The University of Western Ontario
Faculty of Engineering Science

DEPARTMENT OF CHEMICAL AND BIOCHEMICAL ENGINEERING

CBE 9552 – Industrial Three-Phase Reactor Systems

Course Outline 2020-2021

Objective

This course intends to prepare graduate students with advanced knowledge and concepts on industrial multiphase reactor systems analysis, design and modeling. Current and potential applications of these reactor systems in chemical, biochemical, clean and renewable fuels and environmental processes will be discussed.

Delivery Mode

Online using OWL - university's online learning platform
4 lecture hours + 1 tutorial per week using virtual classroom tool

Prerequisites

Graduate Student Status

Instructor

Dr. A. Prakash (TEB 441) Tel: 661-2111, ext. 88528; Email: aprakas2@uwo.ca
Graduate Coordinator: TEB 480

General Learning Objectives

Key knowledge, skills and dispositions to be gained from the course:

1. Key knowledge: Multiphase Reactor Types: structure and components of reactor type, hydrodynamics, heat and mass transfer, engineering and design aspects of reactors, applications of these reactors
2. Skills: Analyze multiphase reactors and describe physical process, quantitative analysis of the reactor, implement fundamental models in mass, energy and momentum balances for the system.
3. Dispositions: Generate an analytical mindset towards various reactor types, study scientific literature for reactor design, ability to perform a quantitative design of a reactor

Specified Learning Objectives

Following reactor types and their variants will be covered and differences will be discussed. Their industrial applications with examples will be presented in details:

- Two and Three-phase Bubble Column Reactors
- Liquid-Solid (L-S) and Gas-Liquid-Solid (G-L-S) Fluidized Bed Reactors
- Gas-Liquid-Solid Agitated Reactors
- Three-phase Trickle Bed Reactors
- Airlift and Jet Loop Reactors

The theory and concepts will be discussed under following main topics:

- Hydrodynamics
  - Flow Regimes
  - Phase Holdups
  - Pressure Drop and Fluctuations
  - Measurement Techniques
  - Bubble Size Distribution and Bubble Dynamics

- Fluid Dynamics and CFD

- Heat and Mass Transfer
- Reactor Design, Modeling and Scale-Up
- Industrial Applications in Chemical, Biochemical and Environmental Processes

Required Text
None

Reference Texts
Pangarkar, V.G, Design of Multiphase Reactors, Wiley, 2015
Nigam, K.D.P., A. Schumpe, Three-Phase Sparged Reactors, Gordon and Breach Publishers, 1996
Deckwer, W.D., Bubble Column Reactors, John Wiley and Sons, 1985.
Fan, L.S., Gas-Liquid-Solid Fluidization Engineering, Butterworths 1989.

Course Notes
Power point lecture slides and condensed course notes in word will be available under Resources tool in OWL.

Lab Notes
None

Units
SI, British and US Engineering units will be used.

Basis of Final Grade

The final mark will be calculated as follows based on online submissions and assessments:

Design Assignments	20%
Reading Assignments	15%
Tests & Quizzes	25%
Project Report	40%

Evaluation
The performance of each student will be judged on the basis of assignments, tests and a project report.

Use of English
In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance
Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Associate Chair (Graduate), after due warning has been given. On the recommendation of the Department concerned, and with permission of the Associate Chair, appropriate action will be taken, with the possibility of course failure.

Cheating

University policy states that cheating is a scholastic offense. The commission of a scholastic offense is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

Plagiarism

University policy states that plagiarism is a scholastic offense. Plagiarism is defined as appropriating and passing off writings or ideas of another person's as one's own. Penalties may include failure or automatic withdrawal from the course.

Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence.

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

For further information on plagiarism, consult the Scholastic Offence Policy in the Western Academic Calendar.

Sickness and Other Problems

Students should immediately consult with the instructor or Associate Chair (Graduate) if they have any problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Notice

Students are responsible for regularly checking their email and notices posted on Instructors' doors.

Consultation

Office hours will be posted. Individual consultation may be arranged by appointment with the instructor.

Accreditation Units

Science = 25%
Design = 60%
Technical Report Writing = 15%
Total AU's (26) = 100%

April 8, 2020