Universidad Politécnica de Madrid

Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos

Subdirección de Relaciones Internacionales

BASIC GUIDE

MÁSTER UNIVERSITARIO INGENIERÍA DE CAMINOS, CANALES Y PUERTOS

(Master Civil Engineering)

Last update: February 2015

IMPORTANT

Please note that this is not an official document. The documents in English are provided for information purposes only and have no legal force. This document has been elaborated by the International Relations Office at ETSICCP-UPM and is intended as a helpful tool for international students coming to our school.

CONTENT

1. INTRODUCTION

This guide is provided in order to help international students with the structure and content of the master degree “Máster Universitario en Ingeniería de Caminos, Canales y Puertos” (Master in civil engineering). The first year of this degree has been offered for the first time in the academic year 2014-2015. The second year will be offered for the first time in the academic year 2015-2016. Due to this fact, some optional subjects are still being prepared. In the meantime, we will progressively update this document. Please try to have always the last version from our web page (http://www.caminos.upm.es/internacional/index.htm).

2. OVERVIEW OF COURSES

This degree includes 4 semesters (2 years). Each semester consists of 30 ECTS. Students can apply for this Master degree after successfully finishing the Bachelor in Civil Engineering (Grado de Ingeniería Civil y Terriorial) or an equivalent Bachelor degree. Subjects of the 1st and 2nd semesters are common for all students. Optional subjects included in the 3rd and 4th semesters shall be chosen by the students depending on their specialization: 1) Structures, Geotechnics, Construction and Materials; 2) Hydraulics, Energy and Environment; 3) Transports, Territory and Urban Planning; 4) Management and Finance of Projects and Infrastructures. A combined option is also possible without achieving any specialization in the final certificate.

Master																				
	4	Techological subjects: 4 specializations: 1) Hydraulics, energy and environment, 2) Transports and urban planning, 3) Project and construction management and finance, 4) Structures, Geotechnics, Construction and Materials												Master's Thesis						
	3	Energetic systems							Planning and management of roads			Structural typology		Hydraulic constructions			Geotechnical engineering			
	2	Applied economics		Hydraulic resources			Technical hydraulics			Applied elasticity				Computational methods for civil engineering			Railway systems			
	1	Mathematic models for civil engineering					Continuum Thermomechanics		Engineering and territory			Water supply and water treatment			Ports and coasts			Transport systems		
ECTS		1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5	18	19.5	21	22.5	24	25.5	27	28.5	30

SPECIALIZATIONS: LIST OF OPTIONAL SUBJECTS (4.5 ECTS each subject)				
Students must choose 1 subject from the whole list and 5 subjects from the desired specialization				
Hydraulics, energy and environment	**Transports and urban planning**	**Project and construction management and finances**	**Structures, Geotechnics, Construction and Materials**	**Combined option: choose 6 subjects from the whole**
Hydroelectric engineering	Demand transport models	Cooperation projects in civil eng.	Morphology of bridges	
Control of hydraulic systems	Railway technology	Labour health and accessibility in construction	Design, analysis and construction of bridges	
Environmental hydraulic engineering	Airports	Manag., direction & planning of civil eng. proj.	Analysis & design of steel & composite struct.	
Analysis of hydraulic systems	Advanced design of linear works	Risk assessment in civil eng. projects	Analysis & design of concrete struct.	
Dams	Port management	Economy applied to public works	Dynamic & seismic structural analysis	
Nuclear engineering and environment	Shapes in civil engineering	Business administration in constr. & consulting	Nonlinear analysis of structures	
Marine energy	Integral management of coastal areas	National and international legal aspects	Rock engineering	
Assessment of environmental impact	Sustainable territorial planning	Finance & manag. of infrastructures and public works	Soil structures	
Energetic uses in sanitary engineering	Urban projects & planning		Geological engineering	
			Geomatic techniques in civil eng.	
			Integral management of construction materials	
			Innovation in construction processes	
			Structural integrity	
			Structural composite materials	
			Conservation, assessment & rehabilitation of struct.	
			Experimental structural analysis	

3. COMPETENCES

The degree “Máster Universitario en Ingeniería de Caminos, Canales y Puertos” provides those who successfully complete it with the qualification for the profession of civil engineer in Spain (“Ingeniero de Caminos, Canales y Puertos”). In agreement with the national regulation (CIN/309/2009), the professional competences achieved are as follows:

3.1. Professional competences (CP)

The 18 professional competences are those listed in the national regulation (namely, competences CGP1 to CGP18 of CIN/309/2009).

3.2. Specific competences (CE)

CE19 to CE31 listed in CIN/309/2009.
CE32. Capacity to apply technical knowledge to evaluate civil engineering projects, construction works and infrastructures.
CE33. Capacity to apply technical knowledge to research and development civil engineering projects.
CE34.Capacity to integrate and apply technical knowledge to all tasks related to assessment, analysis, design, project, construction and technical evaluation of civil engineering infrastructures.
CE35. Capacity to integrate and apply technical knowledge to all tasks related to assessment, analysis, maintenance, construction, technical evaluation, conservation, exploitation and mathematical modelling of hydraulic and energetic resources.
CE36. Capacity to integrate and apply technical knowledge to all tasks related to territorial and urban planning, and its assessment, analysis, technical evaluation, direction, and technical and legal management.
CE37. Capacity to integrate and apply technical knowledge to all tasks related to assessment, maintenance, conservation, technical evaluation, exploitation, evaluation, planning, management and physical-mathematical modelling of environmental aspects affecting infrastructures.
CE38. Capacity to integrate and apply technical knowledge to all tasks related to assessment, analysis, design and physical-mathematical modelling of structural engineering.
CE39. Predictive capacity to optimize solutions in structural engineering.
CE40. Capacity to apply technical knowledge to assessment, analysis, design, construction, maintenance, conservation, exploitation, legal management, business administration, planning and technical management of transportation infrastructures and systems.
CE41. Capacity to apply technical knowledge to evaluation of transportation infrastructures and systems.

3.3. Transverse competences (CT)

CT1. Capacity to prepare and present oral, written and graphical documents with order and clarity.
CT2. Polyvalence and autonomous learning capacity.
CT3. Capacity of technical communication in English, written and oral.
CT4. Capacity to organize and lead teams.
CT5. Capacity to carry out the professional tasks related to project, design, technical evaluation, technical planning and management according to European and international codes.
CT6. Commitment and capacity to apply professional standards and deontology.
CT7. Capacity to use information and communication technologies related to the profession.
CT8. Capacity to design, analyse and understand experiments relevant in civil engineering.

4. DESCRIPTION OF COURSES

4.1. 1st semester

SUBJECT		Mathematic models for civil engineering					
Name in Spanish		**Modelos matemáticos para sistemas de ingeniería civil**					
ECTS	7.5	**Type**	Obligatory	**Semester**	1st	**Code**	43000364
Responsible person		Prof. Manuel Pastor		**E-mail**		manuel.pastor@upm.es	
Department		Mathematics applied to civil engineering		**Language**		Spanish	
Competences		CGP1, CGP6, CGP18, CE19, CE33, CE39, CT2					
Keywords		Field theory, advanced statistics, differential equations, optimization, numerical methods					
Content		1. Advanced Statistics 2. Optimization 3. Numerical analysis 4. Finite element method					

SUBJECT		Continuum thermomechanics					
Name in Spanish		**Termomecánica de medios continuos**					
ECTS	4.5	**Type**	Obligatory	**Semester**	1st	**Code**	43000365
Responsible person		Prof. Andrés Valiente		**E-mail**		andres.valiente@upm.es	
Department		Materials Science		**Language**		Spanish	
Competences		CGP1, CGP6, CGP18, CE20, CE33, CE39, CT2, CT8					
Keywords		Kinematics, dynamics, solids, fluids,					
Content		1. Continuum Mechanics 2. Lagrange Kinematics 3. Small deformations regime 4. Euler Kinematics 5. Internal forces 6. Theorems of Continuum Mechanics 7. Heat and temperature in Continuum Mechanics 8. Principles of Thermodynamics 9. Constitutive equations 10. Material symmetries 11. Fluids 12. Elastic isotropic solids 13. Thermomechanics of hookean solids 14. Elastic-plastic isotropic solids					

SUBJECT		Engineering and territory					
Name in Spanish		**Ingeniería y territorio**					
ECTS	4.5	**Type**	Obligatory	**Semester**	1st	**Code**	43000367
Responsible person		Prof. José Luis Zubieta		**E-mail**		jlzubieta@caminos.upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		CGP2, CGP3, CGP4 CGP5, CGP6, CGP10, CGP12, CGP14, CGP15 CE29, CE30, CE36 CE37, CT1, CT4					
Keywords		Territorial analysis, sustainability, environmental impacts, cost-benefit analysis					
Content		1. The framework of territorial planning 2. The stages of territorial planning 3. Management of spaces with specific uses and basic resources					

SUBJECT		Water supply and treatment					
Name in Spanish		**Sistemas de abastecimiento y saneamiento**					
ECTS	4.5	**Type**	Obligatory	**Semester**	1st	**Code**	43000368
Responsible person		Prof. Juan Manuel Rogel Quesada		**E-mail**		juanmanuel.rogel@upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		CGP2, CGP3, CGP4 CGP5, CGP6, CGP9, CGP12, CGP15, CGP16, CGP26, CGP30, CE37					
Keywords		Water resources, sanitary networks, water treatment, water supply, water					

	recycling, urban waste management
Content	1. Hydrology and water resources generation and renovation. 2. Sanitary network design and management. 3. Advanced water supply treatment. 4. Advanced wastewater treatment and purification. 5. Advanced urban waste management methods.

SUBJECT		**Maritime and Coastal and Harbour Engineering**					
Name in Spanish		**Ingeniería Marítima. Puertos y Costas**					
ECTS	4.5	**Type**	Obligatory	**Semester**	1st	**Code**	43000369
Responsible person		Prof. Vicente Negro Valdecantos		**E-mail**	vicente.negro@upm.es		
Department		Hydraulics, energy and environment		**Language**	Spanish		
Competences		CGP2, CGP3, CGP4 CGP5, CGP6, CGP7, CGP10, CGP12, CGP15, CGP18, CE27, CE30 CE37, CE40, CE41					
Keywords		Climatic effects, Sea wave modelling, port-city-shore interaction, maritime energies, maritime works, port and coastal management,					
Content		1. Wave mechanics 2. Wave transformation 3. Mathematical and computational models of wave propagation and long wave 4. Wave nature: statistical and spectrum description 5. Combination of design factors for ports and marine engineering. 6. Littoral processes 7. Planning and management for sustainable coastal works. Coastal management. 8. Port management. Vessels, floating bodies. 9. Ports. Typologies and advanced outer harbour and defence works design. 10. Ports. Typologies and advanced inner harbour design. 11. Offshore engineering					

SUBJECT		**Transport systems**					
Name in Spanish		**Sistemas de transporte**					
ECTS	4.5	**Type**	Obligatory	**Semester**	1st	**Code**	43000370
Responsible person		Prof. Andrés Monzón		**E-mail**	andres.monzon@upm.es		
Department		Transportation and Urban planning		**Language**	Spanish		
Competences		CGP2, CGP3, CGP4 CGP5, CGP6, CGP7, CGP8, CGP12, CGP15, CGP17, CE28, CE30 CE37, CE40, CE41, CT1, CT4					
Keywords		Transport systems planning, markets, demand models, transport policy and finance					
Content		1. Planning of transportation systems 2. The transportation market 3. Transportation demand 4. Principles of transport economics 5. Technics of evaluation and financing 6. Sustainability and development					

4.2. 2nd semester

SUBJECT		Technical hydraulics					
Name in Spanish		Hidráulica técnica					
ECTS	6	Type	Obligatory	Semester	2nd	Code	43000366
Responsible person		Prof. Luis Garrote de Marcos		E-mail		l.garrote@upm.es	
Department		Hydraulics, energy and environment		Language		Spanish	
Competences		CE1, CE6, CE13, CE15, CE18, CE20, CE35, CE37, CT2, CT5, CT8					
Keywords		Fluids movement, water conductions					
Content		1. Fluid mechanics. 2. Closed conduit systems. 3. Hydraulic transients in closed conduits. 4. Open channel flow. 5. Open channel hydraulics for natural systems.					

SUBJECT		Computational methods in civil engineering					
Name in Spanish		Métodos computacionales en ingeniería civil					
ECTS	6	Type	Obligatory	Semester	2nd	Code	43000377
Responsible person		Prof. José M.ª Goicolea Ruigómez		E-mail		jose.goicolea@upm.es	
Department		Continuum mechanics and structures		Language		Spanish	
Competences		CGP1, CGP6, CGP12, CGP18, CE33, CE39, CT2, CT7					
Keywords		Computational models for solid mechanics, fluid mechanics, geotechnics & design of linear constructions					
Content		1. Finite element method for diffusion problems. 2. Finite element method, solid mechanics. 3. Introduction to computational geotechnics. 4. Introduction to computational hydraulic and maritime engineering.					

SUBJECT		Economics					
Name in Spanish		Economía					
ECTS	3	Type	Obligatory	Semester	2nd	Code	43000376
Responsible person		Prof. Antonio Sánchez Soliño		E-mail		antonio.sanchezso@upm.es	
Department		Construction		Language		Spanish	
Competences		CGP1, CGP6, CGP17, CE33, CE37, CE40 CT2, CT7					
Keywords		Production costs, markets, investment and finance of infrastructures					
Content		1. Basic economic concepts. 2. Production costs. 3. Markets structures. 4. Objectives and macroeconomics indicators. 5. Economic conjuncture analysis. 6. Government economy. 7. Economics and environment. 8. Economic development. 9. Markets with imperfect information. 10. Public works and economy. 11. Public works funding and financing means. 12. Public-Private Partnerships and public works financing. 13. Introduction to investment projects assessment. 14. Cost–benefit analysis. 15. Investment projects financing.					

SUBJECT		Railway systems					
Name in Spanish		Sistemas ferroviarios					
ECTS	4.5	Type	Obligatory	Semester	2nd	Code	43000378
Responsible person		Prof. Alberto Camarero		E-mail		alberto.camarero@upm.es	
Department		Transportation and Urban planning		Language		Spanish	
Competences		CGP2, CGP3, CGP4, CGP5, CGP6, CGP7, CGP12, CGP15, CGP18, CE34, CE37, CE41 CT4, CT7					
Keywords		Railway dynamics, safety and quality, railway networks, stations					
Content		1. Overview of railway aspects					

	2. Railway projects 3. Electrification 4. Railway exploitation 5. Other railway systems 6. Railway complements: tunnels, viaducts and stations

SUBJECT		**Hydraulic resources**					
Name in Spanish		**Recursos hidráulicos**					
ECTS	4.5	**Type**	Obligatory	**Semester**	2nd	**Code**	43000371
Responsible person		Prof. Francisco J. Martín		**E-mail**		f.martin@upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		CGP2, CGP3, CGP4, CGP5, CGP6, CGP9, CGP12, CGP13, CGP15, CGP18, CE25, CE30 CE34, CE35, CE37 CT5, CT7					
Keywords		Water management, hydrologic planning					
Content		1. Hydraulic resources and planning 2. Water use and demand 3. Utilization of water resources 4. Extreme scenarios: flood and drought 5. Water economy 6. Water legislation					

SUBJECT		**Applied elasticity**					
Name in Spanish		**Elasticidad aplicada**					
ECTS	6	**Type**	Obligatory	**Semester**	2nd	**Code**	43000372
Responsible person		Prof. Pablo de la Fuente Martín		**E-mail**		pdelaf@caminos.upm.es	
Department		Continuum mechanics and structures		**Language**		Spanish	
Competences		CGP1, CGP6, CGP11, CGP12, CGP18, CE22, CE23, CE37, CE38, CE39, CT2, CT8					
Keywords		Elastic solids and structures, finite elements, basics of structural dynamics					
Content		1. Linear elasticity 2. Elastic-plastic cross-sections behaviour. 3. Advanced finite element methods. 4. Dynamic analysis.					

4.3. 3rd semester (common subjects)

SUBJECT		Energetic systems					
Name in Spanish		Sistemas energéticos					
ECTS	3	Type	Obligatory	Semester	3rd	Code	Not yet available
Responsible person		Prof. José Ángel Sánchez Fernández		E-mail	joseangel.sanchez@upm.es		
Department		Hydraulics, energy and environment		Language	Spanish		
Competences		CGP6, CGP9, CGP12, CE33, CE35, CE37, CT5, CT8					
Keywords		Production, transport and store of energy, removable energies, sustainable energy					
Content		1. Energy resources 2. Energy production 3. Renewable energy 4. Energy and transport 5. Storage and environmental issues 6. Energy economics					

SUBJECT		Planning and management of roads					
Name in Spanish		Planificación y gestión de carreteras					
ECTS	3	Type	Obligatory	Semester	3rd	Code	Not yet available
Responsible person		Prof. Miguel Ángel del Val		E-mail	miguel.delval@upm.es		
Department		Transportation and Urban planning		Language	Spanish		
Competences		CGP2, CGP3, CGP4, CGP5, CGP6, CGP12, CGP15, CE37, CE40, CE41, CT1, CT4, CT7					
Keywords		Road management and exploitation, traffic management and safety, road conservation					
Content		Coming soon					

SUBJECT		Structural typology					
Name in Spanish		Tipología estructural					
ECTS	3	Type	Obligatory	Semester	3rd	Code	Not yet available
Responsible person		Prof. Hugo Corres Peiretti		E-mail	hugoeduardo.corres@upm.es		
Department		Continuum mechanics and structures		Language	Spanish		
Competences		CGP11, CE22, CE23, CE39					
Keywords		Conceptual design, structural materials, structural elements, structural shapes					
Content		1. Introduction. 2. Basic structural concepts. 3. Materials. 4. Structural elements. 5. Structural elements role.					

SUBJECT		Hydraulic constructions					
Name in Spanish		Obras hidráulicas					
ECTS	6	Type	Obligatory	Semester	3rd	Code	Not yet available
Responsible person		Prof. Francisco J. Martín Carrasco		E-mail	fj.martin@upm.es		
Department		Hydraulics, energy and environment		Language	Spanish		
Competences		CGP2, CGP3, CGP4, CGP5, CGP6, CGP12, CGP13, CGP15, CGP18, CE24, CE34, CE35, CE37, CT5					
Keywords		Irrigation, water transport and energy production works, flood protection, environmental restoration					
Content		1. Dams 2. Channels and pipelines 3. Pumping installations and hydroelectric plants 4. River works, underground water works, environmental restoration					

SUBJECT		Geotechnical engineering					
Name in Spanish		Ingeniería geotécnica					
ECTS	4.5	Type	Obligatory	Semester	3rd	Code	Not yet available
Responsible person		Prof. Claudio Olalla Marañón		E-mail	colalla@caminos.upm.es		
Department		Soil morphology and engineering		Language	Spanish		
Competences		CGP1, CGP2, CGP3, CGP4, CGP5, CGP6 CGP11, CGP12, CGP15 CGP18, CE21, CE34 CE37, CE39, CT5, CT8					
Keywords		Surface and deep foundations, soil improvement, foundations of roads, bridges, maritime and hydraulic works					
Content		1. Introduction to geotechnical problems and reliability. 2. Soil improvements 3. Stability of land slopes 4. Geotechnics for buildings 5. Geotechnics for roads and railways 6. Geotechnics in hydraulic and coastal constructions 7. Seismic problems. Liquefaction					

4.4. 3rd and 4th semesters (specializations)

All subjects are of 4.5 ECTS. Students must choose subjects to complete 27 ECTS.

4.4.1. Structures, Geotechnics, Construction and Materials

SUBJECT		**Morphology of bridges**					
Name in Spanish		**Morfología de puentes**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. Miguel Ángel Astiz Suárez		**E-mail**		miguel.a.astiz@upm.es	
Department		Continuum mechanics and structures		**Language**		Spanish	
Competences		Coming soon					
Keywords		History, evolution, typologies, materials, prefab, pre-dimensioning, structure calculation, bearing pads, bridge design					
Content		1. Introduction to bridges. 2. History bridges. 3. Morphology of bridges. 4. Bridge project. 5. Pre-dimensioning of short span bridges. 6. Forces that act on road bridges. 7. Short span bridges superstructure calculation. 8. Bridge substructure calculation 9. Bridge equipment 10. Short span bridge construction					

SUBJECT		**Design, analysis and construction of bridges.**					
Name in Spanish		**Proyecto, cálculo y construcción de puentes**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Miguel Ángel Astiz Suárez		**E-mail**		miguel.a.astiz@upm.es	
Department		Continuum mechanics and structures		**Language**		English	
Competences		Coming soon					
Keywords		Typology uses and application, dimensioning, non conventional bridges, long span bridges, medium span bridges, alternatives, durability					
Content		1. Introduction to non conventional bridges, medium span and long span bridges 2. Straight box girder bridges 3. Oblique bridges 4. Curved bridges 5. Portal bridge 6. Railway bridge 7. Incrementally launched bridge 8. Arch bridge 9. Cable-stayed bridge 10. Extradosed bridge 11. Unusual forces 12. Maintenance and inspection					

SUBJECT		Advanced Analysis and Design of Steel and Composite Structures					
Name in Spanish		**Análisis y diseño avanzado de estructuras de acero y mixtas**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Francisco Millanes		**E-mail**		fco.millanes@upm.es	
Department		Continuum mechanics and structures		**Language**		Spanish	
Competences		Coming soon					
Keywords		Creep and shrinkage, long term deformation, buckling, connection, ductility, temperature effects, settlements effects, elastic/plastic deformation, moment-curvature, composite structures history.					
Content		1. Steel & concrete composite structures. 2. Fatigue of steel structures. 3. Second-order analysis for steel structures. 4. Design, dimensioning of steel sections and stiffeners.					

SUBJECT		Advanced Analysis and Design of Concrete Structures					
Name in Spanish		**Análisis y Diseño Avanzado de Estructuras de Hormigón**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Hugo Corres Peiretti		**E-mail**		hcp@he-upm.com	
Department		Continuum mechanics and structures		**Language**		English	
Competences		Coming soon					
Keywords		ULS, SLS, prestressed concrete, creep and shrinkage, EC-2, long term, strut and tie, stress fields					
Content		1. Introduction. 2. Ultimate Limit State. 3. Stress/strain and moment/curvature diagrams. 4. Nonlinear mechanical analysis. Stress Redistribution. 5. Slender elements. 6. Ductility. 7. Service Limit State analysis. 8. Behaviour of structures seismic zones. 9. Integral structures: piles dimensioning.					

SUBJECT		Dynamic and Seismic Analysis of Structures					
Name in Spanish		**Análisis dinámico y sísmico de estructuras**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Pablo de la Fuente Martín		**E-mail**		pdelaf@caminos.upm.es	
Department		Continuum mechanics and structures		**Language**		Spanish	
Competences		Coming soon					
Keywords		Dynamic analysis, numerical and analytical methods, seismic risk assessment, seismic behaviour of structures, damping, frequency domain					
Content		1. Structural dynamics. General concepts. 2. Single degree-of-freedom systems. 3. N degree-of-freedom systems. 4. Elements of earthquake engineering.					

SUBJECT		Non Linear Structural Analysis					
Name in Spanish		Comportamiento No Lineal de Estructuras					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. José María Arrieta Torrealba		E-mail		josemaria.arrieta@upm.es	
Department		Continuum mechanics and structures		Language		Spanish	
Competences		Coming soon					
Keywords		Dynamics; statics; causes of nonlinearity; large displacement analysis; FEM; composite structures; supports; Euler critical load; ductility; plasticity; viscoelasticity					
Content		1. Introduction. 2. Nonlinear geometry. 3. Nonlinear materials. 4. Other nonlinearity causes. 5. Nonlinear structural dynamics. 6. Nonlinear structural analysis. 7. Nonlinear structural analysis: safety and reliability.					

SUBJECT		Experimental Structural Analysis					
Name in Spanish		Análisis Experimental de Estructuras					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. Carlos Zanuy Sánchez		E-mail		czs@caminos.upm.es	
Department		Continuum mechanics and structures		Language		English	
Competences		Coming soon					
Keywords		Transducers; signal conditioning processes; static and dynamic measures; experimental analysis techniques.					
Content		1. Instrumentation 1.1. Introduction 1.2. Signal conditioning 1.3. Deformation measure 1.4. Load measure 1.5. Displacement measure 1.6. Acceleration measure 2. Load testing 2.1. Load testing of bridges 2.2. Load testing of buildings 3. Dynamic test 3.1. Frequency domain analysis 3.2. Dynamic analysis: measurement systems 3.3. In-service monitoring 3.4. Forced modal analysis 3.5. Operational modal analysis 3.6. Case study					

SUBJECT		Rock Engineering					
Name in Spanish		Ingeniería de rocas					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. Claudio Olalla		E-mail		colalla@caminos.upm.es	
Department		Soil morphology and engineering		Language		Spanish	
Competences		Coming soon					
Keywords		Rock characterization; foundations					
Content		1. Introduction 2. Geological classification of rocks 3. Defects of rock masses 4. Basic properties of rocks 5. Mechanical classification of rocks 6. Natural stresses 7. Field testing 8. Strength of rock masses					

	9. Hoek and Brown model 10. Strength of discontinuities 11. Anisotropic behaviour of rocks 12. Deformability of rock masses 13. Foundations 14. Stability of slopes 15. Tunnels and underground constructions 16. Computational methods

SUBJECT		**Earth Structures**					
Name in Spanish		**Estructuras de tierra**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Claudio Olalla		**E-mail**		colalla@caminos.upm.es	
Department		Soil morphology and engineering		**Language**		Spanish	
Competences		Coming soon					
Keywords		Geotechnics, foundations, earth structures					
Content		1. Introduction 2. Stability analysis 3. Land fills 4. Compaction and control 5. Soil improvement techniques 6. Earth dams 7. Materials 8. Water effects 9. Internal stability 10. Treatments for dam foundations 11. Pathology of dams 12. Seismic analysis					

SUBJECT		**Geological Engineering**					
Name in Spanish		**Ingeniería geológica**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Eugenio Sanz Pérez		**E-mail**		esanz@caminos.upm.es	
Department		Soil morphology and engineering		**Language**		Spanish	
Competences		Coming soon					
Keywords		Geology, soil and rock mechanics					
Content		1. Fundamentals of geological engineering. Soil and rock mechanics 2. Description of rock masses 3. Hydrogeology 4. On site geological investigations 5. On site testing 6. Geophysical prospections 7. Geological and geotechnical cartography 8. Design of foundations on soils and rocks 9. Slopes 10. Tunnels 11. Dams 12. Geological risks 13. Seismic risks					

SUBJECT		**Geomatic techniques in Civil Engineering**					
Name in Spanish		**Técnicas geomáticas en ingeniería civil**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Rubén Martínez Marín		**E-mail**		ruben.martinez@upm.es	
Department		Soil morphology and engineering		**Language**		Spanish	
Competences		Coming soon					
Keywords		Topographic methods; GPS; DTM; erosion; subsidence; earth remote sensing; structural monitoring; laser scanner					
Content		1. Data acquisition instrumentation and control of ground deformation					

	2. Design of ground control systems and real time warning systems 3. Ground modelling and its applications 4. Final assignment

SUBJECT		**Durability and innovation of construction materials**					
Name in Spanish		**Durabilidad e innovación de materiales de construcción**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Jaime Gálvez		**E-mail**		Jaime.galvez@upm.es	
Department		Civil engineering: construction		**Language**		Spanish	
Competences		Coming soon					
Keywords		Innovative construction materials; corrosion, degradation of materials					
Content		1. Introduction to cement-based materials 2. Chemical degradation of concrete 3. Physical degradation of concrete 4. Transport mechanisms in concrete 5. Depassivation of the reinforcement protection; carbonation. 6. Corrosion of metals 7. Corrosion of steel reinforcements for concrete 8. Protection against reinforcement corrosion 9. Concrete cracking 10. Deterioration of ceramic materials 11. Assessment and monitoring of materials 12. Composite materials 13. Special concrete 14. Sustainability of construction materials 15. Innovation and future trends					

SUBJECT		**Structural Integrity**					
Name in Spanish		**Integridad Estructural**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. Gustavo V. Guinea Tortuero		**E-mail**		gguinea@mater.upm.es	
Department		Materials Science		**Language**		Spanish	
Competences		Coming soon					
Keywords		Crack growth resistance; tenacity; strain energy release; stress intensity factor; fracture; sub-critical crack growth					
Content		1. Global fracture criteria. 2. Local fracture criteria. 3. Fatigue crack propagation. 4. Corrosion crack propagation. 5. Numerical methods. 6. Elastic-plastic fracture criteria.					

SUBJECT		**Structural Composite Materials**					
Name in Spanish		**Materiales compuestos estructurales**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Javier Llorca		**E-mail**		javier.llorca@upm.es	
Department		Materials Science		**Language**		English	
Competences		Coming soon					
Keywords		Manufacturing process; typology; properties; in-service behaviour of structural composite materials					
Content		1. Introduction and Constituents 1.1. Fibers 1.2. Reinforcement architecture 1.3. Matrices 1.4. Interphases 1.5. Metal-matrix composites 1.6. Ceramic-matrix composites 1.7. Polymer-matrix composites 2. Micromechanics of Composites					

	2.1. Constitutive equations. 2.2. Elastic behaviour. 2.3. Higro-thermal stresses. 2.4. Conductivity. 2.5. Strength and failure. 3. Macromechanics of composites 3.1. Orthotropic lamina. 3.2. Failure criteria 3.3. Laminate theory. 4. Behaviour under service conditions. 4.1. Requirements. 4.2. Damage tolerance. 4.3. Non-destructive evaluation. 4.4. Repairs 4.5. Joints 4.6. Applications of composites in Civil Engineering

SUBJECT		**Structural Conservation, Auscultation And Rehabilitation**					
Name in Spanish		**Conservación, auscultación y rehabilitación estructural**					
ECTS	4.5	**Type**	Optional	**Semester**	4^{th}	**Code**	Not yet available
Responsible person		Prof. Hugo Corres Peiretti		**E-mail**		hugoeduardo.corres@upm.com	
Department		Continuum mechanics and structures		**Language**		Spanish	
Competences		Coming soon					
Keywords		Performance and forces evolution; strategic management; monitoring; structural report; rehabilitation and strengthen project; maintenance					
Content		1. Structure maintenance engineering. 2. Structure management system. Components. 3. Description of structural component parts. Typologies and historical context. Identification of resistance mechanisms involved in exiting structures. 4. Principal inspections planning. 5. Special inspections planning. 6. Determining bearing capacities and remaining service life. 7. Load testing and monitoring. 8. Structures rehabilitation. 9. Structural strengthening.					

4.4.2. Hydraulics, Energy and Environment

SUBJECT		Hydroelectric Engineering					
Name in Spanish		Ingeniería Hidroeléctrica					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. José Ángel Sánchez Fernández		E-mail	joseangel.sanchez@upm.es		
Department		Hydraulics, energy and environment		Language	Spanish		
Competences		Coming soon					
Keywords		The value of hydropower in the electric grid, dimensioning, dynamic system response, hydropower plants					
Content		1. General concepts. 2. Water supply infrastructure for hydropower. 3. Hydraulic transients. 4. Energy conversion equipment. 5. Hydroelectric power plants. 6. Special hydroelectric power plants.					

SUBJECT		Control of Hydraulic Systems					
Name in Spanish		Control de Sistemas Hidráulicos					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. José Ignacio Sarasúa Moreno		E-mail	joseignacio.sarasua@upm.es		
Department		Hydraulics, energy and environment		Language	Spanish		
Competences		Coming soon					
Keywords		Dynamic equations and models, linear and nonlinear systems, unforced and forced systems, model stability, modal analysis, feedback, electricity market					
Content		1. Introduction to feedback control. 2. Modelling of dynamic systems. 3. Modelling nonlinear hydraulic systems. 4. Linear dynamical system. 5. Time-domain analysis. 6. Transfer function. 7. Frequency domain analysis. 8. Systems in feedback. 9. Hydropower plant control.					

SUBJECT		Environmental Hydraulics					
Name in Spanish		Hidráulica ambiental					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Luis Garrote de Marcos		E-mail	l.garrote@upm.es		
Department		Hydraulics, energy and environment		Language	Spanish		
Competences		Coming soon					
Keywords		Open channel hydraulics, water bodies, pollutant transport through porous media, numerical integration, erosion and transportation, erosion control, computational hydraulics					
Content		1. Transport of pollutants 2. Groundwater 3. Fluvial hydraulics 4. 2d hydrodynamics					

SUBJECT		Analysis of Hydroelectric Systems					
Name in Spanish		Análisis de sistemas de recursos hidráulicos					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Juan Ignacio Pérez Díaz		E-mail	ji.perez@upm.es		
Department		Hydraulics, energy and environment		Language	English		
Competences		Coming soon					

Keywords	Math programing, economical outlook, dynamic optimization, electricity market knowledge, dynamic programing, simulations for power generation facilities
Content	1. Introduction to electric power systems 2. Revision: math programming 3. Optimization software: Solver (MS Excel); GAMS 4. Spanish electricity market 5. Short-term power generation scheduling 6. Long-term power generation scheduling

SUBJECT		**Dams**					
Name in Spanish		**Presas**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Miguel Ángel Toledo		**E-mail**		matoledo@caminos.upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		Coming soon					
Keywords		Typologies, project, construction, operation, heightening, reinforcements, protections, environmental aspects and protection					
Content		1. Introduction to dam engineering. 2. Gravity dams: Vibrated concrete (VI) & roller-compacted concrete (RCC). 3. Embankment dam. 4. Arch dam. 5. Other types of dams. 6. Spillways. 7. Drains, water intakes and river rechanneling. 8. Foundations and soil treatment. 9. Dams safety. 10. Miscellany					

SUBJECT		**Environmental and Nuclear engineering**					
Name in Spanish		**Ingeniería Nuclear y Medio Ambiente**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. María José Suárez		**E-mail**		mariajose.suarez@upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		Coming soon					
Keywords		Nuclear science and technology, nuclear problems, environmental impact, technological and scientific challenges, applications of ionising radiation					
Content		1. Fundamentals of nuclear engineering 2. Radiation detectors and radiological protection 3. Radioactivity in nature 4. Nuclear fuel cycle 5. Radioactive waste 6. Dismantling nuclear reactors 7. Environmental surveillance					

SUBJECT		**Marine Renewable Energies**					
Name in Spanish		**Energías Renovables Marinas**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. José Santos López Gutiérrez		**E-mail**		josesantos.lopez@upm.es	
Department		Hydraulics, energy and environment		**Language**		English	
Competences		Coming soon					
Keywords		Sustainable exploitation, coastal planning and defence, environmental integration, mathematical, analytical and numerical methods of marine engineering.					
Content		1. Introduction 2. Technologies for marine energy harvesting 3. Forms of marine energy 4. Facilities: Main components 5. Foundations and structures.					

	6. Constructions and operational phases 7. Environmental impact 8. Other aspects 9. Other forms of marine energies 10. The future of marine energies

SUBJECT		**Energetic uses in sanitary engineering**					
Name in Spanish		**Aprovechamientos energéticos en ingeniería sanitaria**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Manuel Macías		**E-mail**		manuel.macias@upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		Coming soon					
Keywords		Energy and environment, water resources, water treatment					
Content		1. Energetic aspects in Spain 2. Water and energy 3. Energetic use of sludge 4. Drying beds plants 5. Electricity production in waste water treatment plants 6. Renewable energies in water cycle 7. Management of energies in waste water treatment plants					

SUBJECT		**Shapes in civil engineering**					
Name in Spanish		**Las formas en la ingeniería civil**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. Jorge Bernabéu		**E-mail**		jorge.bernabeu@upm.es	
Department		Hydraulics, energy and environment		**Language**		Spanish	
Competences		Coming soon					
Keywords		Arts in engineering, conceptual design					
Content		1. Shapes in design and construction 2. Technology and process of designing 3. Roads 4. Bridges 5. Towers and piles 6. Transport terminals 7. Hydraulic works 8. Ports 9. Coasts 10. Cities 11. Past, present and future					

4.4.3. Transports, Territory and Urban Planning

SUBJECT		Transport demand models					
Name in Spanish		Modelos de demanda de transporte					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Andrés Monzón		E-mail	andres.monzon@upm.es		
Department		Transportation and Urban planning		Language	English		
Competences		Coming soon					
Keywords		Transport economics, demand models					
Content		1. The process of land planning 2. Surveys and information search 3. Structure of transportation models for persons and goods 4. Network models 5. Practical cases					

SUBJECT		Railway technology					
Name in Spanish		Tecnología ferroviaria					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. Jesús Ruiz Casamayor		E-mail	jesusjavier.ruiz@upm.es		
Department		Transportation and Urban planning		Language	Spanish		
Competences		Coming soon					
Keywords		Railway infrastructure, railway transport					
Content		1. Railway standards 2. Constructive processes 3. Rolling stock 4. Mechanical behaviour 5. Vertical and transverse dynamics 6. Maintenance of railway infrastructure 7. Comfort of users					

SUBJECT		Airports					
Name in Spanish		Aeropuertos					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Begoña Guirao Abad		E-mail	bguirao@caminos.upm.es		
Department		Transportation and Urban planning		Language	Spanish		
Competences		Coming soon					
Keywords		Characteristics, economic and social impacts, design criteria, rehabilitation, conservation, management					
Content		1. Air transportation 2. Elements of the airport systems 3. Airport design 4. Airport pavement 5. Airport management					

SUBJECT		Road Design					
Name in Spanish		Diseño viario					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. María Castro Malpica		E-mail	maria.castro@upm.es		
Department		Transportation and Urban planning		Language	Spanish		
Competences		Coming soon					
Keywords		Geometric design, design software, consistency, junction element design, design of transport infrastructures					
Content		1. General Concepts 2. Road visibility and sight distances 3. Design consistency 4. Databases and information processing 5. Interchange and junction design 6. Unconventional design					

	7. Road design optimization

SUBJECT		**Port management**					
Name in Spanish		**Gestión portuaria**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. Alberto Camarero Orive		**E-mail**		alberto.camaerero@upm.es	
Department		Transportation and Urban planning		**Language**		Spanish	
Competences		Coming soon					
Keywords		Cargo and bulk needs, functional design, master plan, social impact, economic impact, environmental impact, legal framework, economic framework, policies, wind-waves-weather-coast.					
Content		1. Port evolution. Marine transport. 2. Port system organization. 3. European port policy. Spanish ports policy and roles. 4. Logistics and Transport. 5. Management plan and planning 6. Port management models 7. Port management					

SUBJECT		**Sustainable territorial planning**					
Name in Spanish		**Planificación territorial sostenible**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. Rosa M. Arce		**E-mail**		rosa.arce.ruiz@upm.es	
Department		Transportation and Urban planning		**Language**		Spanish	
Competences		Coming soon					
Keywords		Sustainability, environmental engineering					
Content		1. Regional sustainability 2. Decision making in regional planning 3. Environmental assessment 4. New technologies and regional planning					

SUBJECT		**Urban management and planning**					
Name in Spanish		**Planificación y gestión urbana**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. Juan A. Santamera Sánchez		**E-mail**		santamera@caminos.upm.es	
Department		Transportation and Urban planning		**Language**		Spanish	
Competences		Coming soon					
Keywords		Urban planning					
Content		1. General planning 2. Partial urban plans 3. Environmental aspects 4. Strategic planning of cities 5. Urban laws 6. European laws 7. Contemporary uses of cities 8. Smart cities 9. Urban transports 10. Public networks 11. Construction of infrastructures 12. Large urban actuations					

4.4.4. Management and Finance of Projects and Infrastructures

SUBJECT		Development cooperation in infrastructures					
Name in Spanish		Cooperación al desarrollo en infraestructuras					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Pedro Fernández Carrasco		E-mail	pedro.fernandez@upm.es		
Department		Hydraulics, energy and environment		Language	Spanish/English		
Competences		Coming soon					
Keywords		Human development, environment, society, culture, global and local challenges, sustainability					
Content		1. Development Agendas 2. Cultural and social anthropology for engineers 3. University development cooperation 4. Corporate social responsibility 5. Projects 6. Wars and conflicts 7. Natural disasters and emergencies 8. Volunteering 9. 21st century challenges: cities 10. Codes of conduct 11. Creativity and cooperation					

SUBJECT		Engineering risks management and prevention					
Name in Spanish		Gestión y Prevención de Riesgos en Ingeniería					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Fernando Rodríguez López		E-mail	fernando.rodriguezl@upm.es		
Department		Construction		Language	Spanish		
Competences		Coming soon					
Keywords		Project risk, insurance sector, uncertainty, roles and responsibilities, risk appetite, innovation					
Content		1. General aspects of risk management. 2. Identifying and defining risk. 3. Risk analysis. 4. Risk treatment and prevention. 5. Safety and health in construction.					

SUBJECT		Project Management					
Name in Spanish		Dirección y gestión integrada de proyectos.					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. Fernando Rodríguez López		E-mail	fernando.rodriguezl@upm.es		
Department		Construction		Language	Spanish		
Competences		Coming soon					
Keywords		Project risk management and treatments, achieve project objectives, design management, team managing, legal framework, construction					
Content		1. Project management basic concepts 2. The life cycle of an engineering project 3. Site management					

SUBJECT		Economic and social assessment of investments					
Name in Spanish		Evaluación económica y social de inversiones					
ECTS	4.5	Type	Optional	Semester	3rd	Code	Not yet available
Responsible person		Prof. José Manuel Vassallo Magro		E-mail		josemanuel.vassallo@upm.es	
Department		Transportation and Urban planning		Language		Spanish	
Competences		Coming soon					
Keywords		Investment evaluation, decision, quantify, sustainability, inversion analysis tools, social benefit and private benefit					
Content		1. Microeconomics: investment analysis. 2. Costs benefits analysis. 3. Wider economic impacts. 4. Environmental impacts. 5. Social impact of investments. 6. Risk and sensitivity. 7. Multi-criteria Decision Making. 8. Sustainability assessment of investments.					

SUBJECT		Global economy and international environment in business administration					
Name in Spanish		Economía global y entorno internacional de la empresa					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Antonio Sánchez Soliño		E-mail		antonio.sanchezso@upm.es	
Department		Construction		Language		English	
Competences		Coming soon					
Keywords		Global economy analysis, accrual, finances, infrastructures, services and equipment management, international					
Content		1. International economy: institutions and markets. 2. Foreign trade sector. 3. Economic globalization. 4. EU institutions and how it works. 5. Country risk assessment. Case study. 6. International infrastructure and services management. 7. International outreach of Spanish engineering and construction companies. Case study.					

SUBJECT		Business management and administration					
Name in Spanish		Dirección y gestión empresarial					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Juan Gardeta Oliveros		E-mail		jjgardeta@caminos.upm.es	
Department		Construction		Language		Spanish	
Competences		Coming soon					
Keywords		Business administration					
Content		1. Enterprises. Markets and products 2. Main functions of enterprises. Human resources 3. Financing 4. Production 5. Marketing 6. Logistics 7. Purchasing 8. Controlling 9. Strategic management 10. Economic sectors in civil engineering					

SUBJECT		Business Law					
Name in Spanish		Derecho de la empresa					
ECTS	4.5	Type	Optional	Semester	4th	Code	Not yet available
Responsible person		Prof. Juan Gardeta Oliveros		E-mail		jjgardeta@caminos.upm.es	
Department		Construction		Language		Spanish	
Competences		Coming soon					

Keywords	Laws, business administration
Content	1. Civil law 2. The economic system within the legal system 3. Obligations and contracts 4. Commercial law 5. Labour law 6. European legal system 7. Public law and enterprises

SUBJECT		**Financing infrastructure and public services**					
Name in Spanish		**Financiación de infraestructuras y servicios**					
ECTS	4.5	**Type**	Optional	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof. José Manuel Vassallo Magro		**E-mail**		josemanuel.vassallo@upm.es	
Department		Transportation and Urban planning		**Language**		English	
Competences		Coming soon					
Keywords		Financial assessment, infrastructure management, tariff adjustment mechanisms, EU funding, PPPs, call for tenders, cash flow, capital cost, financial resources					
Content		1. Infrastructures, public services and market economy. 2. Infrastructures management and finance systems. 3. Infrastructures and government budget deficit. 4. Prices, fees and tariffs. 5. Community financial aid and Trans-European Networks. 6. Concepts and characteristics of PPP projects. 7. Risk allocations. 8. Project financial assessment. *9. Project finance* 10. Private financial resources 11. Corporate strategy & PPPs projects					

SUBJECT		**Public-Private Partnerships in infrastructure, facilities and utilities**					
Name in Spanish		**Las colaboraciones público-privadas en infraestructuras, equipamientos y servicios**					
ECTS	4.5	**Type**	Optional	**Semester**	3rd	**Code**	Not yet available
Responsible person		Prof. Antonio López Corral		**E-mail**		alopezcorral@caminos.upm.es	
Department		Construction		**Language**		Spanish/English	
Competences		Coming soon					
Keywords		Economic analysis, legal framework, accrual, finance, management, analysis tools, contract, drawbacks, limitations, advantages, Civil Law versus Common Law, PFI versus Concesión.					
Content		1. PPPs concepts and modalities 2. Legal framework of PPP 3. Economic basis 4. PPP project implementation: Administration activity 5. Developer activity 6. Users 7. Project funding 8. PPP sectors					

4.5. Master's thesis

SUBJECT		Master's thesis					
Name in Spanish		**Trabajo Fin de Máster**					
ECTS	12	**Type**	Obligatory	**Semester**	4th	**Code**	Not yet available
Responsible person		Prof.		**E-mail**	@upm.es		
Department		Various		**Language**	Spanish/English		
Competences		CGP2, CGP3, CGP4, CGP5, CGP6, CGP12, CGP15, CGP17, CGP18, CE31, CE33, CE34, CT1, CT2, CT3, CT6, CT7					
Keywords		Construction projects, civil engineering design					
Content		Individual project of civil engineering guided by a supervisor					