

## **DEPARTMENT OF MECHANICAL ENGINEERING – MCMASTER UNIVERSITY**

### **Course Information Handout**

### **Mech Eng 4W03 – Thermodynamics of Air Conditioning and Refrigeration Systems**

#### **OBJECTIVES**

*To understand principles of applied thermodynamics in the air conditioning and refrigeration systems and their components.*

#### **CALENDER DESCRIPTION**

**Mech Eng 4W03:** *Re-examination of laws of thermodynamics, multicomponent systems, psychrometry, air conditioning, mechanical vapour compression refrigeration, absorption refrigeration, heating and cooling load calculations, air quality and human thermal comfort.*

#### **TEXT BOOK**

Thermal Environmental Engineering – Thomas H Kuehn, James W Ramsey and James L Threlkeld, Prentice Hall.

#### **REFERENCES**

- Thermodynamics – An Engineering Approach: Fifth Edition, Yunus A. Cengel, Michael A. Boles, McGraw Hill.
- Fundamentals of Engineering Thermodynamics, Fifth Edition, M. Moran and H. Shapiro, John Wiley and Sons Inc., 2004
- Thermodynamics for Engineers - Schaum's Outline Series, Merle C. Potter, Craig W. Somerton, Schaum's Outline Series, McGraw Hill.
- Thermodynamics – An Integrated Learning System, Philip S. Schmidt, Ofodike A. Ezekoye, John R. Howell, Derek K. Baker, John Wiley & Sons, Inc..
- Heating, Ventilating, and Air Conditioning – Analysis and Design: Fifth Edition, Faye C. McQuinston, Jerald D. Parker, Jefferey D. Spilter, John Wiley & Sons, Inc..
- Thermal Environmental Engineering: Third Edition, Thomas H. Kuehn, James W. Ramsey, James L. Threlkeld, Prentice Hall, New Jersey.
- Thermal Engineering, P.L Ballaney, Khanna Publishers, Delhi, India.
- Advanced Engineering Thermodynamics, Second Edition, Adrian Bejan, John Wiley & Sons, Inc.
- A textbook of Thermal Engineering: Two Colour Edition, R. S. Khurmi, J. K. Gupta, S. Chand & Company Ltd., New Delhi, India.
- An Introduction to Combustion - Concepts and Applications: Second Edition, Stephen R. Turns, McGraw Hill.

#### **INSTRUCTOR**

Sumanth Shankar

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## **SCHEDULE**

Tuesdays, Thursdays and Fridays → 14:30 AM to 15:20 PM → BSB/B154

## **TEACHING ASSISTANTS**

Steinmann, Noah → [steinmnd@mcmaster.ca](mailto:steinmnd@mcmaster.ca)

## **OFFICE HOURS**

Anytime you want me for a discussion. Contact me through my email, mobile phone or text. DO NOT CONTACT ME THROUGH MY OFFICE PHONE.

## **HOMEWORK**

Solving homework problems is essential to successful assimilation of the course material. Solve the homework problems individually to ensure a good comfort level in examinations. Homework assignments will not be graded. Solutions to homework assignments will be posted regularly on the online course shell.

## **EXAMINATIONS**

Two exams during the term and a final exam at the end of the term. Syllabi for all examinations will be cumulative from the beginning of the course.

Mid-Term Exam #1 → TBA

Mid-Term Exam #2 → TBA

Final Exam → TBA

## **STUDENT EVALUATION**

Mid Term Test #1	30%
Mid Term Test #2	30%
Final Exam	40%
<b>Total</b>	<b>100%</b>

## **COURSE OUTLINE**

- 1. Recap of Thermodynamics (Mech Eng 2W04) (1 Lecture + Handout)**
  - 1.1. Introduction and First Law of Thermodynamics
  - 1.2. Energy and Application of Energy
  - 1.3. Second Law of Thermodynamics and Application
  - 1.4. Entropy and Application of Entropy
- 2. Multi-Component Systems (6 lectures)**
  - 2.1. Thermodynamic Analysis of Ideal Gas Mixtures

## **2.2. Multicomponent Analysis of Ideal Gas-Vapour Mixtures**

- 2.2.1. Psychrometry
- 2.2.2. Thermodynamic properties of moist air
- 2.2.3. Mixing of Air-Water Vapour Streams

## **2.3. Psychrometric Chart**

- 2.3.1. Heat Transfer with Constant Specific Humidity
- 2.3.2. Humidification and Dehumidification

## **3. Air Conditioning (10 Lectures)**

### **3.1. Summer and Winter Air Conditioning**

- 3.1.1. Single Zone
- 3.1.2. Multiple Zone

### **3.2. Humidification and Dehumidification Principles**

### **3.3. Spray Washer Efficiency**

### **3.4. Off-Design Conditions**

- 3.4.1. VAV systems
- 3.4.2. Face and By-Pass Systems
- 3.4.3. Water Temperature Control Systems

## **4. Refrigeration (10 Lectures)**

### **4.1. Mechanical Vapour Compression Refrigeration**

- 4.1.1. Comparison of Various Types of Compressors
- 4.1.2. Compressor Design and Efficiency Evaluation

### **4.2. Absorption Refrigeration**

- 4.2.1. Thermodynamics of Binary Mixtures
- 4.2.2. Aqua-Ammonia Absorption System
- 4.2.3. Lithium Bromide – Water Absorption System.
- 4.2.4. Rectification and Principal Operating Lines

## **5. Heating and Cooling Load Calculations in Buildings (5 Lectures)**

### **5.1. Winter Design Heat Loss**

### **5.2. Instantaneous Heat Gain**

### **5.3. Instantaneous Cooling Load**

### **5.4. Energy Estimation Methods**

## **6. Indoor Air Quality and Human Comfort (5 Lectures)**

### **6.1. Human Body and Environmental Parameters**

### **6.2. Prediction of Human Thermal Comfort**

### **6.3. Airborne Contaminants**

### **6.4. Infiltration and Acceptable Indoor Air Quality**

### **6.5. Modeling Indoor Contaminant Concentration**

**DISCLAIMER**

"The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes."