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E.T.S. de Ing. de Caminos
Canales y P.

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000438 - Bridge Dynamics

DEGREE PROGRAMME

04AM - Master Universitario Ingeniería De Estructuras, Cimentaciones Y Materiales

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	43000438 - Bridge Dynamics
No of credits	4.5 ECTS
Type	Optional/elective
Academic year of the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	04AM - Master Universitario Ingeniería de Estructuras, Cimentaciones y Materiales
Centre	04 - E.T.S. De Ing. De Caminos Canales Y P.
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Alfredo Camara Casado (Subject coordinator)	Torre 9a	alfredo.camara@upm.es	W - 16:00 - 19:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Morfología De Puentes

3.2. Other recommended learning outcomes

The subject - other recommended learning outcomes, are not defined.

4. Skills and learning outcomes *

4.1. Skills to be learned

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CE11 - Capacidad para el ejercicio profesional de alta especialización o para la investigación predoctoral mediante la utilización de recursos de modelización predictiva en Análisis y diseño de puentes.

CG1 - Polivalencia para extender a ámbitos afines las competencias generales adquiridas en el ámbito temático del título.

CG4 - Capacidad de comunicación académica de contenido técnico y científico, oral y escrita en lengua inglesa.

CG5 - Capacidad de utilización de los servicios de comunicación y de obtención de información para su transformación en conocimiento aplicable al ejercicio de las competencias específicas.

4.2. Learning outcomes

RA83 - Los resultados del aprendizaje correspondientes a esta asignatura han quedado definidos en el apartado de competencias de este documento, señalando los que corresponden a conocimientos, habilidades y competencias propiamente dicha

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Understanding and designing for dynamic effects is essential for bridge engineers, because these structures may be prone to vibrations, or because they can be subject to important dynamic actions. Therefore, the aim of this course is to provide you with a solid understanding on the dynamic effects on bridges and how to control them as designers. In this course we will give you a wide view of the key issues on bridge dynamics, along with state-of-the-art assessment techniques and design techniques. To this end, the course is conceived to achieve the following objectives:

1. Provide the student with background knowledge on aspects of structural dynamics that will be needed during the course, and use specialised software to solve problems.
2. Cover a wide range of bridge typologies and their specific dynamic problems, including footbridges, road and railway bridges.
3. Study in depth dynamic effects that can be potentially catastrophic for bridges such as earthquakes or wind actions.
4. Develop an understanding of the most advanced design and control techniques for bridges under dynamic actions, including the use of auxiliary devices such as dampers or isolators.

5.2. Syllabus

1. Introduction to structural dynamics

1.1. Single-degree of freedom systems. Damped movement. Resonance. Duhamel's equation.

2. Dynamics in the time domain

2.1. Multi-degree of freedom systems. Vibration modes. Modal analysis. Damping types. Time integration. Implicit and explicit methods.

3. Dynamics in the frequency domain

3.1. Importance of the frequency domain. Auto-correlation function. Fourier analysis. Parseval's identity, Power spectral density.

3.2. Single- and multi-degree of freedom systems under random loads.

4. Train-induced vibrations in railway bridges

4.1. Description of moving loads in railway bridges. Characteristic velocities. Analysis with moving loads and coupled models. Code treatment of the problem.

5. Vehicle-induced vibrations in road bridges.

5.1. Vehicle models and pavement irregularities. Analysis methods for wind-vehicle-bridge interaction studies. Driving safety and comfort assessment.

6. Pedestrian-induced vibrations in footbridges.

6.1. Traditional treatment of the problem. New developments following the problems with the Millenium footbridge. Human-structure interaction. Setra and Nakamura pedestrian models. Crowd loading. Code specifications.

7. Seismic actions on bridges.

7.1. Description of the seismic action. Multi-modal analysis of the seismic response. Ductility. Capacity design. Pushover method.

7.2. Non-linear dynamic analysis. Damping. Performance-based design. Construction details in bridges.

7.3. Soil-structure interaction. Seismic effects on abutments. Mononobe-Okabe method.

8. Wind effects on bridges.

8.1. Fundamentals of wind engineering. Bluff body aerodynamics. Quasi-static, buffeting and aeroelastic effects in bridges. Stochastic response of bridges under turbulent wind. Vortex-induced vibrations. Code treatment of the problem.

9. Auxiliary devices for the control of bridge dynamics

9.1. Active, semi-active and passive devices. Tuned mass dampers. Viscous shock absorbers

9.2. Modified neoprene devices. Yielding metallic dampers. Shock transmission units. Design of auxiliary damping systems for the control of bridges. Application examples

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				No hay evaluación progresiva, solo exámenes finales Other assessment Progressive assessment Presential Duration: 00:00
17	Examen ordinario de ejercicios Duration: 00:00 Additional activities			Examen ordinario de ejercicios Written test Global examination Not Presential Duration: 04:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
16	No hay evaluacion progresiva, solo exámenes finales	Other assessment	Face-to-face	00:00	100%	0 / 10	CG4 CG1 CG5 CB6 CB9 CE11

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Examen ordinario de ejercicios	Written test	No Presential	04:00	%	/ 10	

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Examination

Description. The final exam will consist of exercises focusing on at least two of the thematic blocks (units) of the course.

Qualification criteria. Each examination exercise is valued from 0 to 10. The exam grade will be the arithmetic average of the grade obtained in the exercises that form the exam as long as the grades corresponding to each of them are above or equal 3.5.

Moment and place: To be determined by the Head of Studies in due course.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Clough R.W. & Penzien J. (1993), Dynamics of Structures, McGraw-Hill	Bibliography	Further reading
Chopra A.K. (2011), Dynamics of Structures, Prentice Hall	Bibliography	Basic
Humar J. (2012), Dynamics of Structures, CRC Press	Bibliography	Further reading
Bachman H. (1995), Vibration problems in structures, Birkhäuser	Bibliography	Further reading
Fryba L. (1999), Vibration of solids and structures under moving loads, Thomas Telford	Bibliography	Basic
O'Connor & Shaw P.A. (2000), Bridge Loads, Spon Press	Bibliography	Basic
fib (2005), Guidelines for the design of footbridges, fib Bulletin nº 32	Bibliography	Basic
Priestley N., Seible F. & Calvi G.M. (1996), Seismic Design and Retrofit of Bridges, Wiley	Bibliography	Basic
Davidovici V.E. (1992), Earthquake Engineering and Structural Dynamics, Oquest Editions	Bibliography	Further reading
Chen W.F. & Duan L. (2003), Bridge Engineering: Seismic Design, CRC Press	Bibliography	Further reading
Kappos A.J., Saiidi M.S., Aydinoglu M.N. & Isakovic T. (2012), Seismic Design and Assessment of Bridges, Springer	Bibliography	Further reading

Simiu E. & Scanlan R.H. (1996), Wind effects on Structures, John Wiley & Sons	Bibliography	Basic
Dyrbye C. & Hansen S.O. (1996), Wind loads on structures, Wiley	Bibliography	Further reading
T.T. Soong and G.F. Dargush. Passive energy dissipation systems in structural engineering. John Wiley and Sons, Chichester (UK), 1997.	Bibliography	Basic
Strommen E. (2006), Theory of Bridge Aerodynamics, Springer	Bibliography	Basic
Área virtual de la ETSICCP. Área virtual (MOODLE)	Web resource	
Biblioteca del departamento de Mecánica de Medios Continuos y Teoría de Estructuras.	Equipment	

9. Other information

9.1. Other information about the subject