Course guide
205278 - 205278 - Applied Research Methods in Engineering Science

Last modified: 05/06/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

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

LECTURER

Coordinating lecturer: Gamez Montero, Pedro Javier

Others:

TEACHING METHODOLOGY

Large group
As learner-centred teaching, in the face-to-face presentation sessions, the lecturer will introduce the theoretical basis of the subject, concepts, methods, and results, illustrating them with convenient examples to facilitate the students understanding, attitudes and problem-solving abilities. Theory classes combine the expository method and active learning and are directly related to Activity 1, and in particular, challenge-based learning in case studies, examples, and applications related to Activity 2 and 4 will be worked on.

Autonomous Learning
Students should autonomously study and exercise to assimilate and learn the concepts and solve the proposed exercises either manually or with the help of the computer. The activities programmed outside the classroom will be designed to serve as self-learning, carrying out evaluable activities and solving the questionnaires.

LEARNING OBJECTIVES OF THE SUBJECT

'Applied Research Methods in Engineering Sciences' intends to be a cross-cutting subject for all undergraduate studies and is designed for undergraduate students, which in turn aligns with postgraduate courses and research degrees, as it is understood that the earlier undergraduate students have this vision, the more guidance they will have for degrees across a broad range of academic disciplines. With the aim of providing comprehensive training for an applied research and development activity for young engineers, it would integrate the branches of engineering, engineering ethics, soft skills with touches of art, reading, the humanities, the social sciences, and a professional approach to face the most demanding challenges and advance in today's global society.

What is expected from this holistic education view is the exchange of culture maps and internationalization at home, which are needed in engineering more than ever. The outcomes include knowledge of research methods for engineers and good engineering practices, how to read (papers, normative, standards, patents), elaborate a literature review, technical writing and ethics, prepare a research presentation, write a research funding proposal, data management, navigate in professional associations, and so on, which are applied to engineering as a combination of hands-on, low-tech, holistic, scientific work and sustainability.

The course will be closely linked to actual FAIR principals and sustainability (planetary boundaries) and is accompanied by in-depth teaching modules tailored to the selected majors.

After completing the course, the general learning objectives of the subject are:

Technology and research in the field of specialty
- Understand the engineering research foundations
- Describe what engineering research is and its associated challenges and opportunities in different disciplines.
- Know how to use the technology and the necessary engineering,
- Explain each phase of engineering research: the literature study, the theoretical and conceptual frameworks, the experimental and study design, the choice of research methods and data collection, the data analyses and the interpretation, validation and verification of the results and discussions of the outcome.

Professional performance
- Analyze specific situations, define problems, make decisions, and implement plans of action in the search for solutions.
- Apply knowledge to real situations, managing resources appropriately.
- Interpret studies, reports, and analyze data numerically.
- Select and manage the information sources.
- Use existing tools as support.
- Working in a multidisciplinary team.
- Evaluate the integral, personal motivation and mobility.
- Explain the importance of research ethics, data management, and guidelines for human research ethics in your research design and practice

Communication
- Understand and speak with the proper terminology.
- Write a research plan, including formulating a research objective and research question, research set-up, planning and reflection
- Discuss and argue on various forums.

Technology transfer.
- Analyze and evaluate the environmental, social and ethical profession.
- Have a critical and innovative spirit.
- Retraining in new technological developments through continuous learning.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Module 1: INTRODUCTION TO APPLIED RESEARCH METHODS IN ENGINEERING

Description:
1.1. What is engineering? Science, technology, and engineering. The primary commitment of engineering.
1.2. Who is an engineer? What do engineers do? What can engineers do? How are engineering decisions made? Why engineers are not scientists.
1.3. What engineers call “engineering science”. Engineering habits of mind.
1.4. Why should engineers be ethical?
1.5. Ethics and engineering context. Professional autonomy and associations.
1.6. Philosophy of research and key concepts.
1.7. Why engineering research?
1.8. Structure of research: scientific method, engineering design cycle, and language of research.
1.9. Planning research, research design, and development: a framework.
1.10. What a research objective and a research question are, and how to formulate them.

Related activities:
Activities from 1 to 4.

Full-or-part-time: 18h 45m
Theory classes: 7h 30m
Self study : 11h 15m

Module 2: EFFECTIVE READING PRACTICES FOR ENGINEERING RESEARCH ARTICLES

Description:
2.1. An overview of science, engineering, and research literature.
2.2. Types of publications: scientific and technical documents (normative, standards and, patents).
2.3. The language game.
2.4. English as the lingua franca of science and technology.
2.5. Telling the story.
2.6. Innovation: one word.
2.7. Anatomy of a research article.
2.8. How to read a paper. A three-pass approach.
2.9. Am I grasping the paper?
2.10. Advice, and finding research articles.

Related activities:
Activities from 1 to 4.

Full-or-part-time: 18h 45m
Theory classes: 7h 30m
Self study : 11h 15m

Module 3: DATA AND SUSTAINABILITY

Description:
3.1. What constitutes conclusive proof?
3.2. Correlation vs. causation. Positive, negative, significant, and null results.
3.3. Data collection methods and data management (FAIR).
3.4. Qualitative and quantitative data analysis.
3.5. Survey research methods.
3.6. Climate action and policies: Green Deal.
3.7. Linear, circular, and 'doughnut' economics.
3.8. Planetary boundaries and product carbon footprint (ISO 14067:2018).
3.9. The culture map and the internationalization in higher education.
3.10. The strategic plan and the SDGs of the UPC.

Related activities:
Activities from 1 to 4.

Full-or-part-time: 18h 45m
Theory classes: 7h 30m
Self study : 11h 15m

Module 4: WRITING, COMMUNICATING AND DISSEMINATING

Description:
4.1. Scientific publishing, communicating, and disseminating: thesis, project, and research.
4.2. Conducting a literature search and review. Standard terms.
4.3. Paper preparation: title, keywords, and writing an abstract.
4.4. Standard research: hypotheses and research questions, research argumentation, concepts, and results.
4.5. How to reply to referees' comments.
4.6. Preparing an oral presentation: being an effective communicator, crystal clear, and using positive body language.
4.7. Thesis, conference, and poster presentations.
4.8. Why take on a research project? Developing a research plan and designing for outcomes.
4.9. Quotation (financial estimate) to undertake the work and allocate further funds.
4.10. Project management.

Specific objectives:
Activities from 1 to 4.

Full-or-part-time: 18h 45m
Theory classes: 7h 30m
Self study : 11h 15m

ACTIVITIES

ACTIVITY 1. ACTIVE LEARNING IN THE CLASSROOM

Description:
Active learning in the classroom in order to enhance motivation, reinforce critical thinking and activate learning, thus adapting to the specific needs of the classroom, among others, such as:
- In-house-designed paper and pencil didactic games and delivered on photocopies / slides (word searches, crossword puzzles, the N differences, pairing, etc.)
- Multiplatform electronic mobile learning and gamification tools
- H5P interactive resources for web learning (open and completely free technology)
- Other tools and resources available

Material:
Photocopies, multiplatform tools, applications, interactive resources, etc.

Delivery:
The activities are carried out, commented and corrected in the classroom between students, peer work, and between lecturer and students. These activities are graded and accounts for 25% of the total mark.

Full-or-part-time: 15h
Theory classes: 15h

ACTIVITY 2. CASE STUDY/PROBLEMS/APPLICATIONS

Description:
Basic exercises and cases are presented in the theoretical documentation of the subject. Problems, case studies and proposed applications to solve in class. The statements of the case studies, problems and applications are discussed, previously prepared by the instructor, in class.

Material:
Photocopies, multiplatform tools, applications, interactive resources, etc.
Book of the subject on Campus ATENEA.

Delivery:
The resolution of the case study, exercise, problem or application include the rationale, discussion and conclusions. Each section should always include a small explanation to reason and argue the steps that have been taken.
These activities are graded and accounts for 25% of the total mark.

Full-or-part-time: 15h
Theory classes: 15h

ACTIVITY 3. SELF-LEARNING QUESTIONNAIRES

Description:
Individual, multiple-choice questionnaires of conceptual exercises are part of autonomous learning.

Material:
A computer-based online multiple-choice individual quiz featuring numerical answers, is administered via the ATENEA platform.

Delivery:
Each questionnaire is graded and the this activity accounts for 25 % of the total mark.

Full-or-part-time: 15h
Self study: 15h

ACTIVITY 4. WRITING, COMMUNICATING AND DISSEMINATING

Description:
Developing and writing a draft of a project plan based on a multidisciplinary research case where students can choose from which discipline, they approach the problem. The basic tasks will be conducting a basic literature search and review, paper preparation (title, keywords, and writing an abstract), and planning an oral presentation.

Material:
Photocopies, multiplatform tools, applications, interactive resources, etc. Book of the subject on Campus ATENEA.

Delivery:
You have to hand in a portfolio of three pieces of work (literature review, paper preparation and oral presentation) of maximum 2000 words at the end of the course. This activity is graded and accounts for 25 % of the total mark.

Full-or-part-time: 30h
Self study: 30h

GRADING SYSTEM

The outline of the course is defined and presented at the first lecture, together with the activities and the timeline. All activities will be carried out week by week with formally integrated continuous student feedback, together with specific and detailed programming. The multiple-choice questionnaires for conceptual exercises are individual activities part of autonomous learning.
Continuous assessment in the subject: there is neither a midterm nor a final exam. The formative assessment course finishes with the last lecture, and the final mark of the subject is the sum of the four activities:
Activity 1. Active learning in the classroom, accounts for 25% of the total mark.
Activity 2. Case study/problems/applications, accounts for 25% of the total mark.
Activity 3. Self-learning questionnaires, accounts for 25% of the total mark.
Activity 4. Writing, communicating and disseminating, accounts for 25% of the total mark.
On the last lecture, each student will know their final mark on the subject.

BIBLIOGRAPHY

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