ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000437 - Design, Analysis And Construction Of Bridges

DEGREE PROGRAMME

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

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000437 - Design, Analysis And Construction Of Bridges
No of credits	4.5 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	04AM - Master Universitario Ingenieria de Estructuras, Cimentaciones y Materiales
Centre	04 - Escuela Tecnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Jose Manuel Simon-Talero Muñoz	Torre 9º	jm.simon-talero@upm.es	M - 14:00 - 16:00 W - 14:00 - 16:00
Diego Guillermo Manzanal Milano	Lab Mec Comp	d.manzanal@upm.es	W - 09:00 - 13:00 W - 14:00 - 16:00

Antonio Aureo Martinez Cutillas (Subject coordinator)	Torre 9º	a.martinez.cutillas@upm.es	Sin horario.

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

3. Skills and learning outcomes *

3.1. 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.

3.2. Learning outcomes

RA31 - Asume los principios de incertidumbre y riesgo en la aplicación de los métodos y modelos de estructuras para el estudio de los puentes.

RA3 - Interioriza los principios de deontología profesional para actividades de I+D+i

RA30 - Plantea el método de construcción de un puente

RA4 - Utiliza con eficacia recursos de información y comunicación

RA8 - Utiliza con eficacia recursos de modelización predictiva en una o más de las materias del módulo

RA2 - Presenta comunicaciones orales, escritas y gráficas, estructurada y argumentadamente, en lengua española e inglesa

* 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.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

The teacher will explain the concepts necessary to understand the concepts of the course in order for the student to achieve the expected indicators. The teacher will use appropriate practical examples and logical reasoning to develop the scientific and technical abilities of the student. The participation of students will be encouraged by means of discussions on the topics taught.

Practice lessons will be aimed at the resolution of exercises and case-studies. Practice lessons are intended as a correlation between the content of theory lessons and engineering practice, in order for the student to achieve the ability to apply the acquired knowledge in the future career. The teacher will first solve some exercises and case-studies to show the students how to work on their own later.

4.2. Syllabus

1. Introduction to non conventional, medium span or large span bridges

   1.1. Determinants that led to plan a non conventional bridge. Bridge typology. Examples.

2. The closed box section for a straight bridge

   2.1. Transverse and longitudinal morphology. Resistant behaviour: longitudinal bending, transverse bending, torsion, non uniform torsion, distortion

   2.2. application of numerical methods, bridge modelling.

   2.3. Construction: movable scaffolding system, launching girder, cantilever segmental construction, precast segments, incremental launching.

3. The skew bridge

   3.1. Morphology, supporting conditions, resistant behaviour, precast beams deck, slab deck, closed box deck. Modelling, prestressing. Applications.

4. The curved bridge

   4.1. Morphology, supporting conditions, resistant behaviour, precast beams deck, slab deck, closed box deck. Modelling, prestressing. Applications.

5. The portal frame bridge

   5.1. Morphology, supporting conditions,resistant behaviour depending on the ground and supporting conditions, prestressing design, construction, applications.

6. The railroad bridge

   6.1. Morphology. Special features of the hi-speed railroad bridges. Specific actions on railroad bridges.

   6.2. Spanish and European regulation. Serviceability conditions. Location of expansion joints in the bridge and on the road. Introduction to dynamic effects.

7. Arch bridges

   7.1. Morphology. Linkages. Resistant behaviour: deck bridge, through bridge, spandrel arch bridge, network arch bridge. Arch construction. Applications.

8. Cable-stayed bridges.

   8.1. Longitudinal morphology. Transverse morphology. Towers. Cable properties. Cable-stayed bridge behaviour against vertical and horizontal actions.

   8.2. Calculation of cable-stayed bridges. Definition of reference state. Modelling. Construction process: cantilever method, over provisional supports. Applications.

9. Extradosed bridges.

9.1. Longitudinal morphology. Transverse morphology. Towers. Cable properties. Extradosed bridge behaviour against vertical and horizontal actions.

9.2. Calculation of extradosed bridges. Definition of reference state. Construction process

10. Extraordinary actions.

10.1. Scouring: description, research, protection design. Ship collision: description, actions during the collision, calculation, protection against the ship collision.

11. Inspection and maintenance.

11.1. Bridge management. Periodic inspection policy. Maintenance programs. Bridge rehabilitation.

12. Integral and semi integral bridges.

12.1. Justification, morphology, design and analysis, applications.

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Unit 1** Duration: 03:45 Lecture		**Unit 1** Duration: 03:45 Lecture	
2	**Unit 2** Duration: 02:30 Lecture		**Unit 2** Duration: 01:15 Problem-solving class **Unit 2** Duration: 02:30 Lecture	
3	**Unit 2** Duration: 02:30 Lecture		**Unit 2** Duration: 02:30 Lecture **Unit 2** Duration: 01:15 Problem-solving class	
4	**Unit 2** Duration: 02:30 Lecture		**Unit 2** Duration: 02:30 Lecture **Unit 2** Duration: 01:15 Problem-solving class	
5	**Unit 3** Duration: 02:30 Lecture		**Unit 3** Duration: 02:30 Lecture **Unit 3** Duration: 01:15 Problem-solving class	
6	**Unit 4** Duration: 02:30 Lecture		**Unit 4** Duration: 02:30 Lecture **Unit 4** Duration: 01:15 Problem-solving class	
7	**Unit 5** Duration: 02:30 Lecture		**Unit 5** Duration: 02:30 Lecture **Unit 5** Duration: 01:15 Problem-solving class	

8	**Unit 6** Duration: 02:30 Lecture		**Unit 6** Duration: 02:30 Lecture **Unit 6** Duration: 00:45 Problem-solving class	**Midterm exam: It consists of an exam formed by several questions of a theoretical nature, related to the subjects explained to date and of a practical exercise.** Written test Continuous assessment Presential Duration: 02:00
9				
10	**Unit 7** Duration: 02:30 Lecture		**Unit 7** Duration: 02:30 Lecture **Unit 7** Duration: 01:15 Problem-solving class	
11	**Unit 8** Duration: 02:30 Lecture		**Unit 8** Duration: 02:30 Lecture **Unit 8** Duration: 01:15 Problem-solving class	
12	**Unit 9** Duration: 02:30 Lecture		**Unit 9** Duration: 02:30 Lecture **Unit 9** Duration: 01:15 Problem-solving class	
13	**Unit 10** Duration: 02:30 Lecture		**Unit 10** Duration: 02:30 Lecture **Unit 10** Duration: 01:15 Problem-solving class	
14	**Unit 11** Duration: 02:30 Lecture		**Unit 11** Duration: 02:30 Lecture **Unit 11** Duration: 01:15 Problem-solving class	
15	**Unit 12** Duration: 02:30 Lecture		**Unit 12** Duration: 02:30 Lecture **Unit 12** Duration: 01:15 Problem-solving class	
				Final exam: The first part consists of several questions of a theoretical and practical nature, corresponding to the subjects of the subject not included in the partial exam. All students should examine themselves in this part. Written test Continuous assessment Presential

16				Duration: 00:50 **Final Exam: The second part consists of several theoretical and practical questions corresponding to the topics related to the partial exam. They are not required to present themselves, only those who want to improve their grades. See evaluation criteria** Written test Continuous assessment Presential Duration: 00:50 **Final exam: the third part consists of a practical exercise related to the types of bridges which have been explained in the second half of the course** Written test Continuous assessment Presential Duration: 01:15 **Final Exam:It will be the same complete final exam that the continuous assessment students take** Problem-solving test Final examination Presential Duration: 03:00
17				

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.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
8	Midterm exam: It consists of an exam formed by several questions of a theoretical nature, related to the subjects explained to date and of a practical exercise.	Written test	Face-to-face	02:00	35%	3.5 / 10	CG1 CG4 CG5 CB6 CB9 CB10 CE11
16	Final exam: The first part consists of several questions of a theoretical and practical nature, corresponding to the subjects of the subject not included in the partial exam. All students should examine themselves in this part.	Written test	Face-to-face	00:50	65%	5 / 10	CG1 CG4 CG5 CB6 CB9 CB10 CE11
16	Final Exam: The second part consists of several theoretical and practical questions corresponding to the topics related to the partial exam. They are not required to present themselves, only those who want to improve their grades. See evaluation criteria	Written test	Face-to-face	00:50	%	3.5 / 10	
16	Final exam: the third part consists of a practical exercise related to the types of bridges which have been explained in the second half of the course	Written test	Face-to-face	01:15	%	3.5 / 10	

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
16	Final Exam:It will be the same complete final exam that the continuous assessment students take	Problem-solving test	Face-to-face	03:00	100%	5 / 10	CG1 CG4 CG5 CB6 CB9 CB10 CE11

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Extraordinary exam: it has the same structure as the final exam. It consists of two parts: one theoretical and another practical.	Written test	Face-to-face	02:00	100%	5 / 10	CG1 CG4 CG5 CB6 CB9 CB10 CE11

6.2. Assessment criteria

Clarification: The virtual teaching mode will have the same criteria and weights as the semi-presential mode both in the continuous assessment method and in the final exam only.

Through continuous assessment

PE1. Partial exam 50%

Description: Consists of an exam that has several theoretical and practical questions, related to the units treated during the classes until the exam date. The approximate duration of the exam will be 2 hour.

Evaluation criteria: The exam will be ranked from 0 to 10 doing the arithmetic mean of the score of each exercise.

Place and period: To be determined by the Head of Studies.

PE4. Final exam 50% or 100%

Description: It will consist of three parts. The first one will have several theoretical and practical questions related to the lessons of the midterm exam. It is not obligatory for the students who have reached a score of 3.5 or higher in the midterm exam to be examined of this part although they can be examined if they want to reach a higher score. For the students who do the midterm exam and the first part of the final exam it will also be taken into account the best of the scores reached in the two exams.

The second part, which will have to be done by all the students, has several theoretical and practical questions, related to the units not included in the midterm exam. All the students have to do this part.

The third part is a practical exercise related to the types of bridges which have been explained in the second half of the course. All the students have to do this part.

Evaluation criteria: Each exercise will be ranked from 0 to 10. The final score of the exam will be the arithmetic

mean of the scores obtained in the exercises. For the students who do the three parts, the weight of the final exam will be the 100% and for those who only do the second part, it will be the 65% and it will be combined with the partial exam which has a weight of 35%.
Place and period: To be determined by the Head of Studies. For organization reasons, first it will be done the second part of the subject (obligatory for all the students). Once this is done, the students who have to or want to do the first part of the subject will do the first part.

Results of the evaluation through continuous assessment

The final score will be the highest of the following:
- For the students who pass the midterm exam: PE1 (50%) and PE2 (505%), provided that the PE1 and PE2 marks are not lower than 3.5.
- For the students who do the complete final exam: PE2 (100%), provided that the PE2 mark is not lower than 3.5.

The subject will be passed if the final score is equal or greater than 5 and both exams are not lower than 3.5.
Those students with a score less than 5 will not pass the subject and will have another opportunity in the second period examination (extraordinary) which will have the same format as the evaluation through final exam only.

Evaluation through final exam only

Description: Consists of the same final exam as the one that will do the students who choose the continuous assessment evaluation.
Evaluation criteria: Each of the exercises will be ranked from 0 to 10 points. The final score will be the arithmetic mean of the scores obtained in each exercise provided that the marks obtained in the first and the second parts are not lower than 3.5.
Place and period: To be determined by the Head of Studies.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Hewson N.R. (2003), Prestressed Concrete Bridges, Thomas Telford	Bibliography	Basic
Manterola J. (2006), Puentes: Apuntes para su Diseño, Cálculo y Construción, Colegio de Ingenieros de Caminos, Canales y Puertos	Bibliography	Basic
Menn C.(1986), Prestressed Concrete Bridges, BirkHäuser Verlag	Bibliography	Basic
Walther R., Houriet B., Isler W., Moïa P. & Klein J.F. (1999), Cable Stayed Bridges, Thomas Telford	Bibliography	Basic
Benaim R. (2008), The Design of Prestressed Concrete Bridges, Taylos & Francis	Bibliography	complementary
Calgaro J.A. (1988), Projet et Construction des Ponts: Analyse Structurale des Tabliers de Ponts, Presses de l?École Nationale des Ponts et Chaussées	Bibliography	complementary
Leonhardt F. (1982), Bridges, Deustche Verlags-Anstalt	Bibliography	complementary
Liebenberg A.C. (1992), Concrete Bridges: Design and Construction, Longman Scientific and Technical	Bibliography	complementary
Monleón S. (1997), Ingeniería de Puentes: Análisis Estructural, Universidad Politécnica de Valencia	Bibliography	complementary

Svensson H. (2012), Cable Stayed Bridges: 40 Years of Experience Worldwide, Wiley	Bibliography	complementary
Área virtual de la ETSICCP. Área virtual (MOODLE).	Web resource	
Biblioteca del departamento de Mecánica de Medios Continuos y Teoría de Estructuras.	Equipment	

8. Other information

8.1. Other information about the subject

Theory lessons:

The teacher will explain the concepts necessary to understand the concepts of the course in order for the student to achieve the expected indicators. The teacher will use appropriate practical
examples and logical reasoning to develop the scientific and technical abilities of the student. The participation of students will be encouraged by means of discussions on the topics taught.

Practice lessons:

Practice lessons will be aimed at the resolution of exercises and case-studies. Practice lessons are intended as a correlation between the content of theory lessons and engineering practice, in order for the student to achieve the ability to apply the acquired knowledge in the future career. The teacher will first solve some exercises and case-studies to show the students how to work on
their own later.

Laboratory classes:

No laboratory classes will be conducted on this subject

Independent work:

The student shall study the contents explained in theory lessons and shall strive to solve the exercises and case-studies.

Group work:

There are not any specific group works.

Office hours

Office hours are intended as a complement for the students to ask questions on the content of the course. Details

of office hours are detailed at the beginning of this guide for each teacher.