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Course Description:
A comprehensive overview of the entire pulping and papermaking process, including statistics and trends of the industry, raw materials, pulp mill and paper mill operations, recycling, paper properties, coating, and environmental topics.

Objectives:
Upon successful completion of this course, students are expected to:

1. Gain a more complete understanding of papermaking terms, equipment, process technology, science, and engineering fundamentals, operations, and variables.

2. Learn how one part of the mill affects other operations.


4. Gain background for more advanced courses.

Methods of Learning:
Course assignments to be successfully completed by each student include:

1. Review of each and all learning module lectures.
2. Discussions with the Instructor (telephone/web)
3. Homework assignments (i.e. analysis of a problem, article)
4. Semester long project to study a topic in more depth
5. Comprehensive Final Exam (open book)

Available from TAPPI Press
Grading:

- Discussions (20%)
- Homework (20%)
- Project (20%)
- Exams (40%)

Incomplete Grades
If an Incomplete grade is received, the student will have one semester to complete all course requirements. After one semester, the incomplete automatically reverts to a grade of F.

Disability and Equal Opportunity:

"Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services Office (http://www.ncsu.edu/dso/) located at 1900 Student Health Center, Campus Box 7509, 515-7653. For more information on NC State’s policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.1.php"

"NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State’s policies and regulations covering discrimination, harassment, and retaliation may be accessed at http://www.ncsu.edu/policies/campus_environ or http://www.ncsu.edu/equal_op. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 515-3148."
WPS 595G  PULP & PAPER TECHNOLOGY  
LECTURE SCHEDULE

Modules will be viewed in the week indicated. Discussion will be scheduled by any combination of telephone (30-45 min) and e-mail the following week at a time convenient to the student and instructor.

<table>
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<tr>
<th>Week</th>
<th>Lessons</th>
<th>Topics</th>
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| 1    | 1, 2, 3 | Overview of Industry  
Wood & Fiber Supply |
| 2    | 4, 5, 6 | Wood and Fiber Properties  
Wood and Chip Preparation |
| 3    | 7, 8    | Overview of Pulping  
Kraft Pulping Equipment |
| 4    | 9, 10, 11 | Kraft Pulping Chemistry  
Kraft Variables  
Mechanical Pulping |
| 5    | 12 & 13 | Pulp Processing, Bleaching |
| 6    | 14, 15, 16 | Chemical Recovery, Recycling |
| 7    | 17, 18  | Paper & Board Properties |
| 8    | 19, 20, 21 | Refining & Additives |
| 9    | 22, 23  | Wet End Operations 1, 2 |
| 10   | 24, 25  | Wet End Operations 3, 4 |
| 11   | 26, 27  | Wet End Operations 5, Pressing |
| 12   | 28, 29  | Drying |
| 13   | 30, 31  | Calendering, Converting |
| 14   | 32, 33  | Size Press, Coating |
| 15   | 34      | Environmental |
| 15   |         | All projects & exam due. |
OVERALL COURSE LEARNING OBJECTIVES

The overall course objective is to give participants increased confidence in understanding the pulp & paper processes; to interact more knowledgeably with process engineers and operators; and increase their ability to contribute to improving mill operations by

1. Gaining a comprehensive overview of pulp & paper industry, mill operations, products, process variables, equipment, and terminology.

2. Increasing knowledge of how one part of the mill affects another, and to increase awareness of the importance of thinking on a mill wide basis.

3. Increasing knowledge of how the P&P processes affect product properties, in order to improve product quality and troubleshoot variations in quality.

4. Increasing awareness of the complex environmental challenges associated with pulp and paper manufacturing.
In order to achieve these overall learning objectives, there are learning outcomes associated with each key topic:

OVERVIEW OF INDUSTRY
1. To increase awareness of the factors that drive industry trends, and to review industry statistics about the major grades of paper and board.

2. To increase awareness of industry information sources.

WOOD & FIBER RAW MATERIALS
1. To learn about wood and fiber sources.

2. To increase knowledge about the major differences between Hardwoods and Softwoods, and important wood & fiber properties that affect paper properties.

PREPARATION OF WOOD & CHIPS FOR PULPING
1. Describe Woodyard operations including debarking, chipping, screening, storage, and recovery.

OVERVIEW OF PULPING
1. Increase general knowledge of the primary categories of pulping, including chemicals, and cooking conditions.

2. Become familiar with general pulping terminology.

3. Increase overview knowledge of the most common pulp properties and tests.

KRAFT PULPING
1. To become familiar with the major types of equipment used in Pulping.

2. To gain an overview picture of the primary operations and reactions occurring in the digesters between wood and the pulping chemicals.

3. To be able to list several major pulping variables.

4. To gain an overview of some major kraft pulping trends.

MECHANICAL AND SEMICHEMICAL PULPING
1. To gain an overview of the primary mechanical pulping processes.

2. To increase knowledge about the differences in mechanical vs chemical and hybrid pulp properties.
PULP PROCESSING
1. To gain an overview knowledge of the different operations in Fiber Line pulp processing, including Fiberizing, Washing, Screening, and Cleaning, prior to the high density (HD) chest that separates the pulp mill and paper mill.

2. To get an overview of major equipment types and key operating variables.

BLEACHING
1. To gain an overview of bleaching trends, equipment, chemicals bleaching reactions, and a general list of process variables for the major bleaching sequences.

RECYCLING
1. To increase knowledge about the categories of recycled paper and board.

2. To increase awareness of the many types of contaminants associated with recycled paper, and the problems they cause.

3. To get an overview of the different operations and equipment involved with contaminant removal.

CHEMICAL RECOVERY
1. To get an overview of the major recovery operations, including Evaporation, Combustion, and Recausticizing.

2. To increase knowledge about the composition and properties of black liquor and what happens in the evaporators and recovery units.

3. To increase understanding of how pulping liquor is regenerated in recausticizing; and to get an overview of lime kiln operations.
INTRODUCTION TO PAPER GRADES AND PROPERTIES
1. To increase understanding of important paper and board properties and tests, including strength, optical, & printing properties,

PAPER MILL STOCK PREPARATION
1. To learn about the Refining Process, primary effects on fibers; and the effects of refining on paper machine operations and paper properties.

2. To gain an overview of the primary Additives used in paper, including strength adhesives, pigments, sizing, and retention aids. A very brief look at foam and deposit control is included.

PAPER MACHINE WET END OPERATIONS
1. To learn about the stock approach system operations prior to the paper machine.

2. To increase understanding about the two main types of Headboxes used in papermaking, and their internal operations to produce a uniform jet of stock to the wet end.

3. To visualize the sheet forming process, slice operations, fiber orientation, formation, microturbulence, dewatering, and sheet structure variations.

4. To increase awareness about the differences in sheet forming operations, and paper properties between Fourdriniers, Twin Wire Gap and Hybrid formers, and multiply board machines.

5. To gain an overview examination of Forming Fabrics.

PRESSING
1. To gain an overview of the different types of press section configurations, and what happens in a press nip.

2. To visualize what happens to the sheet during pressing.

3. To examine several pressing variables and trends.
DRYING
1. To gain an overview of drying operations, including dryer can internal operations with steam and condensate, major water removal rate differences, and major equipment & operating variables that affect rate of drying.

2. To increase understanding of how drying and sheet shrinkage affect paper and board properties; and the role of felts, draw, and sheet restraint.

3. To get an overview of Tissue Machine Yankee Drying and Creping Operations.

CALENDERING & WINDING
1. To increase understanding of the different types of calenders.

2. To examine what happens to sheet properties, by examining the major calendering variables.

3. To briefly describe Winding and roll finishing operations.

SURFACE TREATMENTS
1. To increase awareness of the on machine size press operations, including equipment types, and the variables that affect starch pick up in the size press.

2. To increase awareness of the primary components in a Coating, including pigments, adhesives, and additives.

3. To increase awareness of the differences between Roll, Air Knife, and Blade Coaters.

4. To describe the drying of coating, equipment and mechanism.

EFFLUENT TREATMENT
1. Throughout the course, air and effluent emissions and control were discussed as part of each process operation. This final topic gives an overview of what happens in primary and secondary effluent treatment.