## SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

## SAULT STE. MARIE, ONTARIO


## COURSE OUTLINE

**COURSE TITLE:** HEAT TRANSFER in UNIT PROCESSES

**CODE NO. :** PPE 250-4 **SEMESTER:** IV or V

**PROGRAM:** PULP & PAPER ENGINEERING TECHNICIAN
PULP & PAPER ENGINEERING TECHNOLOGY

**AUTHOR:** JACK BETHUNE

**DATE:** NOV. 2000 **PREVIOUS OUTLINE DATED:** MAY 1994

**APPROVED:**

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**DEAN** **DATE**

**TOTAL CREDITS:** 4

**PREREQUISITE(S):** WTR 330-4

**HOURS/WEEK:** 3

## I. COURSE DESCRIPTION:

The effective use and conversion of energy is one of the routes to cost effectiveness in any process operation. Knowledge of the underlying theories of heat transfer and their application will allow technologists to play a more useful roll in process operation, modification and evaluation. This course deals with the underlying theories and applications of heat transfer that relate to unit processes involved in pulp and paper manufacture. Examples of topics to be covered include a review of the physics of heat, temperature, and basic laws plus the theory and application of theory of combustion, heat exchangers and evaporators.

## II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

Upon successful completion of this course, the student will demonstrate the ability to:

1. Understand the basic laws of heat and temperature.

   Potential Elements of the Performance:

   Define heat and thermal energy in terms of molecular activity.
   Define ice point, boiling point, steam point and triple point.
   Define and use common units of heat energy such as the calorie and British Thermal Unit.
   Calculate specific heat capacity and specific heat of materials.
   Apply the concept of thermal expansion by performing calculations and solving problems.
   Define and similarly apply concepts related to phase changes, heat of fusion, heat of vapourization, vapour pressure, humidity and P-V-T diagrams.

2. Understand some of the more advanced laws of heat and temperature.

   Potential Elements of the Performance:

   Identify and use the components of material and energy balances to solve problems.
   Apply the theories represented in the Ideal Gas Law, Boyle's Law, Charles' Law and Gay-Lussac's Law to practical problems.
   Differentiate between characteristics of Ideal and Van der Waal's gasses and correctly apply these theories.

State the laws of Thermodynamics.
Define Entropy and Enthalpy and use these concepts in the solution of practical problems.

3. Understand the theory of combustion

Potential Elements of the Performance:

Explain the difference between complete and incomplete combustion.
Calculate air/fuel ratios for various combustion situations.
Apply the principles of chemical stoichometry to calculations of air/fuel ratios.
Calculate boiler efficiency values for various industrial combustion situations.

4. Understand the flow of heat.

Potential Elements of the Performance:

Trace the flow of boiler feedwater through a typical furnace generating superheated steam for electrical generation.
Describe differences in heat flow measurements due to conduction, convection and radiation.
Compute heat flow rates for a variety of different scenarios.
Describe and differentiate between various types of equipment commonly used in heat transfer processes.
State the relative advantages and disadvantages of heat transfer equipment types.

5. Understand evaporation.

Potential Elements of the Performance:

Describe the most important properties of evaporating liquids.
Describe and differentiate between types of evaporating equipment.
Define and use common measures of evaporator performance: capacity, economy, and steam consumption.
Describe and evaluate differences between single and multiple effect evaporator systems.
Describe the use and function of reboilers and vapour recompression systems.

## III. TOPICS:

1. Heat and Temperature
2. Some Basic Laws and other Tools
3. Combustion
4. Flow of Heat
5. Evaporation

## IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Bethune, J. and Sudgen, A., Heat Transfer in Unit Processes, Course Manual for PPE 250, (Available in College Bookstore or from instructor)

## V. EVALUATION PROCESS/GRADING SYSTEM:

A final grade will be derived from the results of three tests and four or more assignments as calculated below:

| | |
|---|---|
| Test No. 1 | 25 % |
| Test No. 2 | 25 % |
| Test No. 3 | 25 % |
| Assignments | 25 % |

Assignments will be awarded in class and due dates clearly indicated.

The following semester grades will be assigned to students in postsecondary courses:

| Grade | Definition | Grade Point Equivalent |
|---|---|---|
| A+ | 90 - 100% | 4.00 |
| A | 80 - 89% | 3.75 |
| B | 70 - 79% | 3.00 |
| C | 60 - 69% | 2.00 |
| R (Repeat) | 59% or below | 0.00 |
| CR (Credit) | Credit for diploma requirements has been awarded. | |
| S | Satisfactory achievement in field placement or non-graded subject areas. | |

| | |
|---|---|
| U | Unsatisfactory achievement in field placement or non-graded subject areas. |
| X | A temporary grade. This is used in limited situations with extenuating circumstances giving a student additional time to complete the requirements for a course (see *Policies & Procedures Manual – Deferred Grades and Make-up*). |
| NR | Grade not reported to Registrar's office. This is used to facilitate transcript preparation when, for extenuating circumstances, it has not been possible for the faculty member to report grades. |

## VI. SPECIAL NOTES:

Special Needs:
If you are a student with special needs (e.g. physical limitations, visual impairments, hearing impairments, or learning disabilities), you are encouraged to discuss required accommodations with your instructor and/or the Special Needs office. Visit Room E1204 or call Extension 493, 717, or 491 so that support services can be arranged for you.

Retention of course outlines:
It is the responsibility of the student to retain all course outlines for possible future use in acquiring advanced standing at other postsecondary institutions.

Plagiarism:
Students should refer to the definition of “academic dishonesty” in *Student Rights and Responsibilities*. Students who engage in “academic dishonesty” will receive an automatic failure for that submission and/or such other penalty, up to and including expulsion from the course/program, as may be decided by the professor/dean. In order to protect students from inadvertent plagiarism, to protect the copyright of the material referenced, and to credit the author of the material, it is the policy of the department to employ a documentation format for referencing source material.

Course outline amendments:
The Professor reserves the right to change the information contained in this course outline depending on the needs of the learner and the availability of resources.

## VII. PRIOR LEARNING ASSESSMENT:

Students who wish to apply for advanced credit in the course should consult the professor. Credit for prior learning will be given upon successful completion of a challenge exam or portfolio.

## VIII. DIRECT CREDIT TRANSFERS:

Students who wish to apply for direct credit transfer (advanced standing) should obtain a direct credit transfer form from the Dean's secretary. Students will be required to provide a transcript and course outline related to the course in question.