# Course guide
# 320045 - PSSP - Planning, Simulation and Supervision of Industrial Processes

**Last modified:** 02/04/2024

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| **Unit in charge:** | Terrassa School of Industrial, Aerospace and Audiovisual Engineering |
| **Teaching unit:** | 707 - ESAII - Department of Automatic Control. |

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| **Degree:** | 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 TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject). |

**Academic year:** 2024    **ECTS Credits:** 6.0    **Languages:** English

## LECTURER

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| **Coordinating lecturer:** | Albert Masip-Alvarez |
| **Others:** | Albert Masip-Alvarez |

## PRIOR SKILLS

Basic programming.

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
CE25. ELO: skills for The modelling and simulation of systems.

CE28. ELO: Applied knowledge of industrial computing and communications.

CE1. (ENG) Capacitat per a la resolució dels problemes matemàtics que puguin platenjar-se a l'enginyeria. Aptitud per aplicar els coneixements sobre: àlgebra lineal; geometria, geometria diferencial; càlcul diferencial i integral; equacions diferencials i amb derivades parcials; mètodes numèrics; algorítmica numèrica; estadística i optimització.

**Transversal:**
04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

## TEACHING METHODOLOGY

- On-site lectures for the explanation of the contents.
The lecturer introduces the theoretical basis of the subject during on-site lectures. Basic concepts, methodology and results are developed during the sessions, being illustrated by means of examples in order to make them more understandable.
- On-site sessions for practice.
The students will aboard the tasks in the laboratory by means of a computer.
- Autonomous work and exercises solving.
The students, autonomously, shall assimilate the main concepts and resolve the stated exercises.
- Preparation and implementation of evaluable group activities.
Student groups will make two oral presentations on its resolution of certain exercises in order to contribute to the assessment of the oral part of generic competence Third Language (English). The assessment of these presentations will be carried out by means of peer-to-peer techniques under lecturer's supervision.

## LEARNING OBJECTIVES OF THE SUBJECT

The final objective of the subject is to integrate the different themes that are developed on a real mobile robot in the laboratory. To achieve this goal on the robot, specific partial learning objectives are defined:
- Understanding and mastery on basic skills, principles and applications of systems planning, simulation and process monitoring and supervision.
- The ability for the analysis, synthesis and troubleshooting of planning, simulation and process monitoring and supervision.
- The ability for the selection of the elements involved in the process of planning, simulation and monitoring.
- Design and programming of planners, supervisors and process simulators.
- The ability to integrate planning systems, simulation and monitoring within the industrial production environments.

## STUDY LOAD

| Type | Hours | Percentage |
|------|-------|------------|
| Hours large group | 30,0 | 20.00 |
| Hours small group | 30,0 | 20.00 |
| Self study | 90,0 | 60.00 |

**Total learning time:** 150 h

## CONTENTS

**Process description. Petri Nets**

**Description:**
Petri Nets for process description, Dependencies, Conditions, Parallel Tasks, States and Transitions.

**Specific objectives:**
Describe several example processes by means of Petri Nets.

**Related activities:**
Describe the classic problem of the "Dining Philosophers" and discuss about the implications of resource sharing.

**Related competencies :**
CE25. ELO: skills for The modelling and simulation of systems.

04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

**Full-or-part-time:** 20h
Theory classes: 4h
Laboratory classes: 4h
Self study : 12h

## Modelling and Simulation. Discrete events models.

**Description:**
Entities and Attributes. Queues. Routes. Servers. Timers. Factorial design.

**Specific objectives:**
Translate Petri Nets into simulation models for discrete event systems.

**Related activities:**
Build simulation models for discrete events systems. Simulate the problems of the philosophers and the emergency stage at the hospital.

**Related competencies :**
CE25. ELO: skills for The modelling and simulation of systems.

04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 20h
Theory classes: 4h
Laboratory classes: 4h
Self study : 12h

## Discrete Optimisation

**Description:**
Cost function. Optimisation array. Constraints. Branch and Bound Algorithm.

**Related activities:**
Workplace Assignment; Tasks Assignment; Automatic Solving of SUDOKUS.

**Related competencies :**
CE01. (ENG) Capacitat per a la resolució dels problemes matemàtics que puguin platenjar-se a l'enginyeria. Aptitud per aplicar els coneixements sobre: àlgebra lineal; geometria, geometria diferencial; càlcul diferencial i integral; equacions diferencials i amb derivades parcials; mètodes numèrics; algorítmica numèrica; estadística i optimització.
CE28. ELO: Applied knowledge of industrial computing and communications.

04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
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**Full-or-part-time:** 35h
Theory classes: 7h
Laboratory classes: 7h
Self study : 21h

## Planning

**Description:**
Path planning. Production planning.

**Specific objectives:**
Greedy, Dijkstra and A* algorithms for pathfinding. Production planning by means of optimisation techniques.

**Related activities:**
Programming of the GREEDY pathfinding algorithm.

**Related competencies :**
CE01. (ENG) Capacitat per a la resolució dels problemes matemàtics que puguin platenjar-se a l'enginyeria. Aptitud per aplicar els coneixements sobre: àlgebra lineal; geometria, geometria diferencial; càlcul diferencial i integral; equacions diferencials i amb derivades parcials; mètodes numèrics; algorítmica numèrica; estadística i optimització.
CE28. ELO: Applied knowledge of industrial computing and communications.

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**Full-or-part-time:** 40h
Theory classes: 8h
Laboratory classes: 8h
Self study : 24h

## Supervision

**Description:**
Process supervision. Supervision System Tasks. Communications. Integration.

**Related activities:**
Coding of supervision systems: one for the emergency stage simulation model and another one for a real application with a specific mobile robot in the laboratory.

**Related competencies :**
CE28. ELO: Applied knowledge of industrial computing and communications.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 35h
Theory classes: 7h
Laboratory classes: 7h
Self study : 21h

## GRADING SYSTEM

- Exams (theoretical and laboratory contents): 50%
- midterm: 25%
- final: 25%
- Theoretical and laboratory deliverables: 30%
- Two video presentations: 10% each (10%+10%=20%)

In order to return the unsatisfactory results of the midterm exam you have the chance of doing, in the act of evaluation of the second exam, a final exam that includes the contents of the first and second parts of the subject. All the students can accede to this modality. The grade of this final exam corresponding to the issues of the first part will replace that obtained in the first part only if it is higher.

Whoever wants to opt for this mechanism of renewal can do it by previous enrollment in the Digital Campus of the subject until 48 hours before the date of the final examination. Laboratory practice marks are excluded from this re-engaging mechanism.

## EXAMINATION RULES.

Written exams will be individually resolved.

The rest of activities that contribute to the assessment of the subject will be performed gathered in groups; the marks obtained by the group members may differ in those cases where their efforts and performances are manifestly different.

## BIBLIOGRAPHY

**Basic:**

- Masip Álvarez, A.; Damunt Masip, J. Planning, simulation and supervision of industrial processes (Classnotes). Terrassa: UPC, 2015.
- Pinedo, Michael L. Planning and scheduling in manufacturing and services [on line]. 2nd ed. New York: Springer, 2009 [Consultation: 11/05/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-1-4419-0910-7. ISBN 1441909109.

## RESOURCES

**Hyperlink:**

- MATLAB. Creating Graphical User Interfaces. http://www.mathworks.com/help/pdf_doc/matlab/buildgui.pdf

**Other resources:**

Not defined