Universidad Zaragoza

Academic Year/course: 2022/23

28935 - Irrigation and drainage systems in horticulture and fruit farming

Syllabus Information

Academic Year: 2022/23
Subject: 28935 - Irrigation and drainage systems in horticulture and fruit farming
Faculty / School: 201 - Escuela Politécnica Superior
Degree: 583 - Degree in Rural and Agri-Food Engineering
ECTS: 6.0
Year: 4
Semester: First semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

In this course, knowledge is provided for the design, calculation and management of irrigation and drainage systems.

The particular training objectives to be achieved upon completion of this course are the following:

- Knowing how to determine the water needs and irrigation schedule of horticultural and fruit crops.
- Knowing how to project and manage irrigation systems located on a plot.
- Knowing how to project and zonal and parcel drainage systems.
- Knowing how to dimension and project small hydraulic works (rafts, ditches, drains, collectors, etc.).

SDGs alignment:

Aforementioned goals are aligned with the following UN Sustainable Development Goals (SDGs), contributing to some extent to their development:

- *SDG 2*: Zero Hunger
- *SDG 6*: Ensure access to water and sanitation for all

and, in particular, with the following targets:

- *Target 2.4*: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.
- *Target 6.4*: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

1.2. Context and importance of this course in the degree

Almost all horticultural production requires the application of irrigation to cover the water needs of vegetables and fruit trees.

Some of the main fields of work of the graduates in Rural and Agri-Food Engineering are the realization of technical projects within their professional competences, which include the calculation of irrigation and drainage systems, as well as the management of water resources in Irrigation Communities, Hydrographic Confederations and the rest of the Administration.

The concepts and calculation methods explained in this course are based on the concepts presented in previous courses in subjects such as Geology, Edaphology and Climatology, Plant Science and Hydraulics. In turn, it serves as the basis for the Irrigation Networks course.

1.3. Recommendations to take this course

Having pursued the *Chemistry*, *Physics*, *Mathematics*, *Geology, Edaphology and Climatology*, *Plant Science* and *Hydraulics* courses in the first, second and third year of this Degree is strongly recommended.

Likewise, learning performance will certainly profit from investing time in the study of the subject and from attending all

sessions, both theoretical and practical.

2. Learning goals

2.1. Competences

The students who pass this course will have developed the following competences:

Generic or transversal competences:

- Apply their knowledge to their work or vocation in a professional manner and equip themselves with the skills that are typically demonstrated through the devise and defense of arguments and the solving of problems within their field of study.
- Be able to gather and interpret relevant data (usually within their field of study) that would allow them to make judgments that include reflections on relevant social, scientific or ethical issues.

Specific competences:

- Know, understand and use the principles of engineering of green areas, sports spaces and horticultural farms: irrigation and drainage.
- Acquisition of knowledge and systematics for the design, calculation and management of irrigation and drainage facilities.

2.2. Learning goals

The student, in order to pass this course, should be able to:

- Describe and synthesize the current state of irrigation and discuss its possible future evolution.
- Interpret water legislation.
- Identify and evaluate the most relevant properties of soil and water to determine their suitability for irrigation.
- Select the most appropriate method to estimate the evapotranspiration of the plants, based on the available data, and apply it.
- Predict the water needs of the different crops to set the design flow of an irrigation system and plan the most appropriate irrigation schedule for each crop, thus contributing to the efficient use of water resources and ensuring the sustainability of freshwater extraction and supply to address water scarcity (in line with targets 2.4 and 6.4).
- Calculate the balance of water in the soil.
- Describe and understand the basics of surface irrigation.
- Describe the elements of pressurized irrigation networks, classify the different sprinkler irrigation systems in a plot and compare them.
- Understand the fundamentals of drip irrigation and use them for the agronomic and hydraulic design of practical cases (in line with targets 2.4 and 6.4).
- Explain and express the principles of water movement in the soil. Solve the equations and quantify the uncertainty of data and results. Project parcel and zonal drainage systems.
- Interpret the principles of surface water behavior to design small hydraulic structures.

2.3. Importance of learning goals

The learning goals are important in order to be able to apply the methods of calculation, dimensioning and management of irrigation and drainage installations, of vital importance in the professional career of the graduates in Rural and Agri-Food Engineering, according to sustainability of food production systems criteria and applying agricultural practices that increase productivity and production and contribute to the maintenance of ecosystems (in line with target 2.4).

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that he/she has achieved the intended learning outcomes through the following evaluation activities:

Completion of a final exam at the end of the semester according to the syllabus of the subject (theoretical sessions and problems) and according to the date scheduled in the Center's official examination calendar for the two official calls.

This final exam will be a written test consisting of two different blocks of limited duration.

- *Block 1*: 10 questions about theoretical-practical contents, to be answered without the support of any

documentation.

- Block 2: resolution of 4 or 5 problems related to irrigation systems, drainage and hydraulic works, in which the students may make use of printed documentation.

Evaluation criteria:

The written test will be favorably graded if the chosen approach, the results, the order, the presentation and the interpretation are correct. The two parts of the exam will be graded on a 10 point scale.

Requirements to pass and to weight the various evaluation activities:

- If the grade in one of the two blocks is lower than 5.0, the student will fail. The grade obtained in any of the two blocks will not be saved for subsequent calls.
- If the grade in the two blocks is higher than 5.0, the final grade over 10 points will be obtained by applying the following formula:

Final grade (FG) = (0.3 * block 1 score) + (0.7 * block 2 score)

In the event that the above requirements are not met, the final grade will be obtained as follows:

- If FG > 4.0, the final grade will be: fail (4.0)
- If FG < 4.0, the final grade will be: fail (FG)

Alignment with SDGs

In relation to 2030 Agenda, the acquisition by students of the competences related to goals 2.4 and 6.4 will be evaluated mainly through the problems concerning agronomic design, water balance and design of drip irrigation systems. These assessment activities account for over 40% of the overall grade of the course.

Success rates in previous academic years

2018/2019	2019/2020	2020/2021
75.0%	75.0%	50.0%

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. Although a wide range of teaching and learning tasks are implemented, the learning process designed for this course is mainly based on the following teaching modalities:

- *Theoretical sessions*. Face-to-face modality in which the contents of the proposed topics will be developed. It comprises the lectures (master classes) and debate.
- *Practical sessions focused on engineering problems solving*, during which questions and problems will be raised and solved in the classroom, using numerical calculation or software tools, and experimental field trials (flow measurement and infiltration tests).

4.2. Learning tasks

This is a 6 ECTS course. The program that the student is offered to help him/her achieve the expected results includes the following activities:

- *Theoretical sessions*: at the beginning of each session, the theoretical content that the teacher will cover in the class will be described. So as to develop reasoning abilities and in order to extend the study conditions, during these classes the students will also participate in the resolution of the issues raised and not explained by the teacher.
- *Problem-solving sessions*: a collection of exercises and problems will be provided for each of the topics covered in the syllabus. Some of those engineering problems will be solved in the classroom, leaving the rest for the autonomous work of the student. The proposed problems will address issues aimed at facilitating the learning of the theoretical foundations explained in the theoretical sessions and also different aspects representative of the engineering problems that occur during the development of a real irrigation, drainage or hydraulic project. In the case of lab sessions involving software tools, links will be provided for downloading the software installation files (in the case of free tools), as well as program manuals and video-tutorials.
- *Experimental field trials*. Measurements of flow rates and infiltration rates will be carried out.
- *Office hours*. Meetings with the teacher, either in the teacher's office or virtually, either individually or in groups, for those students struggling with classes. To make the most of these office hours, previous work and having checked the recommended bibliography, both basic and supplementary, is strongly encouraged.

- *Non-contact activities*. Non-contact activities basically consist in reinforcing what has been explained in the classroom, solving proposed exercises or problems and drafting reports for the lab sessions (i.e., guided and individual self-study).

In relation to the SDGs, several of the theoretical and practical sessions are closely related to SDGs 2 and 6, as indicated in section 4.3 of this syllabus.

4.3. Syllabus

The course will address the following topics:

Theoretical contents:

1. Introduction
2. Soil and water properties related to irrigation
3. Surface irrigation
4. Sprinkler irrigation
5. Drip irrigation
6. Drainage
7. Design of small hydraulic structures

Practical contents:

Lab sessions with software tools

1. Calculation of crop water requirements with CropWAT and ClimWAT.
2. Simulation of surface irrigation with SIRMOD.
3. Hydraulic calculation of pipes and weirs with FlowMaster.
4. Hydraulic calculation and simulation of uniformity distribution in sprinkler and micro-sprinkler irrigation with NaanCAT.
5. Design of drip irrigation systems with AquaFlow / HydroCalc / DIDAS.
6. Design of non-rectangular modules, main pipes and irrigation stations with Aqua.
7. Catchment and stream delination in qGIS.

Field trials

1. Practice on water flow measurement.
2. Practice on water infiltration in the soil.

Alignment with SDGs

In relation to the SDGs, the topics covered in the course directly contribute to the acquisition of competencies linked to targets 2.4 and 6.4, given that they address practices that increase water use efficiency and reduce runoff, helping to improve water quality and, in some cases, conserve water that may be available for other uses. Students are introduced to how to adapt irrigation methods and technologies to improve efficiency, evaluate crop choices based on climate and water availability, institute techniques or technologies to limit or improve runoff water quality, changes in management practices and behaviors that lead to efficiency gains (e.g., reducing losses/leakage within the water system), etc.

4.4. Course planning and calendar

Student workload distribution

Face-to-face sessions			Autonomous work	Assessment
Theoretical sessions	Problem-solving sessions	Experimental field trials		
30	25	5	84	6

Schedule of face-to-face sessions

Week	Theoretical sessions (h)	Practical sessions (h)
1	2	2
2	2	2
3	2	2
4	2	2
5	2	2
6	2	2
7	2	2

8	2	2
9	2	2
10	2	2
11	2	2
12	2	2
13	2	2
14	2	2
15	2	2
Total	30	30

The theoretical sessions will be conducted in the classroom for the entire teaching group. Students will have support material for the follow-up of the course, which will be provided through Moodle. It is also advisable that they take notes during the sessions.

In the problem-solving sessions, the instructor will pose diverse problems to be solved, and after deliberation with the students, their results will be solved and discussed.

The final exam will be conducted on the date appointed by the Higher Technical School of Huesca Board, according to the official examination schedule. Further details on the timetable, classroom, office hours, and other details regarding this course will be provided on the first day of class.

4.5. Bibliography and recommended resources

BB Agua y agronomía / Obra dirigida y coordinada por Francisco Martín de Santa Olalla Mañas, Prudencio López Fuster, Alfonso Calera Belmonte. Madrid : Mundi-Prensa, 2005

BB Gavilánez Luna, F. El drenaje agrícola y sus elementos de diseño. - Mawil, (2020).

BB MOYA TALENS, J. A. Riego localizado y fertirrigación (4a. ed.). [s. l.], 2009.

BB Pascual España, B. y Pascual Seva, N. Riegos de gravedad y a presión. Editorial de la Universidad Politécnica de Valencia, (2020)

BB Tarjuelo Martín-Benito, José Mª. El riego por aspersión y su tecnología / José Mª Tarjuelo Martín-Benito. 3ª ed. rev. y amp. Madrid [etc.] : Mundi-Prensa, 2005

BC Castañón Lión, Guillermo. Ingeniería del riego : utilización racional del agua / Guillermo Castañón. Madrid : Paraninfo, D.L. 2000

BC Chow, Ven Te. Hidraúlica de canales abiertos / Ven Te Chow ; traducción, Juan G. Saldarriaga ; revisión técnica, Antonio Zuluaga Angel. [1a. ed.]. Santafé de Bogotá : McGraw-Hill, cop. 1994

BC Crop evapotranspiration : guidelines for computing crop water requirements / by Richard G. Allen ...[et al.]. Rome : FAO, 1998

BC Díaz Ortiz, J. E. Riego por gravedad. Programa Editorial Universidad del Valle,(2006)

BC Drainage Principles and Applications / H.P. Ritzema (editor-in-chief). 2nd. ed. [completely revised]. Wageningen (Netherlands): ILRI, 1994

BC Escribá Bonafé, Domingo. Hidraúlica para ingenieros / Domingo Escribá Bonafé. [1a. ed.]. Madrid : Belliso, 1988

BC Fertirrigación : cultivos hortícolas, frutales y ornamentales / obra colectiva dirigida y coordinada por Carlos Cadahía. 3ª ed. rev., act. y ampl. Madrid [etc.] : Mundi-Prensa, 2005

BC Gómez Pompa, Pedro. Instalaciones de bombeo para riego y otros usos / Pedro Gómez Pompa. Madrid : Agrícola Española, D.L. 1993

BC Losada Villasante, Alberto. El riego. II, Fundamentos de su hidrología y de su práctica / A. Losada Villasante. Madrid : Mundi-Prensa, 2005

BC Martinez Beltran, Julián. Drenaje agrícola / Julián Martínez Beltrán. [Madrid] : Secretaría General Técnica, Ministerio de Agricultura, Pesca y Alimentación, 1986

BC MARTÍNEZ CORTIJO, F. J. Introducción al riego. [s. l.], 2014.

BC Monge Redondo, Miguel Ángel. Diseño agronómico e hidráulico de riegos agrícolas a presión / Miguel Ángel Monge Redondo. Madrid : Editorial Agrícola : Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente, 2018

BC Paco López-Sánchez, José Luis de. Fundamentos del cálculo hidraúlico en los sistemas de riego y drenaje / José Luis de Paco López-Sánchez. Madrid : Mundi-Prensa : MAPA-IRYDA, D.L. 1993

BC Pizarro Cabello, Fernando. Drenaje agrícola y recuperación de suelos salinos / Fernando Pizarro. 2a. ed. Madrid : Agrícola Española, 1985

BC RAMÍREZ GUTIÉRREZ, A. Riego por goteo simplificado. [s. l.], 2001.

BC Riego localizado / J. Rodriguez López... [et al.]. Madrid : IRYDA : Mundi-Prensa, D.L. 1992

LISTADO DE URLs:

Brouwer, C., Prins, K., Kay, M., Heibloem, M. (1988). Irrigation water management: irrigation methods. Roma: FAO, Training manual 5 [english friendly]
[http://www.fao.org/3/S8684E/s8684e00.htm]

iAgua, revista online sobre el sector del agua.
[https://www.iagua.es/]

Kraatz, D.B., Mahajan, I.K. (1982). Small hydraulic structures (Vol. 1). Roma: FAO. Irrigation and Drainage Paper 26/1 [English friendly]
[http://www.fao.org/3/f6268e/f6268e.pdf]

Kraatz, D.B., Mahajan, I.K. (1982). Small hydraulic structures (Vol. 2). Roma: FAO. Irrigation and Drainage Paper 26/2 [English friendly]
[http://www.fao.org/3/a-bl046e.pdf]

Repositorio FAO Water. Seleccionar "Irrigation & Drainage" en el campo "Series".
[http://www.fao.org/land-water/outreach/publications/en/]

Repositorio International Water Management Institute
[https://www.iwmi.cgiar.org/publications/latest/]

Van den Bosch, B.E., Snellen, W.B. (1993). Structures for water control and distribution. Roma: FAO, Irrigation Water Management Training Manual 8 [english friendly]
[http://www.fao.org/3/a-ai586e.pdf]

The updated recommended bibliography can be consulted in:http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28935