UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

COURSE SYLLABUS 2016-2017

SUBJECT DATASHEET

Course information	
Name	Fire Dynamics
Code	DIM-OPT-628
Degree	Master in Industrial Engineering
Year	Second
Semester	Second (Spring)
ECTS credits	3
Type	Elective
Department	Mechanical Engineering
Area	Mechanical
Coordinator	Pablo Ayala Santamaría

Instructor information	
Instructor	
Name	Pablo Ayala Santamaría
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Area	Mechanical
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SPECIFIC SUBJECT DATASHEET

Subject contextualization

Contribution to the professional profile of the Title

This course provides the student with a broad overview of fire dynamics, comprising the relevant variables of fire growth and spread. Basic principles of fire dynamics will be used to analyze their influence on the behavior of structures.

The production and movement of smoke within enclosures will also by studied, focusing on smoke management systems.

Zone models and field models (CFD) will be also introduced. Fire Dynamics Simulator (FDS) will be used to implement and model basic fire scenarios.

Fire tests and experimental techniques will also be presented. Their comparison with numerical models will be analyzed.

Pre requirements

There are not any pre requirement needed to study the subject. However basic Heat Transfer and Fluid Mechanics knowledge will be a good asset.

THEME SEGMENT AND CONTENTS

Contents – Theme segments
THEME 1: Introduction to Fire
Unit 1: Introduction to fire dynamics
1.1 Fire in History **1.2** Introduction to Heat and Mass Transfer **1.3** Introduction to Fluid Mechanics **1.4** Thermochemistry **1.5** Premixed and Diffusion Flames **1.6** Spontaneous Ignition
Unit 2: Combustion of solid and liquid fuels
2.1 Ignition of liquids **2.2** Ignition of solids
THEME 2: Fire Dynamic Simulation
Unit 3: Production of smoke
3.1 Numerical tools **3.2** Fire Dynamic Simulation **3.2** Fire Scenarios
THEME 3: Fire Spread and Fire Plumes
Unit 4: Fire spread
4.1 Surface Flame Spread **4.2** Solid Surface Spread
Unit 5: Fire plumes
5.1 Buoyant Plumes **5.2** Combustion Plumes **5.3** Temperatures **5.4** Entrainment rate **5.5** Flame height **5.6** Jet flames
THEME 4: FIRE IN ENCLOUSRES
Unit 6: Compartment fires
6.1 Phases of fires in enclosures **6.2.** Zone modelling **6.3.** Fire and Structures
THEME 5: SMOKE
Unit 7: Production of smoke
7.1 Movement of smoke **7.2** Fire Testing and Analysis

Competences – Learning Outcomes
Competences
General Competences

CG1. To have appropriate knowledge about the scientific and technological aspects of: mathematical, analytical and numerical methods in engineering, electrical engineering, power engineering, chemical engineering, mechanical engineering, continuum mechanics, industrial electronics, automation, manufacturing, materials, quantitative methods management, industrial computing, planning, infrastructure, and so on.
General and Basic Competences
CB2. Knowing how to apply and integrate their knowledge, understanding these, its scientific basis and troubleshooting capabilities in new and imprecisely defined environments, including multidisciplinary contexts both researchers and highly skilled professionals.
Learning outcomes
At the end of the course students should be able to: LO1. To have an overview of the processes involved in fire dynamics. LO2. To know the mechanisms of ignition in both liquids and solids and how fire is spread. LO3. To simulate simple fire scenarios. LO4. To recognize the different fire plumes, how they develop and how to quantify their main properties. LO5. To understand the behavior of fire in enclosures and its effect on structures. LO6. To know the production and smoke motion due to a fire. LO7. To have an overview of fire testing and the analysis of the measurements.

TRAINING METHODOLOGY

Subject methodological aspects	
In-class methodology: Activities	**Competences**
1. **Lectures.** The teacher will explain basic concepts for every theme showing the more important aspects. Special attention to be paid with equations and how to use. Examples will be presented, discussed and solved to complete the understanding. **(23 hours)**.	**CG1**
2. **In-class case discussion and problem solving.** Students will discuss the cases and problems proposed by the teacher. Cases will be open challenges that can be analyzed and solved by the use of the concepts already presented in class. **(3 hours)**.	**CB2**
3. **Team Work projects**. The teacher will ask for team works of any proposed matter, using Fire Dynamic Simulator. Students will have to look for additional documentation to what was shown in class. Students must justify their conclusions and add value with their engineering mind. These works will be public presented in class. **(2 hours).**	**CB2**
4. Assessment. A written and individual exam will be done in the last session of the course. **(2 hours).**	**CB2**
Distance Methodology: Activities	**Competences**
Main target of the distance Works is to be able to understand theoretical concepts and to be able to apply them.	
1. **Self-learning on the concepts presented in class**. Material to be used are slides, multimedia files, personal and teacher notes, recommended books and magazines. **(23 hours).**	**CG1**
2. Cases study. To be revised and updated with the rest of information given in the subject. **(6 hours).**	**CB2**
3. Team Works. Preparation and presentation of team Works. Students must find the information sources to create outstanding works. **(16 hours).**	**CB2**
4. Exam preparation. Students will prepare the final exam based on the provided material and the adquired knowledge. **(15 hours).**	**CB2**

	IN-CLASS ACTIVITIES					DISTANCE ACTIVITIES				Learning Outcomes	
Week	**h/s**	**Lectures and problem solving**	**Simulation**	**Presentation**	**Exam**	**h/s**	**Self-learning of concepts presented in class**	**Solving problems**	**Project preparation**	**Learning Outcomes**	**Description**
1	**2**	Theory of Unit 1 (2 hours)				**2**	Unit 1 (2 hours)			LO1	To have an overview of the processes involved in fire dynamics.
2	**2**	Problems of Unit 1 (2 hours)				**3**	Unit 1 (1 hour)	Unit 1 (2 hours)		LO1	To have an overview of the processes involved in fire dynamics.
3	**2**	Theory of Unit 2 (1 hour) Problems of Units 1 and 2 (1 hour)				**3**	Unit 2 (1 hour)	Unit 2 (2 hours)		LO2	To simulate simple fire scenarios.

4	**2**	Theory of Unit 3 (2 hours)				**3**	Unit 3 (3 hours)			LO3	To know the mechanisms of ignition in both liquids and solids and how fire is spread.
5	**2**	Theory of Unit 4 (1/2 hour) Theory of Unit 5 (1/2 hour)			Mid-term exam (1 hour)	**4**	Unit 4 (1 hours) Unit 5 (1 hour)	Unit 5 (2 hour)	Work description and topic delivery to the students. Students can propose alternative works which should be approved by instructor	LO4	To recognize the different fire plumes, how they develop and how to quantify their main properties
6	**2**	Theory of Unit 5 (1 hour)	Unit 5 (1 hour)			**4**	Unit 5 (1 hour)	Unit 5 (2 hours)	Working on project (1 hour)	LO3 L04	To understand the behavior of fire in enclosures and its effect on structures.

7	**2**	Theory of Unit 6 (1 hour)	Unit 6 (1 hour)			**4**	Unit 6 (1 hour)	Unit 6 (2 hour)	Working on project (1 hour)	LO3 LO5	To know the production and smoke motion due to a fire.
8	**2**	Theory of Unit 7 (1 hour)	Unit 7 (1 hour)			**3**	Unit 7 (1 hour)	Unit 7 (1 hour)	Working on project (1 hour)	LO3 LO6	To have an overview of fire testing and the analysis of the measurements.
9	**2**	Theory of Unit 7 (1 hour)	Unit 7 (1 hour)			**4**	Unit 7 (1 hour)	Unit 7 (2 hour)	Working on project (1 hour)	LO3 LO7	To have an overview of fire testing and the analysis of the measurements.
10	**2**	Theory of Unit 8 (1 hour)	Unit 8 (1 hour)			**5**	Unit 8 (1 hour)	Unit 8 (2 hour)	Working on project (2 hour)	LO3 LO7	
11	**2**	Theory of Unit 8 (1 hour)	Unit 8 (1 hour)			**5**	Unit 8 (1 hour)	Unit 8 (1 hour)	Working on project (3 hour)	LO3 LO7	

12	**2**		Unit 8 (2 hours)			**5**		Unit 8 (1 hour)	Working on project (4 hours)	LO3	
13	**2**		Unit 8 (2 hours)			**5**			Working of Final Report (5 hours)	LO3	
14	**2**			Project presentations (2 hours)		**5**	Exam preparation (5 hours)				
15	**2**				End term exam (2 hours)	**5**	Exam preparation (5 hours)				

ASSESSMENT AND SCORING CRITERIA

Assessment activities	Criteria	Weight
Performing exams: • Mid-term exam • End of term exam	- Concepts understanding. - Use of concepts to solve real cases. - Problem solving solution analysis and results interpretation. - Presentation and written communication.	**10%** **50%**
Contonuous assessment: • Team works	- Technical writing. - Oral presentations	**40%**

Scoring
Ordinary summon: • 50% comes from the end of term exam. • 10% comes from the mid-term exam • 50% comes from the project. **Extraordinary summon:** • 100% from the extraordinary summon exam. **Attendance:** The absence of more than 15% of the total amount of classes can entail to fail the ordinary summon.

WORKING SCHEDULE

In-class and distance activities	Do date	Delivery date
• Self-learning of concepts presented in class	After lesson	
• Problem solving	After lesson	
• End of term exam	Last session (week 15)	
• End of term exam preparation	Weeks 13, 14 and 15	
• Project preparation	Weeks 5 to 12	M1: week 7 M3: week 14
• Team work presentation	Week 14	

STUDENT SCHEDULE SUMMARY (HOURS)			
LIVE			
Lectures	**Simulation**	**Presentations**	**Exams**
15	10	2	3
DISTANCE			
Self-study on theory	**Self-work on problems**	**Project preparation**	**Exam preparation**
15	17	18	10
		ECTS:	**3 (90 hours)**

BIBLIOGRAPHY AND RESOURCES

Basic bibliography
Notes and Slides
• Available slides at Moodle.
Additional bibliography
Reports
• Collections of articles and presentations on the subjects • References and grey literature