Time: Tuesday, 6-9pm
Room: GB 119

Instructor: David Warnica
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Course Description:

- This course provides the 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 and design, and different methods of analysis for performance (rating) and sizing. More specialized design considerations are also introduced. The objective is for students to become familiar with the design and specification of industrial heat exchangers by solving practical problems using a synthesis of other mechanical engineering subjects such as thermodynamics, heat transfer, and fluid mechanics.

Textbook: Robert W. Serth and Thomas G.Lestina, Process Heat Transfer: Principles, Applications and Rules of Thumb (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. Heat Exchangers; Thermal Analysis & Design (Ch 3)
   a. Overall Heat-Transfer Coefficient
   b. Log-Mean Temperature Difference
   c. F-Factor (Correction) Method
   d. ε-NTU Method (Heat Exchanger Effectiveness – Number of Transfer Units)
   e. Preliminary Design and Rating
4. Heat Exchanger Design Procedures
   a. Double-Pipe Heat Exchangers (Ch 3 & 4)
   b. Shell-and-Tube Heat Exchangers (Ch 3 & 5)
      - Pressure Drop Analysis;
        - Delaware Method (Ch 6) & Stream Analysis Method (Ch 7)
        - Computer Software
   c. Air-Cooled (Crossflow) Heat Exchangers (Ch 12)
   d. Compact Heat Exchangers (Tube-Fin, Plate-Fin, and Plate-and-Frame, Ch 3)
5. Other Design Considerations (selected topics)
   a. Boiling Heat Transfer and Boilers (Ch 9 & 10)
   b. Condensers (Ch 11)
   c. Heat-Exchanger Networks (Ch 8)
   d. Flow-Induced Vibration

Grading Scheme:

- Three (3) Problem Sets worth a total of 20%;
  - Approximately two weeks to complete each problem set
- Midterm Exam worth 35%
- Design Project worth 45% (in groups of 2-3 people)

Schedule

- 13 weeks to finish lectures on Tuesday, April 2
- Key dates:
    - January 8 (Week 1);
        - **First Lecture**
    - February 5 (Week 5);
        - **Due:** Problem Set #1
    - February 19 (Week 7);
        - **Due:** Problem Set #2
        - **Reading week – There will be a lecture this week.**
    - March 5 (Week 9);
        - **Midterm Exam instead of lecture**
    - March 12 (Week 10);
        - **Due:** Problem Set #3
        - **Finalize project topics and groups**
    - April 2 (Week 13);
        - **Last lecture**
    - **April 5 (Friday) - Projects are due**

HTRI Xchanger Suite 7.0 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 https://ssl.ecf.utoronto.ca/ecf/services/rd
    - Login procedure to be provided

Other Expectations:

- Class participation is highly encouraged
- Independent work on problem sets and design projects; These must be in your own words and by your own hand, spreadsheet, or other software application
- Appropriate format, contents, and quality of engineering calculations