

**SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY**

**SAULT STE. MARIE, ONTARIO**



Sault College

**COURSE OUTLINE**

**COURSE TITLE:** RAW MATERIALS AND CHEMICAL PULPING  
**CODE NO. :** PPE 156 **SEMESTER:**  
**PROGRAM:** PULP and PAPER MAKING OPERATIONS  
**AUTHOR:** J. BETHUNE  
**DATE:** Apr. 2004 **PREVIOUS OUTLINE DATED:** June 2001  
**APPROVED:**

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	<b>DEAN</b>	<b>DATE</b>
<b>TOTAL CREDITS:</b>	5	
<b>PREREQUISITE(S):</b>	NONE	
<b>HOURS/WEEK:</b>	5	

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**I. COURSE DESCRIPTION:**

This course discusses the sources and nature of woody raw materials used by the pulp and paper industry with an emphasis upon chemical pulping requirements, including how wood is processed in the mill prior to pulping. Generalities of fibre separation by all chemical pulping processes are discussed with specifics of the kraft process, including principles of recovery.

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

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

1. Indicate a knowledge of Canada's forest regions, including where and how trees grow.

Potential Elements of the Performance:

- Explain what constitutes a forest region.
- Name and locate Canada's forest regions.
- Explain and calculate MIA.
- Explain how a tree grows.
- Differentiate between primary and secondary growth.
- Indicate how many km<sup>2</sup> of forest land there are in Canada.
- Relate the effects of extreme temperatures and low rainfalls of central Canada on our forests.
- Describe how cells of a tree divide.
- Calculate the maximum size mill possible without depleting the forest.

2. Demonstrate a knowledge of the structure of a tree.

Potential Elements of the Performance:

- Define xylem, phloem, nucleus, cell wall, ray cells, and lumen.
- Name the three functions of cells in wood.
- Discuss why ray cells are a concern in the manufacture of pulp and paper.
- Explain the difference between diffuse porous and ring porous hardwoods.
- List three ways that hemicellulose differs from cellulose.

- Calculate the density and specific gravity of a block of wood.
- List four factors that contribute to the specific gravity of wood.
- Calculate solids content and moisture content of wood.
- Define bound water.

3. Demonstrate an understanding of the structure of a fibre.

Potential Elements of the Performance:

- Define a microfibril and a macrofibril.
- Calculate the number of fibres in a given weight of pulp.
- Identify the various layers of a fibre wall.
- Explain the term fibril angle.
- Discuss the problems caused by vessels in papermaking.
- Indicate where the shortest fibres are found in a tree and discuss their implications on the quality of pulp.
- Explain fibre flexibility index.
- Explain runkle ratio and why it is important to burst strength.
- Discuss the significance of variations in a mill's wood supply.

4. Demonstrate an understanding of how wood and fibre characteristics control pulp and paper properties.

Potential Elements of the Performance:

- Discuss the effects that wood porosity has on chemical pulping.
- Briefly explain why certain chemical pulping processes are more likely to be detrimental to lignin.
- Discuss the effects of specific gravity on residual lignin content in kraft pulps.
- Discuss, in relative terms, the breaking length of Tamarac and Eastern White Pine.
- Name three factors that control tear strength in paper.
- Explain the difference between machine direction stretch and cross-machine direction stretch in paper.
- Explain the effect of thick walled fibres on Opacity.
- Explain the effect of latewood content on Bulk.
- Explain the effect of specific gravity on Tear.

5. Demonstrate a knowledge of the mill's bulk raw material.

Potential Elements of the Performance:

- Explain the difference between crown land and private ownership.
  - Explain the differences between land ownership in Canada and the United States.
  - Discuss how forest management areas are managed.
  - Explain stumpage fees.
  - Explain the argument for private ownership of forest land in Canada.
  - Give reasons why river drives were ended in Ontario.
  - Explain why mechanical harvesting is used.
  - Discuss factors limiting efficiency of mechanical harvesting.
  - Explain why a kraft mill would prefer to use sawmill chips.
  - Discuss the problems caused by crooked logs in a mill.
  - Discuss defects in wood and their affect on pulp quality.
6. Demonstrate an understanding of how wood is processed in the mill.

Potential Elements of the Performance:

- Explain the advantages of small woody raw material inventories.
- Conduct a case study on a mill's raw material requirements.
- Explain why a mill measures the woody raw material it receives.
- Discuss the quality properties a mill would measure on its woody raw materials.
- Calculate chip dryness.
- List three conditions log storage piles should meet.
- Explain FIFO.
- Discuss the different types of chip unloading equipment.
- Discuss the technical reasons for paving chip storage pads.

7. Demonstrate an understanding of how wood is prepared for pulping.

Potential elements of the performance:

- Explain why a mill might use log sorting.
- Discuss problems that decayed wood could cause in a pulp mill.
- Discuss the quality problems associated with large branch stubs on logs.
- Explain the purpose of a slasher.
- Describe how a drum barker works.
- Explain the difference between cambial shear and cutterhead debarkers.
- Calculate the amount of bark needed to heat a given quantity of water.
- Discuss the purpose and function of a bark press.
- List three factors that control chip length in a disc chipper.
- Name the three technical problems caused by broomed chips.
- Give four technical reasons for removing thick or long chips from digester feed.

8. Demonstrate a general understanding of chemical pulping.

Potential elements of the performance:

- List four differences between chemical and mechanical pulps.
- Describe the major difference between fibre separation methods for chemical and mechanical pulping.
- List the two main types of chemical pulping processes.
- Know the major difference in wood chemistry between softwood and hardwood.
- Name the two events that must happen to lignin before it can be removed during chemical pulping.
- Explain the term sulphonation.
- Explain what kappa number tells us.
- Explain why uniform chip size is important in chemical pulping.
- Explain why wood moisture is important in chemical pulping.
- Know the meaning of "Time to maximum temperature" and its importance.
- List the measurements that contribute to H factor.
- Know the usual maximum temperature for a kraft cook.
- Explain the differences between directly and indirectly heated digesters.

- Describe the main differences between batch digesters and continuous digesters.
- Describe the purpose of a blow tank.
- Indicate reasons why blow heat recovery is important.
- Give reasons why final heat and chemical recovery from waste liquor are important.

9. Demonstrate an understanding of kraft pulping.

Potential elements of the performance:

- List five differences between kraft and sulphite pulps.
- Know which two pieces of information are necessary in order to calculate the bone dry mass of chips loaded into a digester.
- Explain why black liquor is added to the digester before cooking.
- List four variables that must be controlled to produce kraft pulps of uniform kappa number.
- Explain the purpose of a trash extractor.
- Name the components of the pulp blown from the digester.
- Explain why sodium sulphate is added to strong black liquor.
- Name the three chemicals found in white liquor.
- Briefly explain the purpose of the XYZ titration.
- Define Effective Alkali, Active Alkali, Total Titratable Alkali, Sulphidity and Liquor to Wood Ratio.
- Make pulp yield calculations.
- Explain why a mill would want to know the solids content of black liquor coming out of the digester.
- Explain the importance of H factor control in cooking.
- Name four factors that limit a mill's ability to use higher cooking temperatures as a means of increasing production.
- Know the largest area of environmental concern in a kraft mill.

10. Demonstrate an understanding of the principles of kraft recovery.

Potential elements of the performance:

- Name four objectives of chemical and heat recovery.
- Name four objectives of pulp washing.
- Explain the concept of countercurrent washing.
- Explain the purpose of a seal tank.
- List the advantages of a thune press over a vacuum washer.

- Explain why evaporators are arranged in a countercurrent system.
- Explain why vacuum is used in some evaporator effects.
- List two reasons why modern recovery furnaces have water tube walls.
- Explain suspension firing.
- Name the three most important chemical reactions that occur in a kraft recovery furnace.
- Explain the purpose of the green liquor clarifier.
- Name the two most important chemicals in green liquor.
- Describe what happens in the slaker and causticizer.
- Explain the purpose of the lime kiln.
- Explain what limits a mill's ability to burn all its waste stream in the recovery furnace.
- Explain what some mills are doing to change this limitation.

### **III. TOPICS:**

1. What you need to know about Canada's forests.
2. All you ever wanted to know about wood.
3. Fibres and other useful stuff.
4. How wood and fibre characteristics control pulp and paper properties.
5. Preparation of raw materials.
6. Wood handling at the mill.
7. Preparing wood for pulping.
8. Chemical pulping.
9. Kraft pulping.
10. Principles of chemical recovery processes.

### **IV. REQUIRED RESOURCES/TEXTS/MATERIALS:**

Sugden, A.E. et al, "Study Guide for PPE 156 Raw Materials and Chemical Pulping", Sault College of Applied Arts and Technology, Sault Ste. Marie, 2001.

**V. EVALUATION PROCESS/GRADING SYSTEM:**

A final grade will be based upon the results of four tests weighted equally. Course material will be divided as follows:

- Test 1 on Module 1 Lessons 1 and 2
- Test 2 on Module 1 Lessons 3 and 4
- Test 3 on Module 2 Lessons 1, 2 and 3
- Test 4 on Module 3 Lessons 1, 2 and 3.

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

<u>Grade</u>	<u>Definition</u>	<u>Grade Point Equivalent</u>
A+	90 – 100%	4.00
A	80 – 89%	4.00
B	70 – 79%	3.00
C	60 – 69%	2.00
D	50 – 59%	1.00
F (Fail)	49% or below	0.00
CR (Credit)	Credit for diploma requirements has been awarded.	
S	Satisfactory achievement in field/clinical placement or non-graded subject areas.	
U	Unsatisfactory achievement in field/clinical placement or non-graded subject areas.	
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.	
NR	Grade not reported to Registrar's office.	
W	Student has withdrawn from the course without academic penalty	

Under extreme circumstances, students with a final grade of 45-49 % may be allowed to write supplementary exams for a maximum grade of "D" provided they obtained a minimum grade of 60 % in at least two of the written tests.



**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.

Substitute course information is available in the Registrar's office.

**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.