Course guide
205124 - 205124 - Colloids, Interfaces and Nanoscale Engineering

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Justin Zoppe

Others: Farayde Matta Fakhouri

TEACHING METHODOLOGY

The course is divided into 3 parts:
1) Theory classes - teachers will introduce the theoretical basis of the concepts, methods and results and illustrate them with appropriate examples, hands-on experiments and demonstrations to facilitate their understanding.
2) Practical classes - teachers guide students (in the classroom) in applying theoretical concepts to solve problems, always using critical reasoning. We propose that students solve exercises in and outside the classroom, to promote contact and use of the basic tools needed to solve problems.
3) Self-study for doing exercises and activities - Students, independently, need to work on the materials provided by teachers and the outcomes of the sessions of exercises/problems, in order to reinforce and assimilate the concepts. The teachers provide the syllabus and monitoring of activities (by ATENEA).

LEARNING OBJECTIVES OF THE SUBJECT

This course offers students an opportunity to extend their academic and technical education through examination of colloidal and interfacial phenomena, e.g., fluid-fluid, solid-liquid interfaces, colloidal dispersions, emulsions and foams, and their importance in various industries and emerging nanotechnologies. Some of the relevant industrial applications include:

- Processing of food emulsions
- Aircraft deicing
- Separation of crude oil from oil sands
- Stability of a multiphase consumer products
- Mineral flotation
- Recycled paper deinking
- Paint and coating formulation
- Printing inks
- Heterogeneous catalysis reactors
- Fluid-lubricated systems
- Nanofabrication of micro-electromechanical systems (MEMS), optical, microfluidics, and biotechnological devices

The specific learning objectives are:

1) To introduce colloidal and interfacial phenomena and discuss the relevance of interfaces in heterogeneous systems, their structure and stability.
2) To describe the effect of intermolecular and surface forces in dispersion stability, capillary effects and interfacial behavior.
3) To determine the structures that result from molecular adsorption at interfaces.
4) To introduce surface characterization techniques.
5) To introduce emerging colloid-related technologies in nanofabrication and nanostructured materials.
6) To explain the fundamentals in emulsion, foam and dispersion formulation.

STUDY LOAD

Type	Hours	Percentage
Hours large group	16,5	22.00
Self study	48,0	64.00
Hours small group	10,5	14.00

Total learning time: 75 h

CONTENTS

Module 1: Introduction and Fluid Interfaces

Description:
Introduction to colloids, interfaces and nanoscale engineering
Industrial importance of interfacial phenomena
Interfacial tension
Capillarity
Measurement of surface and interfacial tension

Full-or-part-time: 11h
Theory classes: 2h 30m
Laboratory classes: 1h 30m
Self study : 7h

Module 2: Surfactants and Polymers in Fluids

Description:
Surfactant solutions and micellization
Hydrophilic-lipophilic balance (HLB)
Polymer solutions and phase behavior
Interactions between polymers and surfactants

Full-or-part-time: 11h
Theory classes: 2h 30m
Laboratory classes: 1h 30m
Self study : 7h

Module 3: Solid-Liquid Interfaces

Description:
Intermolecular and surface forces
Adsorption of surfactants and polymers on solid surfaces
Adsorption isotherms
Contact Angle
Wetting, spreading and adhesion
Particles at interfaces
Surface characterization techniques

Full-or-part-time: 19h 30m
Theory classes: 4h 30m
Laboratory classes: 2h 30m
Self study : 12h 30m

Module 4: Colloidal Systems

Description:
Preparation of dispersions and morphology of colloids
Interactions between colloid particles
Derjaguin-Landau-Verwey-Overbeek (DLVO) theory
Sedimentation and aggregation
Nanoparticles and nanostructured materials
Colloidal liquid crystals
Colloidal nanofabrication

Full-or-part-time: 19h 30m
Theory classes: 4h
Laboratory classes: 3h
Self study : 12h 30m

Module 5: Emulsions and Foams

Description:
Formulation Engineering
Coalescence and breakup
Emulsion and foam stability
Pickering emulsions

Full-or-part-time: 14h
Theory classes: 3h
Laboratory classes: 2h
Self study : 9h

GRADING SYSTEM

The final grade of the course will depend on the following evaluation activities:
1) Four Problem Sets: 40%
2) One written report/oral presentation in groups of a minimum of 2 students and a maximum of 4 students: 35%
3) One Final Exam: 25%

BIBLIOGRAPHY

Basic:
- Berg, John C. An introduction to interfaces & colloids: the bridge to nanoscience. Singapore; Hackensack, N.J.: World Scientific, cop. 2010. ISBN 9789814299824.
- Evans, D. Fennell. The colloidal domain: where physics, chemistry, biology, and technology meet. 2nd. ed. New York, NY: VCH Publishers, cop. 1999. ISBN 0471242470.

Complementary:
- Israelachvili, Jacob N. Intermolecular and surface forces [on line]. 3rd ed. Amsterdam: Academic Press, 2011 [Consultation: 28/05/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=716265. ISBN 9780123751829.
- Myers, Drew. Surfaces, interfaces, and colloids: principles and applications. 2nd ed. Wiley, 1999. ISBN 9780471330608.

RESOURCES

Other resources:
Selected representative articles relevant to the modules covered in class will be provided (by ATENEA).