Doc. #37

SAULT COLLEGE OF APPLIED ARTS **AND** TECHNOLOGY

SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: Introduction to Thermodynamics

CODE **NO.:** MCH130 **SEMESTER:** Three

PROGRAM: Mechanical Technology

AUTHOR: W. J. Adolph

DATE: September 1993 **PREVIOUS OUTLINE DATED:** 1992

APPROVED: *J^Pd^f^^* */ 993 C8 / 9*

DEAN 2? DATE

COURSE NAME	CODE NO.
INTRO. TO THERMO.	MCH130

TOTAL CREDIT HOURS: Three (3)

PREREQUISITE(S): None

I. PHILOSOPHY/GOALS:

This course provides the student of MECHANICAL TECHNOLOGY the opportunity to examine and apply the fundamentals of THERMODYNAMICS to the solution o problems involving heat and heat transfer. The student will use and justify units in both systems and will become comfortable with the skill of dimensional analysis. Upon successful completion, the student will be prepared to move on to more advanced topics in thermodynamics.

II. STUDENT PERFORMANCE OBJECTIVES:

Upon completion of this course the student will:

1. Write and explain all the terms of the GENERAL ENERGY equation.
2. Use the three fundamental units and the derived units.
3. Use dimensional analysis to verify the units of the solved quantities.
4. Understand the concepts and apply the principles of heat, temperature and Internal Energy to the solution of problems.
5. Understand the concepts and apply the principles involved in Energy Work and Power to the solution of problems.
6. Apply the principles of Calorimetry to the solutio of heat balance problems.
7. Understand and apply the principles of changes of phase to the solution of heat balance problems.
8. Understan and apply the princiles involved in Thermal Expansion of solids and liquids.
9. Undersand and apply the principles involved in the expansio and compression of perfect gases.
10. Understand and apply the laws involved in the transfer of Heat by the three modes of heat transfer.
11. Understand the fundamental principles underlying HEAT ENGINES.
12. Understand and be able to explain the workings of a basic refrigeration cycle.

INTRO. TO THERMO. **MCH130**

III. TOPICS TO BE COVERED	**APPROXIMATE HOURS**
1. Temperature and Heat	**3**
2. The Nature of Heat	**5**
3. Laws of Gases	**7**
4. Heat and Changes of State	**12**
5. Heat Transfer	**10**
6. Heat Engines	**4**
7. Refrigeration	**4**

IV. T KARNING ACTIVITIES

1.0 TEMPERATURE AND HEAT

Upon completion of this unit the student will be able to:

1.1 Write the terms of the General Energy Equation in its steady flow form.

1.2 Define Temperature, Internal Energy and Heat.

1.3 Identify the different heat-related terms in the General Energy Equation.

1.4 Compare the Fahrenheit and Celsius scales.

1.5 Explain how liquid - glass thermometers are constructed.

1.6 Differentiate between Dial thermometers, Resistance thermometers, Thermocouples and Optical Pyrometers.

REQUIRED RESOURCES FOR 1.0
Textbook Pages 314 to 321
Instructional film on Heat and Temperature

IV. T F ARNTNG ACTIVITIES (cont'd)

2.0 THE NATURE OF HEAT

Upon completion of this topic the student will be able to:

2.1 Relate Temperature to Internal Energy and differentiate the meaning of heat from the previous.

2.2 Explain Temperature in relation to the Kinetic Theory.

2.3 Write the formulae for Linear, Area and Volume expansion of solids and liquids.

2.4 List some practical applications for the pehnomenon of expansion.

2.5 Explain the peculiarities of the expansion of water.

2.6 Solve problems Pages 339, 340 and 342.
Group two 11,12,13,15,17, 18,19, 23. 26, 27, 28
Group three 33, 34, 35, 36, 37

REQUIRED RESOURCES FOR 2.0
Textbook Pages 322 to 331

3.0 THE LAWS OF GASES

Upon completion of this topic the student will be able to:

3.1 Write and solve problems involving the laws of Boyle, Charles and Gay-Lussac.

3.2 Compare the Four temperature scales against each other using the temperatures of known common phenomenon.

3.3 Write and use the Ideal gas law in the solution of gas expansion problems.

3.4 Define a mole and relate it to Avogadro's number.

3.5 Write and use the equation of state for perfect gases.

3.6 Write and use the equation relating moles, molecular weight and mass.

3.7 Solve problems pages 341, group three 32, 33, 34, 35, 36 and 37.

REQUIRED RESOURCES FOR 3.0
Textbook pages 331 to 338 with necessary review of pages 291 to 305 which deals with properties of gases

TV. T F.ARNTNfi ACTIVITIES (cont'd)

4.0 HEAT AND THE CHANGE OF STATE

Upon completion of this topic the student will be able to:

4.1 Define the quantities of heat known as the kilo joule, the kilocalorie and the Btu.

4.2 State the relationship between the various quantities of Heat.

4.3 Define the term Heat of Combustion.

4.4 Using the appropriate formula, perform calculations involving the heats of combustion.

4.5 Write the heat balance formula.

4.6 Define the term "specific heat".

4.7 Use the Heat balance formula to make calculations ivolving the specific heat of substances.

4.8 State the specific heat of water in S.I. and Imperial systems.

4.9 Define the Heats of fusion and Vaporization for any substance.

4.10 Draw the Temperature-Heat curve for water and label all sections.

4.11 Perform calculations to solve mixing problems.

4.12 Explain what happens to its volume as water freezes and thaws.

4.13 Explain what happens when water boils.

4.14 Explain why Evaporation is a cooling process while Condensation is a warming process.

4.15 List factors which have an effect on the rate of evaporization.

4.16 Draw and explain the TRIPLE POINT CURVE for water.

IV. TFARNTNG ACTIVITIES (cont'd)

4.17 Answer questions and solve problems on pages 363 to 365
Questions 1 thru 17.
Group one - 1, 3, 5, 7, 9.
Group two - 11,13, 15,17,19, 21, 23, 25, 27, 29.
Group Three - 31, 33, 35, 37, 39.

REQUIRED RESOURCES FOR 4.0
Textbook for pages 342 to 365

5.0 HEAT TRANSFER

Upon completion of this topic the student will be able to:

5.1 List and give examples of the three mechanisms of Heat Transfer.

5.2 State the equation and list the units for Heat Transfer by Thermal Conductivity.

5.3 State the difference between Q and H - use units.

5.4 Define "Thermal Resistance" in terms of material thickness and thermal Conductivity.

5.5 Write the formula that relates the resistance of a composite to the resistances of the individual constituent materials.

5.6 State the relationship between the "overall heat transmission coefficient' and the "thermal resistance" of materials.

5.7 Make a sketch of the Searles apparatus for measuring the heat conductivity of metals and other materials.

5.8 Differentiate between forced and natural convection.

5.9 Write the formula for the rate of heat transferred by convection.

5.10 State the practical values for h and h for inside and outside common walls.

5.11 State the Stephan-Boltzmann Radiation Law and define Emissivity.

TV. T.F.ARNTNG ACTIVITIES (cont'd)

5.12 Answer questions and solve problems on pages 387 to 389.
Questions 2, 4, 5, 6, 7, 8, 9,11,12,13,14,15,16.
Group one - 3 thru 10.
Group two - 11, 12,13,15,18,19, 20, 21, 23, 26, 27.
Group three - 30, 31, 32, 33, 35.

REQUIRED RESOURCES FOR 5.0
Textbook pages 366 to 386
Experiment on Conductivity

6.0 THERMODYNAMICS - HEAT ENGINES

Upon completion of this topic the student will be able to:

6.1 State the meaning of Joule's constant

6.2 State that part of the General Energy equation that relates the conversion of work to heat.

6.3 State the first law of the conservation of energy.

6.4 State the first law of thermodynamics as it applies to heat engines.

6.5 State the first law of thermodynamics as it includes,changes in internal energy.

6.6 State two expressions of the 2nd law of thermodynamics.

6.7 Give an example of "entropy".

6.8 On a p-v diagram draw lines of:
a) constant volume
b) constant pressure
c) isothermal
d) adiabatic

6.9 On a p-v diagram draw the processes that form the Carnot cycle and explain how the cycle works.

6.10 State the Ideal Carnot thermal efficiency in terms of temperatures of the reservoir and the sink.

IV. T EARNING ACTIVITIES (cont'd)

6.11 Answer questions and solve problems on pages 417 to 419.

Questions - 6,12,16,18.
Group one - 1 , 2, 3, 4, 7, 8, 9,10,11,12.
Group two -15,17, 23, 26, 29.

REQUIRED RESOURCES FOR 6.0
Textbook pages 390 to 416

7.0 REFRIGERATION

Upon completion of this topic the student will be able to:

7.1 Draw the thermodynamic symbol for both a Heat Engine and a Refrigerator.

7.2 Define "Refrigeration Ton".

7.3 Given a diagram representing the components of a mechanical refrigerator, explain how it works to remove heat from the hamburger in the freezer.

7.4 State the formula for the Coefficient of Performance (COP) of a Carnot Refrigerator.

7.5 State the formula for the Energy Efficiency Ratio.

7.6 Answer Questions and solve problems on pages 443 thru 445.
Questions 1, 3, 5, 7, 9.
Group one - 1 , 3, 5.

REQUIRED RESOURCES FOR 7.0
Textbook pages 420 to 430.

V. EVALUATION METHODS: (INCLUDES ASSIGNMENTS, ATTENDANCE REQUIREMENTS. ETC.)

Attendance at all classes is mandatory. Attendance will be taken randomly at least once per week at the start of each class.

There will be three major tests given one week after the test is announced. The first test will include topics 1, 2, and 3, while the second will deal with topic 4. The final test will include topics 5 and 6 while testing of the final topic will be done by quiz.

There will be several short labs handled in the "job" style requiring only observations and conclusions to be recorded. The labs are worth 20% of the final mark.

Numerical marks will be converted to grades according to the schedule below:

A+ 90-100
A 80-89
B 70-79
C 60-69
X or R less than 60

Rewrites: Providing the student has proven to be a serious student by virtue of respectable attendance and good homework habits, then student would be permitted to rewrite the first or the third test if by so-doing the new mark will raise the average to 60%.

VI. REQUIRED RESOURCES

Textbook: Physics
Principles and Applications (5th edition)
Harris Hemmerling Mallmann
McGraw Hill

VII. SPECIAL NOTES

Students with special needs (eg. physical limitations, visual impairments, hearing impairments, learning disabilities) are encouraged to discuss required accommodations confidentially with the instructor.

Your instructor reserves the right to modify the course as he/she deems necessary to meet the needs of students.