McGill
Faculty of Engineering

CHEE 400 Principles of Energy Conversion

Fall 2016

Class Schedule

TR 11:35-12:55, Wong Bldg. 1020, Sept 6 – Dec 1

Instructor

Alejandro D. Rey, James McGill Professor
Office: Wong 4100
Phone: 398-4196
Email: alejandro.rey@mcgill.ca
Office hours: M 16:00-17:00 or by appointment

Tutorials

W 4:35-5:25 PM, Wong Bldg. 1020, Sept 14 – Nov 23

Teaching Assistants (TAs)

Vahid Adibnia	vahid.adibnia@mail.mcgill.ca
Mahdi Roohnikan	mahdi.roohnikan@mail.mcgill.ca
Oscar Matus Rivas	oscar.matusrivas@mail.mcgill.ca

Teaching assistants will provide limited assistance with course material during the tutorials and will be responsible for homeworks. The TAs' tutorial and assignments schedule is given in the COURSE SCHEDULE below.

Communication

My personal website (accessible via http://rey1.chemeng.mcgill.ca/) will be used to distribute course materials, including lecture slides, assignments, resources, links, and reading assignments. If you need to reach me, please send an email to alejandro.rey@mcgill.ca. I will try to respond within 48 hours. If you have questions about the material, please come to my designated office hours or schedule an appointment. Specific questions about problems or theory will not be answered through email. If you have questions about the assignments, please see the assigned teaching assistant at his/her designated office hours or schedule an appointment.

Course Description

Fossil fuels, renewable and nuclear energy resources and use. Principles of energy conversion and thermodynamic engine cycles. Solar radiation, heat, mechanical, chemical, nuclear, and electrical energy conversion processes.

COURSE MATERIALS

All necessary material, e.g., lecture notes, assignments, readings, etc., will be posted on my website or given in class.

REFERENCE MATERIAL

BOOKS

- Energy Science, J. Andrews and N. Jelley, Oxford, Second Edition, 2013.
- Student Online Resource Centre: http://global.oup.com/uk/orc/physics/andrews_jelley2e/
- Scientific pocket calculator. Only an official Faculty of Engineering approved standard calculator may be used during examinations. http://www.mcgill.ca/engineering/student/sao/policies/examinations/calculators/
- Lecture notes and slides. Instructor generated course materials (e.g., handouts, notes, summaries, exam questions, etc.) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission of the instructor. Note that infringements of copyright can be subject to follow up by the University under the Code of Student Conduct and Disciplinary Procedures.

LEARNING OBJECTIVES

-Develop a quantitative knowledge of primary energy resources.
-Learn and apply the scientific principles involved in energy conversion and conversion efficiencies
-Develop a working knowledge of engineering models and applications of energy conversion devices and processes.
-Learn the methods and controls to optimize the use of renewable energy.

INSTRUCTIONAL METHODS

The course will involve lectures, tutorials and office hours. The students are required to pre-read the assigned chapter and course materials before attending each class.

MISSED ASSIGNMENT, QUIZ AND EXAM POLICIES

The weight of a missed assignment, quiz and/or midterm exam will be carried to the final exam only if a valid, dated, signed, properly identified (i.e. quiz #, assignment #) note with proofs is provided by e-mail. The signed note and attached proofs must be submitted to Dr. Rey within 5 business/working days, otherwise, a zero (“0”) will be entered.

POLICY FOR QUIZ AND EXAM REVIEWS

This will be done individually in the instructor's office only during office hours and no later than two weeks after you are informed of your grade (For other times please request your appointments by email). After that, no request will be granted. Failing this, you will be asked to make an official request with the Student Affairs office. Exams and quizzes will not be returned.

EVALUATION AND ASSESSMENT

The students will be responsible for submitting the assignments at the beginning of each tutorial. Late submissions will be returned ungraded. There will be 9 assignments, 9 quizzes, 1 midterm examination and 1 final exam. All weight of missed quizzes and examination will be carried to the final exam for the course. Under no circumstances will there be make up assignments, quizzes, midterm and/or final exams.

ASSIGNMENTS (A1-A9)

The assignments are individual work. If pictures and graphs are taken from websites and copyrighted texts, proper referencing must be done. Be thorough and clear.

QUIZZES AND EXAMINATION RULES

The 15 minutes quizzes, 60 minutes midterm exam and 3 hours final exam are closed books, closed notes, and closed electronic devices. Only the faculty calculator is allowed. The content of each quiz includes the corresponding book chapter and corresponding class lectures. For example, Q4(4) denotes quiz number 4 and the topic is based on the textbook's Chapter 4, and class lectures for Chapter 4. The content of the midterm covers all material up to October 16. The final exam is all inclusive. The 15 minute quizzes will take place at the end of each tutorial. The location of the midterm is

A-H: Wong Bldg., Room 1020
I-Z: TBA

MARK DISTRIBUTION

- 9 Assignments 5% *Wed., Sept 21;Sept 28;Oct.5,12,19;Nov.2,9,16,23.*
- 9 Quizzes (15 min each) 25% *Wed., Sept 21;Sept 28;Oct.5,12,19;Nov.2,9,16,23.*
- Midterm examination (60 min) 25% *Tuesday, October 25 (class time)*
- Final examination (3 hours) 45% *TBA*

SCHEDULE

THE SCHEDULE MAY BE SUBJECTED TO CHANGE DURING THE SEMESTER.

Week # Date Chapter	Topic	PreRead (book) Questions (student online resources) Slides	Assignment Due (Wednesdays)	Quiz Date and # (book chapter topics)
Week #1 9/6-9/8 Chapter 1 (Dr Jendi)	Energy Sources/Trends; HDI, Earth Energy Budget, GHG,CC, Capacity, Scaling	1-17 Chapter 1 Qs Slides #1	-	-
Week #2 9/13,9/15 Chapter 2	Thermal Energy, Passive-Active Solar, GHG	20-29 Chapter 2 Qs Slides #2	9/14:review of course syllabus,Ch1 (Dr. Rey)	9/14:review of course syllabus,Ch1 (Dr. Rey)
Week #3 9/20,9/22	Heat Pumps, Geothermal	30-48 Chapter 2 Qs	A1	9/21;Q1(1) TA:Vahid

Chapter 2		Slides #2		
Week #4 9/27,9/29 Chapter 3	Fossil Fuels	53-74 Chapter 3 Qs Slides #3	A2	9/28;Q2(2) TA:Mahdi
Week #5 10/4,10/6 Chapter 4	Fluid Mechanics For Energy Conversion	79-96 Chapter 4 Qs Slides #4	A3	10/5;Q3(3) TA:Matus
Week #6 10/11,10/13 Chapter 5	Hydro, Tidal,Wavepower	99-136 Chapter 5 Qs Slides #5	A4	10/12;Q4(4) TA:Vahid
Week #7 10/18,10/20 Chapter 5-6	Wavepower /Wind	139-176 Chapter 5-6 Qs Slides #5-6	A5	10/19;Q5(5) TA:Mahdi
Week #8 (midterm) 10/27(lecture) Chapter 6	Wind	148-176 Chapter 6 Qs Slides #6	No Assignment MIDTERM 10/25	No Tutorial MIDTERM 10/25
Week #9 11/1-11/3 Chapter 7	Solar	181-224 Chapter 7Qs Slides #7	A6	11/2;Q6(6) TA:Matus
Week #10 11/8-11/10 Chapter 7-8	Solar/Biomass	181-255 Chapter 7-8 Qs Slides #7-8	A7	11/9;Q7(7.1-7.4) TA: Vahid
Week #11 11/15-11/17 Chapter 8 (contd)	Biomass	229-255 Chapter 8 Qs Slides #8	A8	11/16;Q8(7.5-7.12) TA:Mahdi
Week #12 11/22-11/24 Chapter 9	Biomass/Nuclear	257-297 Chapter 9 Qs Slides #9	A9	11/23;Q9(8) TA:Matus
Week #13 11/29-12/1 Chapter 9	Nuclear+ Summary	257-297 Chapter 9 Qs Slides #9	-	-

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PRINCIPLES OF ENERGY CONVERSION
DETAILED COURSE CONTENTS 2016

TEXT: ENERGY SCIENCE PRINCIPLES, TECHNOLOGIES, AND IMPACTS - ANDREWS/JELLEY

1. Introduction to Energy Science
2. Thermal energy
3. Energy from Fossil Fuels
4. Essential Fluid Mechanics for Energy Conversion
5. Hydropower, Tidal and Wave Power
6. Wind Power
7. Solar Energy
8. Biomass
9. Energy from Fission

NB: Book topics not included in the list below are left to self-study.

CHAPTER 1 AN INTRODUCTION TO ENERGY SCIENCE

1.2 Global energy trends
1.3 Global warming and the greenhouse effect
1.4 Implications of global warming for energy supply
1.5 Energy units and capacity factors

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 2 THERMAL ENERGY

2.1 Heat and temperature
2.2 Heat transfer
2.3 Thermal insulation
2.4 Thermal mass
2.5 Solar thermal energy
2.6 The greenhouse effect
2.7 Laws of thermodynamics and efficiency of a Carnot cycle
2.8 Useful thermodynamic quantities
2.10 Ground- and air-source heat pumps
2.11 Geothermal energy

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 3 ENERGY FROM FOSSIL FUELS

3.1 Coal
3.2 Crude oil and natural gas
3.3 Unconventional fuels
3.4 Fossil fuel production and reserves
3.5 Oil and fossil fuel prices
3.6 Combustion
3.7 Carbon capture and storage

3.8 Thermodynamics of steam power plants
3.9 Disadvantages of Carnot cycle for a steam power plant
3.10 Rankine Cycle for steam power plants
3.10.1 Rankine cycle without reheat
3.10.2 Rankine cycle with reheat
3.11 Gas turbines and the Brayton (or Joule) cycle
3.12 Combined cycle gas turbine
3.13 Fluidized beds
3.14 Supercritical and ultracritical plants
3.15 Outlook for fossil fuels

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 4 ESSENTIAL FLUID MECHANICS FOR ENERGY CONVERSION

4.1 Basic physical properties of fluids
4.2 Streamlines and stream tubes
4.3 Mass continuity
4.4 Thermal mass
4.5 Energy conservation in an ideal fluid: Bernoulli's equation
4.6 Lift and circulation
4.7 Euler's turbine equation

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 5 HYDROPOWER, TIDAL POWER AND WAVE POWER

5.0 Introduction
5.1 Natural resources
5.2 Power from a dam
5.3 Measurement of volume flow rate using a weir
5.4 Water turbines
5.5 Micro hydro
5.8 Tides
5.9 Tidal power
5.10 Power from a tidal barrage
5.11 Tidal resonance
5.12 Kinetic energy from tidal currents
5.15 Wave energy
5.16 Wave power devices
5.17 Spill-over devices
5.18 Oscillating water columns

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 6 WIND POWER

6.1 Source of wind energy
6.2 Global wind patterns
6.3 Modern wind turbines
6.4 Kinetic energy of wind

6.5 Principles of a horizontal-axis wind turbine
6.6 Wind turbine blade design
6.7 Dependence of the power coefficient C_p and the tip-speed ratio λ
6.8 Design of a modern horizontal-axis wind turbine
6.9 Turbine control and operation
6.10 Wind characteristics
6.11 Power output
6.12 Wind farms
6.15 Wind variability
6.16 Global wind potential

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 7 SOLAR POWER

7.1 The Solar Spectrum
7.2 Semiconductors
7.3 p-n junction
7.4 Solar photocells
7.5 Efficiency of solar cells
7.6 Commercial solar cells
7.8 Solar panels
7.12 Solar thermal power plants

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 8 BIOMASS

8.0 Basic Definitions
8.1 Photosynthesis & crop yields
8.2 Biomass potential and use
8.3 Biomass for heat and power
8.4 Liquid biofuels

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.

CHAPTER 9 ENERGY FROM FISSION

9.0 Introduction
9.1 Binding energy and stability of nuclei
9.2 Fission
9.3 Thermal reactors
9.4 Thermal reactor designs
9.5 Fast reactors
9.6 Present-day nuclear reactors
9.7 Safety of nuclear power

Summary: Key primary energy resource quantities, key scientific principles, key engineering process and devices, and key formulas.