CHEN30005 Heat and Mass Transport Processes

Credit Points:	12.5
Level:	3 (Undergraduate)
Dates & Locations:	2015, Parkville This subject commences in the following study period/s: Semester 1, Parkville - Taught on campus. Semester 2, Parkville - Taught on campus.
Time Commitment:	Contact Hours: 4 x one hour lectures + 1 x one hour tutorial per week + 2 x three hours of laboratory work per semester + 1 x two hour computer practical per semester Total Time Commitment: Estimated 170 hours
Prerequisites:	Students must have completed the following subjects prior to enrolling in this subject:

Subject	Study Period Commencement:	Credit Points:
CHEN20009 Transport Processes	Semester 2	12.50

AND ONE OF:

Subject	Study Period Commencement:	Credit Points:
CHEN20008 Chemical Process Analysis 2	Semester 2	12.50
CHEN20011 Chemical Process Analysis	Semester 2	12.50

AND the following subject which may be taken concurrently:

Subject	Study Period Commencement:	Credit Points:
CHEM20018 Chemistry: Reactions and Synthesis	Semester 1	12.50

Corequisites:	None
Recommended Background Knowledge:	None
Non Allowed Subjects:	None
Core Participation Requirements:	For the purposes of considering applications for Reasonable Adjustments under the Disability Standards for Education (Cwth 2005) and Students Experiencing Academic Disadvantage Policy, this subject requires all students to actively and safely participate in laboratory activities. Students who feel their disability may impact upon their participation are encouraged to discuss this with the Subject Co-ordinator and the Disability Liaison Unit http://www.services.unimelb.edu.au/disability/
Coordinator:	Dr Kathryn Mumford, Prof Sandra Kentish
Contact:	Semester 1: Professor Sandra Kentish Email: sandraek@unimelb.edu.au Semester 2: Dr Kathryn Mumford Email: mumfordk@unimelb.edu.au
Subject Overview:	**AIMS** This subject aims to extend the fundamental concepts of heat transfer from that covered in CHEN20009 Transport Processes to include natural and forced convection and two phase

	systems. Mass transfer concepts are extended to unsteady state mass transfer and Fick's Second Law, prediction of diffusivity and of mass transfer coefficients. These fundamental concepts are then applied to the design of processes and equipment including shell and tube, air-cooled and plate heat exchangers, evaporator systems, membrane devices, binary distillation systems, gas absorbers and cooling towers. Experience in the use of appropriate simulation packages such as HYSYS for exchanger and distillation column design are included. This simulation work builds on the skills developed in CHEN20009 Chemical Process Analysis 2. **INDICATIVE CONTENT** # Forced Convection: Use of heat transfer correlations to predict coefficients # Heat Exchange: concept of an overall heat transfer coefficient, fouling factors; determination of the area required for a given heat duty, Heat exchanger design. Use of simulation packages such as HYSYS and ASPEN # Free convection: discussion and application of Grashof Number and other dimensionless groups # Condensation and Boiling: Fundamentals. Evaporation: various evaporator types and their advantages and disadvantages (forced circulation, film types); multiple and single effects; backward and forward feed; boiling point elevation; mechanical recompression; evaporator energy balances # Mass Transfer: Unsteady state mass transfer and Fick's Second Law; prediction of diffusivity; dimensional analysis and equations of change for mass transfer # Distillation: single-stage separations, equilibrium flash, differential distillation; multistage separations, operating lines, reflux; binary distillation, varying reflux ratio, minimum reflux, total reflux, optimum reflux, feed plate location, side streams, open steam; tray efficiency via overall and Murphree efficiencies. Use of simulation packages such as HYSYS # Gas absorption: basic mass transfer mechanism; material balances, co-current and countercurrent flow, limiting L/G ratio; multistage absorption and the absorption factor method; continuous contact, transfer units, height of a transfer unit, calculation of number of transfer units. Humidification and cooling tower height calculation # Membrane Systems: Microfiltration, ultrafiltration, nanofiltration and reverse osmosis. Gas separation systems. Robeson’s bound. Electrodialysis and pervaporation. Membrane selection.
Learning Outcomes:	**INTENDED LEARNING OUTCOMES (ILOs)** On completion of this subject the student is expected to: 1 Be able to apply the principles of heat transfer to solve heat transfer problems, particularly those involving two phase systems 2 Be able to assess quantitatively the performance of heat exchanger and evaporation equipment 3 Be able to apply the principles of mass transfer to solve mass transfer problems and to membrane separation processes 4 Be able to describe the concepts of equilibrium stage and continuous contactor analysis and apply these concepts to simple distillation and gas absorption problems 5 Be able to assess quantitatively the performance of simple, conventional distillation, gas absorption, membrane and cooling tower equipment 6 Be able to use simulation and spreadsheet software for the basic design of heat exchangers, absorption equipment, cooling towers and distillation columns.
Assessment:	A written assignment (5%) of approximately 1000 words. Due in week 10, requiring approximately 5 - 6 hours of work. ILO 6 is addressed in the assignment Attendance and participation in two laboratory classes held between weeks 3 - 11, each with a written assignment of approximately 1000 words (5% each) and each requiring around 4 hours of work. ILOs 2 and 4 are addressed in these laboratory classes. Assignments are due in week 8 and 12 One written 90-minute test (15%). ILOs 1 and 2 are addressed in the test. Held between weeks 5 - 7 One written 3-hour closed book end-of-semester examination (70%). Intended Learning Outcomes (ILOs) 1 to 5 are addressed in the exam. Hurdle requirement: The examination is a hurdle and must be passed to pass the subject.
Prescribed Texts:	None
Breadth Options:	This subject potentially can be taken as a breadth subject component for the following courses:

	# **Bachelor of Arts (https://handbook.unimelb.edu.au/view/2015/B-ARTS)** # **Bachelor of Commerce (https://handbook.unimelb.edu.au/view/2015/B-COM)** # **Bachelor of Environments (https://handbook.unimelb.edu.au/view/2015/B-ENVS)** # **Bachelor of Music (https://handbook.unimelb.edu.au/view/2015/B-MUS)** You should visit **learn more about breadth subjects (http://breadth.unimelb.edu.au/breadth/info/index.html)** and read the breadth requirements for your degree, and should discuss your choice with your student adviser, before deciding on your subjects.
Fees Information:	Subject EFTSL, Level, Discipline & Census Date, http://enrolment.unimelb.edu.au/fees
Generic Skills:	# Ability to apply knowledge of basic science and engineering fundamentals # In-depth technical competence in at least one engineering discipline # Ability to undertake problem identification, formulation and solution # Ability to use a systems approach to design and operational performance.
Notes:	**LEARNING AND TEACHING METHODS** The subject will be delivered through a combination of lectures, self managed assignments, and self managed work on tutorial questions supported by tutorial classes. The assignments will focus on: 1 Development of HYSYS simulation skills through a computer-based exercise 2 Development of skills in MS Excel through a computer-based exercise 3 A laboratory based exercise which will reinforce the material covered in lectures. **INDICATIVE KEY LEARNING RESOURCES** Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H. (1999). *Coulson and Richardson's Chemical Engineering Volume 1 - Fluid Flow, Heat Transfer and Mass Transfer* (6th Edition). Elsevier Richardson, J.F.; Harker, J.H.; Backhurst, J.R. (2002). *Coulson and Richardson's Chemical Engineering Volume 2 - Particle Technology and Separation Processes* (5th Edition). Elsevier. **CAREERS / INDUSTRY LINKS** The skills gained in this subject are crucial to the career of a process engineer. They will be important for students wishing to progress to jobs in engineering design offices and in operational roles within a wide range of industries including petrochemicals, food processing, wastewater treatment and pulp and paper manufacture.
Related Majors/Minors/ Specialisations:	B-ENG Chemical Engineering stream B-ENG Chemical and Biomolecular Engineering stream Chemical Systems Master of Engineering (Biochemical) Master of Engineering (Chemical with Business) Master of Engineering (Chemical) Science-credited subjects - new generation B-SCI and B-ENG.