

**SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY**

**SAULT STE. MARIE, ONTARIO**



Sault College

**COURSE OUTLINE**

**COURSE TITLE:** ADVANCED PAPER MANUFACTURING

**CODE NO.** PPE 211 **SEMESTER:** 4

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

**AUTHOR:** JACK BETHUNE

**DATE:** NOV. 2000 **PREVIOUS OUTLINE DATED:** NEW

**APPROVED:**

	_____	_____
	<b>DEAN</b>	<b>DATE</b>

**TOTAL CREDITS:** 5

**PREREQUISITE(S):** PPE 110

**HOURS/WEEK:** 4

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**I. COURSE DESCRIPTION:**

This course combines two previous courses, PPE 240, Paper Machine, Wet End and PPE 340, Pressing and Drying as it reviews basic paper machine manufacturing theory and goes on to expand upon such topics as stock preparation, stock proportioning, use of additives, approach systems, pressing theory, press roll design, and felt design, along with aspects of dryer condensate removal, steam control and dryer ventilation.

**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 stock preparation, beating and refining.

Potential Elements of the Performance:

Cite the criteria for a successful paper making furnish.

Indicate the problems that might arise from feeding an unrefined stock to a paper machine.

Discuss the actions of beating and refining and their effects on pulp properties.

Explain the basic phases of refiner bar crossing.

Discuss refining intensity, gap control, ICPM, C factors, MIC and the relationships between them.

Know the four conditions to be considered when setting up a refiner control scheme.

Name and discuss five possible refiner control schemes.

Discuss refiner control scheme deadbands from the point of view of optimal control.

2. Indicate a knowledge of stock preparation measurements.

Potential Elements of the Performance:

Explain why online freeness testing is important.

Describe the operation of an innomatic freeness tester.

Know the drawbacks and limitations of automatic freeness testing.

Cite the drawbacks of the older consistency regulators.

Explain the principles behind the fixed and rotating consistency sensing elements.

List the advantages and disadvantages of the fixed and rotation consistency sensing elements.  
 Name five types of consistency sensors.  
 Explain the operation of a rotometer.  
 Explain the principles of operation of a magnetic flow meter.  
 Explain the operation of an ultrasonic flow meter.  
 Cite the precautions advised when using an ultrasonic flow meter.  
 List four types of level indicators used in industry.  
 Explain how a bubble pipe works.  
 Know the problems encountered when using pH electrodes in stock lines and how to overcome them.  
 List four advantages of pH control.  
 Explain how stock proportioning is done.  
 Perform simple calculations on stock proportioning.

3. Indicate a knowledge of papermaking additives

Potential Elements of the Performance:

Name two broad categories of papermaking additives with examples.  
 List the three main groups of chemicals involved in wet end chemistry.  
 Explain what colloids are.  
 Name ten wet end additives and explain the purpose of each.  
 List six factors that affect molecular and colloidal interaction.  
 Explain what causes particles in suspension to be charged.  
 Explain ionization by charged parts of molecules and by capture and adsorption of ions.  
 Explain zeta potential.  
 Explain how fast potential energy drops (in relative terms) across the various layers surrounding a colloidal particle.  
 Quote two uses for zeta potential.

4. Indicate a knowledge of additives used to improve paper machine performance

Potential Elements of the Performance:

Know which pH range most mills operate in and why.  
 List six possible uses for alum.  
 Know which form of alum is generally the most economical and why.  
 Explain why alum is a popular acid pH control chemical.  
 List four of the most important alumina complexes used in papermaking.

Explain optimum retention in relation to flocculation.  
Define first pass retention and overall retention.  
Complete a simple wet end balance and calculate first pass and overall retentions.  
Explain coagulation and flocculation.  
Cite differences between soft and hard flocs.  
List and describe five commonly used retention aids.  
Differentiate between dual retention aid and microparticle retention aid systems.  
List ten benefits of good first pass retention and ten effects of poor first pass retention.  
Explain defoamers and antifoamers.  
Explain four ways that foam reducing agents work.  
Explain how particulate defoamers and surface active agent defoamers work.  
List the four types of foam control agents available.  
Cite the advantages and disadvantages of foam control agents.  
Know why we are concerned with pitch in a paper mill.  
List three approaches to pitch control.  
Explain how the two types of pitch stabilizers work.  
Explain how talc controls pitch.  
Know what a pitch pacifier is and how it works.  
List six problems caused by microbial growth and comment on each.  
Know the conditions for slime growth.  
List the general categories of slime control products with advantages and disadvantages of each.

5. Indicate a knowledge of additives which enhance paper properties.

Potential Elements of the Performance:

Explain why paper is sized.  
Explain what influences liquid penetration into a sheet.  
List the four requirements of an internal sizing agent.  
Explain how rosin works as a sizing agent.  
Explain what capillaries and wide channels in a sheet do to liquid movement.  
Explain why machine glazed papers have uneven sizing on each side.  
List two factors that sintering temperature is dependent upon.  
Describe wax sizes.  
List five benefits to dry strength additives.  
Describe the natural polymers used as dry strength additives.  
Describe the mechanism by which synthetic polymers perform as dry

strength agents.

Describe what starches do to various grades of paper.

List three possible mechanisms by which wet strength resins function.

List the properties required of an internal wet strength resin.

List six paper properties improved by fillers.

Name the four most common fillers and why each is used.

Explain why alumina trihydrate is used as a filler.

List various reasons for adding colour to paper.

List four classifications of dyes.

Explain why basic dyes are important to papermaking.

Explain graniting.

List what sort of pulping residuals there might be which could interfere with functional additives.

6. Indicate a knowledge of the approach flow system.

Potential Elements of the Performance:

List seven objectives of the headbox.

Explain what determines jet velocity in open headboxes, in pressure headboxes and in hydraulic headboxes.

State the purpose of a holy roll.

Explain what hydraulic headboxes use instead of rectifier rolls.

Define jet to wire ratio, rushing, dragging and angle of impingement.

Explain velocity and pressure formation and sheet sealing.

Explain the importance of L/b ratio.

Perform headbox pressure/velocity calculations.

7. Indicate a knowledge of the former.

Potential Elements of the Performance:

Name and explain the eight variables that effect drainage.

Describe what happens in each of the four zones of the drainage table.

List the five basic requirements of a forming fabric.

Define warp, weft, twill and mesh.

Identify single layer-plain weave, twill, double later and triple layer fabrics.

Differentiate between mesh and count.

Explain the problem of a sheet with low support.

Define open area, air permeability, void volume and void volume distribution.

Explain how a table roll functions.  
Explain why some table rolls are grooved and why deflectors are sometimes installed between table rolls.  
Explain how foils operate and why they were developed.  
Explain harmonic motion on a wire.  
Explain how vacuum is controlled with a foil.  
Explain what the dry line is and what forms it.

8. Indicate a knowledge of the Cylinder Machine

Potential Elements of the Performance:

Describe the operation of a cylinder machine.  
Explain the stock flow in a counterflow vat.  
Discuss the washing action of the inlet stock.  
Discuss the driving force for the formation of the vat.  
Describe the influences of a making board and a wing board.  
Discuss end of vat dilution.  
Explain how a machine tender could change basis weight in a localized portion of the sheet.  
Explain the theory of rectifier strips.  
Name at least one advantage and one disadvantage of uniflow vats.  
Explain where maximum deposition occurs in a uniflow vat.  
Explain what a dry vat is and list two advantages.  
Discuss the advantages offered by a Hogenkamp vat.  
Define blowing, checking, crushing, drop off, cylinder wrap, felt picking, wet streaks and dirty cylinder mould face and discuss the causes of each.

9. Indicate a knowledge of Pressing.

Potential Elements of the Performance:

Discuss the primary and secondary objectives of pressing.  
Discuss the characteristics of standard roll press configurations.  
Discuss sheet transfer from the point of open and closed transfer.  
Discuss press design according to press roll type, use of textiles, configuration, long residence time and impulse drying.  
Explain the various designs of presses with long nip residence time.  
Explain Whalstrom's theory on pressing.

10. Indicate a knowledge of Drying.

Potential Elements of the Performance:

Discuss the primary and secondary objectives of drying.  
Explain the standard drying configuration.  
List the keys to good dryer section runnability.  
Discuss drying theory and what happens in each of the four phases.  
Define heat transfer and the various methods of heat transfer.  
Differentiate between heat transfer and mass transfer.  
Perform rate of heat transfer calculations.  
List and explain the three drying zones.  
Discuss the objectives of the steam and condensate system.  
Name and explain the three major control loops in the steam and condensate system.  
Name and differentiate between the two arrangements for steam and condensate removal.  
Explain the operation of a thermocompressor.  
Differentiate between stationary and rotary dryer siphons.  
Explain the use of spoiler bars.  
Explain the objectives of pocket ventilation.  
Discuss air flows and humidity in the pocket.  
Discuss the various methods of obtaining pocket ventilation.

### **III. TOPICS:**

1. Stock Preparation-Beating and Refining
2. Stock Preparation-Measurements
3. Papermaking Additives
4. Additives Used to Improve Paper Machine Performance
5. Additives Which Enhance Paper Properties
6. The Approach Flow System
7. The Former
8. The Cylinder Machine
9. Pressing
10. Drying

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

Bethune, Jack, Study Guide for PPE 240, Paper Technology I The Wet End, Draft of Private Notes, Available from Instructor.

Pevato, Kevin, Study guide for PPE 340, Paper Technology II, Pressing and Drying, Sault College of Applied Arts and Technology, Sault Ste. Marie, 1992.

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

A final grade in this course will be based on the results of four tests weighted equally.

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

<u>Grade</u>	<u>Definition</u>	<u>Grade Point Equivalent</u>
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 <i>Policies &amp; Procedures Manual – Deferred Grades and Make-up</i> ).	
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.

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.