)
Report 4 - Process Supply Chain: Polyethylene Terephthalate (Due 29 February)
Report 5 - General Purpose Batch Processing: Fine Chemical Manufacture (Due 21 March)

Report 6 - Safety and Environmental Protection: Methyl Isocyanate (Due 4 April)
Report 7 - Sustainability: Carbon Management (Due 25 April)
Bonus Report: Process Narrative: Major Chemical Intermediate (Due 25 April)

Grading:

20% Attendance and class participation
80% Reports (Report 7 counts double)
Bonus Report: Up to +10 percentage points

Academic Honesty:

Students are individually responsible for each homework report. Cheating will not be tolerated. While discussions of homework among classmates are to be expected, students are responsible for submitting their own work. Copying the work of others, specifically including wholesale copying from electronic sources, is plagiarism and is considered a form of cheating.

Accommodation:

Purdue University strives to make learning experiences as assessable as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let the instructor know so that options may be discussed. You are also encouraged to contact the Disability Resource Center at drc@purdue.edu or by phone at 765-494-1247.

In addition to the University policy, the Davidson School of Chemical Engineering has established procedures for students seeking accommodations. These can be found online at the ChE Undergrad Office website. Only those accommodation requests that conform to both University and ChE policy guidelines will be implemented.

Protect Purdue:

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is a campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center if you feel ill or know you have been exposed to the virus, wearing a mask in classrooms and campus buildings at all times, disinfecting workspace prior to and after use, maintaining proper physical distancing, and maintaining robust personal hygiene. Measures will be taken to provide alternative remote instructional experiences if the course had an on-line delivery option or if on-line delivery becomes mandated during the course of the semester.

References:

Kirk-Othmer Encyclopedia of Chemical Technology (5^{th} Ed and On-line, Wiley)
Ullmann's Encyclopedia of Industrial Chemistry (5^{th} Ed and On-line, Wiley)
Shreve's Chemical Process Industries (5^{th} Ed, McGraw-Hill Special Reprint Edition)
Handbook of Chemical Technology and Pollution Control (Robert Myers, 3^{rd} Ed, Elsevier)
Handbook of Petroleum Refining Processes (Martin Hocking, 2^{nd} Ed, McGraw Hill)