Lecture Day & Time: Wednesday, 1 pm – 4 pm
Lecture Room: BA B024

Instructor: David Warnica – https://www.linkedin.com/in/davidwarnica/
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Course Description:
- This course provides fundamentals and applications for thermal and hydraulic design of heat exchangers. It covers a wide range of relevant topics including the main considerations for equipment selection, design, and specification, and different methods of analysis for sizing and rating. Some specialized design considerations are also introduced. The principal objective is for students to become familiar with designing industrial heat exchangers using a design thinking approach and a synthesis of engineering subjects such as thermodynamics, heat transfer, and fluid mechanics.

Textbook: Robert W. Serth and Thomas G. Lestina, <u>Process Heat Transfer: Principles, Applications and Rules of Thumb</u> (Second Edition), Academic Press, 2014.
- Available through UTOR Library Online Resources
  http://www.sciencedirect.com.myaccess.library.utoronto.ca/science/book/9780123971951

Course Outline:
1. Classification of Heat Exchangers
2. Review Heat Conduction (Ch 1) and Convective Heat Transfer (Ch 2)
3. Thermal Analysis and Preliminary Design Methods (Ch 3)
   a. Overall Heat-Transfer Coefficient
   b. Log-Mean Temperature Difference (LMTD)
   c. F-Factor Design Method (LMTD Correction factor)
   d. ε-NTU Design Method (Effectiveness-Number of Transfer Units)
   e. Preliminary Design and Rating
4. Heat Exchanger Design Considerations
   a. Double-Pipe Heat Exchangers (Ch 3 & 4)
   b. Shell-and-Tube Heat Exchangers (Ch 3, 5, 6 & 7)
      - Introduction to Computer Software (HTRI Xchanger Suite)
   c. Air-Cooled (Crossflow) Heat Exchangers (Ch 12)
   d. Plate Heat Exchangers (Ch 3)
   e. Boilers and Evaporators (Ch 9 & 10)
   f. Condensers (Ch 11)
5. Other Design Considerations (selected topics)
   a. Flow-Induced Vibration (FIV) of Tubes and Tube Banks
   b. Heat-Exchanger Networks (Ch 8)
      - Pinch Analysis and Process Integration (PI)
      - Data Validation and Reconciliation (DVR)

Grading Scheme:
- Three (3) Problem Sets worth a total of 15%
- Midterm Exam worth 40%
- Design Project worth 45% (individual or groups of no more than two people)

Schedule
- 12 lectures to finish Wednesday, April 1
- Key dates:
  - January 7 – First Lecture
  - February 4 – Lecture 5 – Due: Problem Set #1 (thermal hydraulics)
  - February 18 – Winter Study Break – No lecture
  - February 25 – Lecture 7 – Due: Problem Set #2 (double-pipe heat exchangers)
  - March 11 – Lecture 9 – Midterm Exam instead of lecture
  - March 18 – Lecture 10 – Due: Problem Set #3 (shell-and-tube heat exchangers)
  - April 1 – Last Lecture 12
  - April 7 (Tuesday) – Last day of Winter Session classes – Due: Project Design Reports

HTRI Xchanger Suite 9.3 Software
- Tool to design, rate, and simulate heat-exchanger performance in an integrated graphical environment;
  - Xchanger Suite Educational has three modules:
    - Xace – Air-Cooled Heat Exchangers (Crossflow)
    - Xist – Shell-and-Tube Heat Exchangers
    - Xphe – Plate-and-Frame Heat Exchangers (Compact)
  - See https://www.htri.net/htri-xchanger-suite-educational.aspx for other features
- Available by Remote Desktop through Engineering Computing Facility
  - Login procedure will be provided

Other Expectations:
- Class participation is highly encouraged;
  - Please don't hesitate to contact me if you have any questions or comments
  - I try to respond to all communications within 24 hours
- Appropriate engineering format, content, and quality are expected of problem sets and design reports;
  - Ten percent of the marks are based on both the quality and timeliness
- Problem sets, exams, and design projects must be in your own words and by your own hand, spreadsheet, or other software application