CHEE 221
CHEMICAL PROCESSES & SYSTEMS

Course Syllabus – Fall 2020

This is your course syllabus. Please download the file and keep it for future reference.

TEACHING TEAM

COURSE INSTRUCTOR

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Please check the course website for an up-to-date list of Teaching Assistants (TAs) and other course personnel.

COURSE INFORMATION

COURSE DESCRIPTION

Introduction to the fundamentals and principles of chemical engineering, with applications to chemical and biochemical processes, via an analysis of processing units including distillation, crystallization, and combustion. Specific topics include conservation equations for mass and energy, process flow diagrams, material and energy balances, chemical reaction fundamentals, and applications of the First Law of Thermodynamics. (0/0/0/42/0)
Prerequisites: APSC 131, APSC 132, APSC 172, or permission of the department.

COURSE LEARNING OUTCOMES (CLO)

The objective of this course is to develop proficiency at performing mass and energy balance calculations for single-unit and multiple-unit processes, for processes involving recycle, bypass or purge streams, and for systems involving reactions.

Specific course learning outcomes include:

CLO	DESCRIPTION	INDICATOR
CLO 1	Draw and fully label a process flow diagram (PFD) for application of material and energy balances.	CO-Graphics PA-Formulate
CLO 2	Formulate and solve the material balance equations to analyze steady-state single-unit and multiple-unit processes without reaction.	KB-ES-Process (a) PA-Formulate PA-Solve
CLO 3	Formulate and solve the material balance equations to analyze steady-state processes with reaction.	KB-ES-Process (a) PA-Formulate PA-Solve
CLO 4	Formulate and solve combined steady-state material and energy balances for chemical processes	KB-ES-Process (a) PA-Formulate PA-Solve

This course assesses the following attributes at the 2nd year level:

Knowledge base, Engineering Science (**KB-ES**): **Process (a)** Formulates and solves steady-state and dynamic mass and energy balances for a chemical process.

Problem analysis (PA): Formulate Develop appropriate frameworks for solving complex engineering problems. **Solve** Implement solutions for complex engineering problems.

Communications (CO): Graphics Create figures, maps, tables, and drawings to engineering report standards.

Relevance to the Program

This course lays the foundation for all subsequent courses dealing with chemical engineering processes and systems. It is therefore an essential prerequisite for the entire Chemical Engineering and Engineering Chemistry programs. The course assumes knowledge of first year chemistry and calculus.

Course Structure and Activities

3 lecture hours + 1 tutorial hour per week. Please refer to SOLUS for times and locations.

Expectations for Lectures/Tutorials

Lecture material will be posted in advance on the Learning Management System (LMS) site. Students are expected to read associated sections and study worked examples provided in the textbook and through the course LMS.

Tutorial problems are posted on the course LMS. These are meant to be solved interactively. Solutions will be worked out during tutorial periods with the TAs each week. Maximum benefits from the interactive solutions can be gained only if students come prepared for the tutorial sessions by studying the questions in advance.

Practice problems, suggested readings, comprehension questions, and assignments are provided to guide student learning. All exercises and assignments should be completed promptly to keep up with the deliver of lecture material.

In group assignments, each group member is expected to contribute fairly and equitably. In the event of serious deficiencies in the contributions (*e.g.* observed by instructor, through peer assessments, or through complaints from other group members and/or teaching assistants), the student will be issued a written warning, stating the expectations and timeline for remediation and compliance. The student may be assigned individual work to compensate for the lack of contribution. If the student does not comply within the specified time frame, a second written warning will be issued (with a copy to the Associate Head and Undergraduate Chair). Failure to comply will result in automatic expulsion from the group, and possibly a failing mark in the assignment and/or in the course. A peer evaluation form is available through the LMS. This form may be filled out by a group member at any time during the semester. The form must be submitted to the instructor, who will take appropriate action in response to this submission (response may include a request for each group member to fill out a peer evaluation, individual meetings, group meetings, and follow up action as described above).

COURSE MATERIALS

Recommended Textbook

- "Elementary Principles of Chemical Processes" 4th Edition, 2016 by Felder, Rousseau and Bullard. The course uses an electronic version of the textbook, accessed through the WileyPLUS website.
  NOTE: previous editions may be consulted; however, the online version of the current (4th) edition is ***recommended*** to complete this course (a portion of the course mark may be obtained through online assessments).

Other Material

- All course material is accessible through the course LMS.

Learning Support

- Instructor and TAs are available during office hours and by appointment (through e-mail).
- Additional review and help session may be scheduled as required during the term.

COURSE EVALUATION

Deliverable	Hours	Weight%	CLOs
Quizzes (Quiz 1 = 8%; Quiz 2 = 8%; Quiz 3 = 9%)	After lecture hour 10, 18, 28	25	1,2,3,4
Written Assignments (3; each worth 5%) assignments may be completed individually or in groups of up to 4 students	Throughout term	15	1,2,3,4
E-Assignments (3) - WileyPLUS	Throughout term	6*	
Comprehension E-Questions - WileyPLUS	Throughout term	4*	
Final Exam	Exam period	50	All

*if optional WileyPLUS assignments are not submitted, then course weight is divided by 0.90.

There are three quizzes and a final exam in this course. Students are required to acknowledge an academic integrity statement before accessing each test. Quizzes are designed to provide learners with immediate feedback on their knowledge. These quizzes are taken on the course LMS. Student will have a 24-hour window to complete each quiz. Once initiated, students will have 80 minutes (which includes 50 minutes for the test and 30 minutes to upload written solutions) and one attempt to complete a quiz.

The final exam and some tests in this course may use remote proctoring provided by Proctortrack. Proctortrack is a service that enables the completion of a proctored exam or test from an off-campus location, through the course LMS. This online proctoring solution was chosen as part of the approach to maintaining academic integrity. For more details about this tool: https://www.queensu.ca/its/remote-proctoring-solutions/proctortrack. Information about how

Proctortrack will be used in this course will be posted on the course LMS.

GRADING

All assessments in this course will receive numerical percentage marks. The final grade a student receives for the course will be derived by converting the numerical course average to a letter grade according to the established Grade Point Index.

Students must pass the individual examination component (combined mark on quizzes + final) to pass the course, as stated in Departmental Policy. Attendance at mid-term (quizzes) and final exam is mandatory. No make-up mid-terms will be provided. Marks assigned to the mid-term may be transferred to the final exam for a medical reason supported with proper documentation following the stipulations of the departmental policy.

Practice problems, tutorials, and assignments will be completed during the term. The aim of these exercises is to apply the theory presented in the course. Assignments completed on paper (see specific assignment instructions) must be scanned and combined into a single PDF (see detailed schedule below). Only one submission per group, with the name of each group member clearly indicated. Assignment solutions and reports may be hand-written (pen or pencil), or typed, but must be complete and fully support the answers.

Feedback on Assessments

The teaching team will provide feedback on graded activities. Markers will take the time necessary to provide detailed feedback on assessed tasks and tests; the goal is to return marked activities within seven days following the due date.

To be eligible for mark reassessment (of assignments or tests), a request must be submitted within one weeks of the initial return date along with a mark reassessment form (available on the course LMS) and the complete original submission. Please note that a selection of marked assignments and quizzes will be archived.

Accessing Final Grade

Final grades will be posted on SOLUS. Official transcripts showing final grades will be available on the Official Grade Release Date. Please note that, in official transcripts, a mark of IN (incomplete) is considered a grade, and your transcript is released with this grade.

HOW TO DO WELL IN THIS COURSE

This course introduces important engineering concepts that are fundamental to the understanding and applications of advanced topics taught in upper years of your undergraduate program. The concepts range in difficulty from fundamental and straight-forward to a certain level of complexity associated with non-ideal systems. As such, significant practice is required to formulate and solve problems efficiently and correctly. Students should plan on attending lectures and tutorials having prepared for the session as detailed on the course LMS. Students are expected to assimilate new concepts and methodologies in the lectures, to practice by solving suggested problem set questions, and to seek help outside the course when they do not understand the concepts. Students are expected to remember and apply concepts taught in

previous courses.

Students are expected to apply the concepts and to implement the methods taught in class and presented in the textbook. These concepts and methodology will be tested in assignments, quizzes, and a final exam, and students must be capable of extrapolating the applications to a variety of problems in the context of this course.

To obtain full marks, the complete methodology must be clearly and logically presented; where appropriate, clearly labeled diagrams must be included with the solution. For questions involving multiple parts, partial credit may be given for correct methodology, but the final answer must also be correct. If the answer does not reflect the expected outcome, or if it is not physically representative, then the student is encouraged to provide comments, using critical analysis skills, to point out any outstanding issue. All relevant assumptions must be stated, and proper units must always be included.

Suggested Time Commitment

This course is offered through a study period of one semester spanning 12 weeks. Learners can expect to invest on average 7-9 hours per week in this course. Learners who adhere to a pre-determined study schedule are more likely to successfully complete the course.

COURSE COMMUNICATION

In this course, you may be expected to communicate with your peers and with the teaching team through electronic communication. You are expected to use the utmost respect in your dealings with your colleagues and instructors, or when participating in activities, discussions, and online communication.

Following is a list of *netiquette* guidelines that the teaching team and Queen's personnel has adopted. Please read them carefully and use them to guide online communication in this course and beyond.

1. Make a personal commitment to learn about, understand, and support your peers.
2. Assume the best of others and expect the best of them.
3. Acknowledge the impact of oppression on the lives of other people and make sure your writing is respectful and inclusive.
4. Recognize and value the experiences, abilities, and knowledge each person brings.
5. Pay close attention to what your peers write before you respond. Think through and re-read your writings before you post or send them to others.
6. It's alright to disagree with ideas, but do not make personal attacks.
7. Be open to be challenged or confronted on your ideas and challenge others with the intent of facilitating growth. Do not demean or embarrass others.
8. Encourage others to develop and share their ideas.

Course Announcements

The teaching team will routinely post course news in the Announcements section on the course LMS. Please sign up to be automatically notified by email of these posts. Instructions on how to modify your notifications are available on the LMS platform.

Office Hours

In addition to interaction through Q&A sessions, students can interact in a synchronous fashion with either a TA or the instructor through office hours. A schedule for office hours will be determine in consultation with the class at the beginning of the term. Students may also contact the teaching team by e-mail to ask questions and/or to request an appointment. Points of contact are available on the course LMS home page.

Confidential Matters

Students who wish to discuss a confidential matter can reach the instructor by e-mail to make an appointment. The instructor will normally reply within 48 hours during workdays.

COURSE POLICIES

Please review the following policies concerning copyright, academic integrity, absences, and academic accommodations:

COPYRIGHT

Unless otherwise stated, the material on the course website is copyrighted and is for the sole use of students registered in this course. The material on the course LMS may be downloaded for a registered student's personal use but shall not be distributed or disseminated to anyone other than students registered in this course. The material presented in this course is intended for use as part of the course at Queen's University and is the property of the instructor unless otherwise stated. Copying this material for distribution (e.g. uploading material to a commercial third-party website) can lead to a violation of Copyright law and constitutes a violation of Academic Integrity.

ACADEMIC INTEGRITY

Engineering students have made a decision to join the profession of engineering, a long-respected profession with high standards of behaviour. As future engineers, students are expected to behave with integrity at all times. Please note that Engineers have a duty to:

- Act at all times with devotion to the high ideals of personal honour and professional integrity.
- Give proper credit for engineering work.

The standard of behaviour expected of professional engineers is explained in the Professional Engineers Ontario Code of Ethics. Information on policies concerning academic integrity is available in the Queen's University Code of Conduct, in the Senate Academic Integrity Policy Statement, on the Faculty of Engineering and Applied Science website, and from the course instructor.

Late Policy

Students are expected to complete their work on time. The course instructor will provide notification (during lectures and/or on the course LMS) of due dates and any revisions thereof.

Submissions after the due date will not be accepted without prior arrangement and may be penalized at up to 20% per day (24-hour period following due date/time) unless a suitable justification is provided.

In the event of extenuating circumstances, A student may request an extension to an assignment due date without penalty. Requests must be made to the instructor prior to the original due date of the assignment, and some substantiating documentation may be required (see information below on absences). Note that unacceptable reasons include extra-curricular activities, travel plans, generally behind on schoolwork, etc. In the absence of substantiating documentation, the normal late penalty will apply as described above and according to departmental policies.

Absences (Academic Consideration) and Academic Accommodations

For absences and academic accommodations please review the information on the FEAS website.

ACADEMIC AND STUDENT SUPPORT

Queen's has a robust set of supports available to you including the Library, Student Academic Success Services (Learning Strategies and Writing Centre), and Career Services. Learners are encouraged to visit the Faculty of Engineering and Applied Science Current Students web portal for information about various other policies such as academic advisors, registration, student exchanges, awards and scholarships, etc.

Individual Needs and Support

If you have a disability or health-related condition that may require academic accommodations, please approach the Queen's Accessibility Services. The staff at Accessibility Services are available by appointment to develop individualized accommodation plans, provide referrals, and assist with advocacy. The sooner you let us know your needs, the better we can assist you in achieving your learning goals. For questions or assistance with requesting Academic Consideration or Accommodation, contact the FEAS Academic Accommodation Coordinator at engineering.aac@queensu.ca.

Every effort has been made to provide course materials that are accessible. For further information on accessibility compliance of the educational technologies used in this course, please consult the links below.

Educational Technology	Accessibility Compliance Information
onQ (Brightspace Learning Management System by D2L)	https://www.d2l.com/accessibility/standards/
RocScience	https://www.rocscience.com/
Google Spreadsheets	https://www.google.com/accessibility/products-features/

If you find any element of this course difficult to access, please discuss with your instructor how you can obtain an accommodation.

Religious Observance

Students in need of accommodation for religious observance are asked to speak to their professor within a week of receiving their syllabus. Please note that Rosh Hashanah falls on the eve of September 18, 2020 so students in need of accommodation should speak to their professors right away. Note also that alternative assignments are considered a "reasonable accommodation" under the Ontario Human Rights Code. Students with questions about their rights and responsibilities regarding religious accommodation should contact Chaplain Kate Johnson via Chaplain@queensu.ca.

Technical Support

Basic hardware and software skills and online access are required for this course. If you require technical assistance, please contact Technical Support.

Supportive Personal Counselling

If at any time you find yourself feeling overwhelmed, anxious, sad, lonely, or distressed, consider confidential supportive counselling offered by the embedded counselors at the Student Wellness Service Faculty of Engineering and Applied Science.

Inclusivity Statement

Queen's students, faculty, and staff come from every imaginable background – small towns and suburbs, urban high rises, Indigenous communities, and from more than 109 countries around the world. You belong here: https://www.queensu.ca/inclusive/.

COURSE OVERVIEW

CHEE 221 | | Module overview

Course learning outcomes (CLO): Students will be able to:

1. Draw and fully label a process flow diagram (PFD) for application of material and energy balances.
2. Formulate and solve the material balance equations to analyze steady-state single-unit and multiple-unit processes without reaction.
3. Formulate and solve the material balance equations to analyze steady-state processes with reaction.
4. Formulate and solve combined steady-state material and energy balances for chemical processes.

Students are expected to augment lecture material through reading of associated sections of the textbook, and to practice execution of course principles by completing posted problem sets

Module	Lectures	Tutorials & Practice Problems*	Assessment (CLOs)
Module 0 (2 hrs)	Course Introduction Review of Dimensions, Units, Mass/Moles, Conversions (F&R 2, 3, and 5.2)	Tutorial Mod 0 WileyPLUS Mod 0 Interactive Tutorial Problem Set 0	WileyPLUS Mod 0 E-Reading WileyPLUS Mod 0 E-Comprehension **WileyPLUS Module 0 E-Assignment**
Module 1 (4 hrs)	Material Balance Methodology applied to Process Single Units without Reaction (F&R 4.1, 4.2, 4.3)	Tutorials Mod 1A, 1B WileyPLUS Mod 1 Interactive Tutorial Problem Set 1	WileyPLUS Mod 1 E-Reading WileyPLUS Mod 1 E-Comprehension
Module 2 (4 hrs)	Material Balance Methodology applied to Multiple Unit Processes without Reaction (F&R 4.4, 4.5)	Tutorial Mod 2 Problem Set 2	WileyPLUS Mod 2 E-Reading WileyPLUS Mod 2 E-Comprehension **Modules 1-2 Assignment**
Quiz 1 (1 hr)	Covers Modules 1-2	Taken during normally scheduled tutorial period	construction of PFD (CLO1), and steady-state material balances for non-reactive processes (CLO2)
Module 3 (7 hrs)	Reaction Stoichiometry and Material Balance Methodology applied to Multiple Unit Processes with Reaction. (F&R 4.6 – 4.8) Application of balances methodology to open-ended problems; life-cycle analysis	Tutorials Mod 3A, 3B WileyPLUS Mod 3 Interactive Tutorial Problem Set 3	WileyPLUS Mod 3 E-Reading WileyPLUS Mod 3 E-Comprehension **Module 3 Assignment**

Module	Lectures	Tutorials & Practice Problems	Assessment (CLOs)
Quiz 2	Covers Modules 1-3	During tutorial period	steady-state material balances for multiple unit and reactive processes (CLO2, CLO3)
Module 4 (5 hrs)	Introduction to Energy Balances: Energy Balances for Closed and Open Systems, Reference States, Thermodynamic Properties, Steam Tables (F&R 7.0 – 7.6)	Tutorial Mod 4 Mod 4 Discussion Tutorial Problem Set 4	WileyPLUS Mod 4 E-Reading WileyPLUS Mod 4 E-Comprehension **WileyPLUS Module 4 E-Assignment**
Module 5 (4 hrs)	Energy Balance Methodology Applied to Systems without Reaction (F&R 8)	Tutorial Mod 5 WileyPLUS Mod 5 Interactive Tutorial Problem Set 5	WileyPLUS Mod 5 E-Reading WileyPLUS Mod 5 E-Comprehension **Module 5 Assignment**
Quiz 3 (1 hr)	Covers Modules 4-5	During lecture period	energy balances without reaction, including sensible heat and phase change calculations, and steam tables (CLO4).
Module 6 (5 hrs)	Energy Balance Methodology Applied to Systems with Reaction (F&R 9.1 – 9.5)	Tutorial Mod 6 WileyPLUS Mod 6 Interactive Tutorial Problem Set 6	WileyPLUS Mod 6 E-Reading WileyPLUS Mod 6 E-Comprehension **WileyPLUS Module 6 E-Assignment**
Review (2 hrs) & Final Exam (3 hrs)	Covers all modules	Q&A / Review	All CLOs

* Tutorials and in-class example problems are offered for students to work through ahead of presentation. Solutions will be summarized during tutorials and lectures.