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220232 - Paper Manufacturing Technology and Derivatives

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 717 - EGE - Department of Engineering Presentation
Academic year: 2019
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Cusola Aumedes, Oriol

Degree competences to which the subject contributes

Specific:

4. Ability to select and evaluate various sources of vegetable fibers suitable for the manufacture of fibrous materials (biomaterials, pulp and paper) with certain technical characteristics.
1. Ability to analyze, implement and project the main unitary operations and systems which compose manufacturing processes of fibrous materials (biomaterials, core and paper).
2. Ability to analyze and evaluate the physical, mechanical and optical properties about specific fibrous materials (biomaterials, core and paper).
3. Ability to develop new types of paper or paper products according to their specifications and specific technical applications.

Teaching methodology

Methodology is divided in three main parts:
· Lectures for theoretical issues.
· Working sessions (exercises and problem solving and and facilities visit).
· Self-study, exercises and activities.
Theoretical sessions will be used to present and develop the theoretical foundations of the subject, also the concepts and methods, and finally appropriate examples to facilitate understanding.
Practical sessions in the classroom will provide students the ability to apply theoretical concepts to problem solving, always based on critical thinking. Coursework will promote the contact and use of the basic tools needed to solve problems.
Students will work in autonomous way on material provided by the teachers and also on the results of the working sessions to definitively fix the theoretical concepts. Teachers will provide a study guide through ATENEA.

Learning objectives of the subject

At the end of the course the student should:

Having the theoretical knowledge related to papermaking unit operations.

Having the knowledge and skills to analyze and design the manufacturing processes of different types of paper from different types of pulps and recycled papers (old papers), as well as the operations related to the conversion of paper.

Having the knowledge and skills to perform the verification and control of facilities, processes and systems whose purpose is the manufacture of paper and related operations.

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Study load

Total learning time: 125h	Hours large group:	30h	24.00%
	Hours small group:	15h	12.00%
	Self study:	80h	64.00%

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Content

Unit 1. Introduction to paper manufacturing

Learning time: 4h
Theory classes: 1h
Self study : 3h

Description:
Introduction. Raw materials. Definition of paper. Paper types and classification. Raw materials. General scheme of a paper mill.

Related activities:
Realization of a scientific-technical work on features and technological properties of different types of papers.

Unit 2: Preparation of stock for papermaking

Learning time: 30h
Theory classes: 8h
Laboratory classes: 3h
Self study : 19h

Description:
Fiber suspensions circuits from virgin pulp: disintegration, agitation and refining. Design data and calculation examples.
Characteristics of recycled fibres. Pulp production circuits adapted for paper recycling: disintegration, sieving, liquid cyclone and de-inking systems.

Related activities:
Material balances applied to papermaking circuits. Design of pulp suspensions circuits.
Delivery of proposed problems.

Unit 3. Approach system and sheet forming process

Learning time: 16h
Theory classes: 5h
Laboratory classes: 1h
Self study : 10h

Description:
Stock flow operations and approach system. Water and stock circuits (primary, secondary and tertiary).
Overview systems sheet formation. Fundamentals of sheet formation by filtration. Industrial systems for sheet formation: Fourdrinier; Cylinder mold machines; Twin wire forming; Hybrid formers. Properties of paper related with this part of the process.

Related activities:
Design of approach system circuits.
Delivery of proposed problems.

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Unit 4. Press section	Learning time: 9h Theory classes: 3h Self study : 6h

Description:
Pressing fundamentals. Types of presses . Balances in the press section. Paper properties related to this part of the process.

Unit 5. Paper drying	Learning time: 29h Theory classes: 5h Laboratory classes: 4h Self study : 20h

Description:
Fundamentals of paper drying. Overview of paper drying systems. Multi Cylinder drying section. Steam supply and condensate removal. Hood and ventilation systems. Balances in the drying section. Other industrial drying systems. Final paper properties related to this process.

Related activities:
Physical properties of moist air. Psychrometry. Matter and energy balances in the drying process. Design a drying unit.
Delivery proposed problems.

Unit 6. Paper converting	Learning time: 13h Theory classes: 4h Laboratory classes: 1h Self study : 8h

Description:
Paper finishing: Physical treatments (calendering, creping, embossing, etc.). Physico-chemical treatment (surface sizing, coating, etc.).

Related activities:
Power requirements to drive paper machines.
Delivery of proposed problems.

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Unit 7. Reduction of environmental impact of the manufacture of paper	Learning time: 24h Theory classes: 4h Laboratory classes: 6h Self study : 14h

Description:
Study of the environmental impact of paper production process: water pollution abatement. Definition and overview of the water circuits of a paper mill. Internal treatment systems. Characterization of wastewater from papermaking processes. Overview of treatment systems wastewater from a paper mill. Design data and calculation examples.

Related activities:
Design of water units process and wastewater treatment. Paper mill visits in order to make an approach to the industrial reality of the manufacturing processes.
Delivery of proposed problems and report paper mill visits.

Qualification system

The final mark is based on the following evaluative acts:
- Activity 1 (control knowledge written test): Midterm Exam: 35%
- Activity 2 (Evaluation of resolution of case studies and work with individual reports and oral presentations): problems and practical cases: 30%
- Activity 3 (control of knowledge written test): Final exam: 35%
The unsatisfactory result in the midterm exam (Activity 1) may be redirected by a written test on the day set for the final exam (Activity 3). Students who didn't assist at the midterm exam (Activity 1) or with a grade lower than 5.0 in the midterm exam (Activity 1) can access this test. The grade obtained in the redirected test will replace the initial grade as long as it is higher.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

Bibliography

Basic:

Ek, M.; Gellerstedt, G.; Henriksson, G. (eds.). Pulp and paper chemistry and technology. Berlin: De Gruyter, cop. 2009. ISBN 9783110213430.

Professorat de l'assignatura. Apunts lliurats pel professorat.

Complementary:

Smook, Gary A. Handbook for pulp & paper technologists. 3rd ed. Vancouver [etc.]: Angus Wilde, cop. 2002. ISBN 0969462859.

Paulapuro, Hannu. Papermaking. Helsinky: Fapet Oy, cop. 2000-. ISBN 9789525216004.

Göttschling, G.; Pakarinen, H. Recycled fiber and deinking. Helsinky: Fapet Oy, cop. 2000. ISBN 9525216071.