Universidad Zaragoza

Academic Year/course: 2021/22

28928 - Livestock farming facilities and equipment

Syllabus Information

Academic Year: 2021/22
Subject: 28928 - Livestock farming facilities and equipment
Faculty / School: 201 - Escuela Politécnica Superior
Degree: 583 - Degree in Rural and Agri-Food Engineering
ECTS: 6.0
Year: 3 and 4
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

This course and its expected outcomes meet the following goals:

- Acquire criteria to establish the bases for the design of livestock housing.
- Determine the environmental, physiological and available space requirements of the main livestock species.
- Establish the different aspects of environmental control in livestock housing.
- Technically describe and gauge the necessary facilities for ventilation, heating and cooling in livestock housing.
- Technically describe and gauge the necessary equipment for the distribution of food and water, as well as other livestock housing facilities: lighting, milking, sanitation and waste management.

SDGs alignment:

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

- *Goal 2*: Zero Hunger
- *Goal 7*: Affordable and clean energy.
- *Goal 9*: Build resilient infrastructure, promote sustainable industrialization and foster innovation
- *Goal 12*: Ensure sustainable consumption and production patterns

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 7.2*. By 2030, increase substantially the share of renewable energy in the global energy mix
- *Target 7.3*. By 2030, double the global rate of improvement in energy efficiency
- *Target 9.4*. By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
- *Target 12.4*. By 2030, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
- *Target 12.5*. By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

It should also be noted that the knowledge acquired in terms of energy efficiency and integration of renewable energies is fully aligned with the objectives of the Spanish National Integrated Energy and Climate Plan (PNIEC), which envisages a 30% improvement in the energy efficiency of farms in the period 2021-2030, as well as a tripling of the consumption from renewable sources in farms by 2030.

1.2. Context and importance of this course in the degree

This is an eminently applied course, with a physiological basis, but with a technical orientation closely linked to the proper functioning of livestock facilities.

The design and sizing of the different systems of environmental control and equipment in different livestock facilities is an aspect of crucial importance in this Degree, complementing in a precise manner the knowledge acquired in other courses of the Degree in the basic engineering and animal production areas. The knowledge that is taught in this course can be deemed as almost essential for the engineer to know how to properly identify the different existing air conditioning systems, in order to solve problems and to perform the appropriate calculations. In this sense, a very high percentage of the pathological problems or of the productive problems detected at the exploitation level can be avoided or solved with an adequate environmental control.

On the other hand, the knowledge and sizing of the most suitable equipment for the distribution of food and water is an essential basis for any engineer who develops his/her professional activity in the agricultural sector.

Undoubtedly, the importance of the objectives and competences provided by the subject will increase over time, as future graduates should know how to assess the suitability of different environmental control systems, both to design and to build them, and to evaluate their effectiveness and possible improvements and relate them to animal welfare aspects, with a view to achieving an adequate profitability of farms on the basis of efficiency and energy savings.

1.3. Recommendations to take this course

This course is also offered in the *English Friendly* format.

Having pursued the Mathematics I and II; Physics I and II; Graphic expression; Electrotechnics and rural electrification; Animal Science I and II; and Projects courses is strongly recommended. Attending class regularly is also advised so as to make the most of this course.

2. Learning goals

2.1. Competences

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

- Know, understand and use the engineering principles of agricultural farms: facilities for animal health and welfare.
- 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.

2.2. Learning goals

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

- Select and size the space and feeding needs for a livestock housing facility according to the principles of animal welfare and according to the current regulations.
- Calculate both the insulating capacity of livestock buildings and the heat balances in them, technically justifying the choice of construction materials. To this end, in addition to his/her knowledge of the influence of animals on the changes in the environment of livestock farms, on the mechanisms of heat transmission in construction elements and on the thermal insulating materials and their qualities, the student will take into account sustainability and energy efficiency criteria (in line with target 9.4).
- Quantify the ventilation and air-conditioning needs of livestock housing facilities, selecting and sizing the components of the corresponding facilities, prioritizing animal welfare needs as well as sustainability (in line with target 2.4). Make a more efficient use of resources and promote the adoption of clean and environmentally sound technologies and processes, including the integration of renewable energies in agricultural and livestock facilities (in line with targets 7.2, 7.3 and 9.4).
- Describe and technically justify other livestock housing facilities: lighting, milking, sanitation and waste management facilities. In relation to waste management, the student will seek to reduce the generation of waste and minimize its adverse effects on the environment (in line with SDG 12).

2.3. Importance of learning goals

The achievement of the learning results planned for this course will partly facilitate the acquisition by the students of a specific competence of the specialty. This competence (CE24) is of obligatory fulfillment when dealing with a Degree with professional attributions.

On the other hand, the strengthening of certain generic or transversal competences (capacity for analysis and synthesis, oral and written communication, information management skills, teamwork, autonomous learning capacity and personal commitment skills) will contribute, together with the rest of the courses, to the integral formation of future graduates in Rural

and Agri-Food Engineering.

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:

1. A written test of the Engineering part of the course (according to the syllabus). The value of this exam will be 50% of the final grade. The test will consist in both theoretical questions and problems. The total grade of the test will be 5 points, out of which 1.5 points will correspond to the theory part and 3.5 points to the problems part. Students need ?2.5 points to pass the Engineering part.
2. A written test and a practical assignment of the Animal Production part of the course (according to the syllabus). The value of this part will be 50% of the final grade. The written test will consist in several short (or test type) questions related to all the contents taught during the academic year. There will also be a practical assignment related to the sizing of a farm with the incorporation by the student of the sustainability criteria in the development of his/her proposal. The total grade of this part will be 5 points, and students need ?2.5 points to pass the Animal Production part.

In relation to the SDGs, the acquisition by the students of the competences related to SDGs 7 and 9 will be assessed in the written test theoretical questions and problems of the Engineering part, with a specific theoretical question (0.3 points) and two closely related problems (2 points), which represent 23% of the final grade of the course.

Assessment criteria

Written tests and papers: the correctness, concreteness and orderly exposition of concepts, as well as the establishment of relationships between techniques applicable in different fields will be positively valued. The quality of the scientific information provided will be especially valued in the papers.

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. A wide range of teaching and learning tasks are implemented. The learning process designed for this course is based on the following teaching modalities:

- *Lectures*. Face-to-face modality in which the contents of the course syllabus will be covered. This modality comprises the lectures (master classes) and debates.
- *Practical sessions focused on engineering problems solving*. Modality in which problems related to the contents of the course will be solved, applying the fundamental concepts learnt in the theoretical classes.
- *Guided and individual self-study*. Non-contact modality focused on the autonomous work of the student so as to complete various learning activities.
- *Technical visits*. In this modality, students will acquire a practical and realistic view of the theoretical and practical contents covered throughout the course.
- *Office hours*. Meetings with the teacher, either in the teacher's office or virtually, for those students struggling with classes.

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:

- *Lectures*: 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 project.
- *Lab sessions*: students will interpret the theoretical and real operation of different livestock farm facilities, learning how to justify them by numerical calculations and through the use of instruments and specific software.

- *Supervised work sessions,* in which the student will carry out a non-presential task proposed by the teachers and focused on the justification and implementation of livestock facilities.

4.3. Syllabus

The course will address the following topics:

Section I: Introduction to animal welfare

- Topic 1: Importance of livestock farms in the general context of animal science. Adequacy of requirements of stockmen and animals. Importance of well-being in livestock farms.
- Topic 2: Concept of animal welfare. Physiology of stress. Relationship between animal behavior and welfare.
- Topic 3: European, national and regional rules on livestock buildings.
- Topic 4: Environmental requirements in the main livestock species ? ruminants, monogastric animals and poultry. Space requirements, temperature and relative humidity in the different stages of production and their practical implications. Acceptable gas concentrations
- Topic 5: Main methods of heat exchange between the animal and its environment. Thermoneutral zone. Lower critical temperature. Higher critical and evaporation temperature. Factors modifying critical temperatures. Heat losses by convection, conduction and radiation. Sensible heat. Heat losses by evaporation. Latent heat. Comfort in livestock farms.

Section II: Insulation and air conditioning in livestock farming facilities

- Topic 6: Insulation. Thermal equilibrium. Gains and losses of heat in livestock farms. Concept and importance of thermal insulation. Heat transfer coefficients. Insulation of walls, roof and screed.
- Topic 7: Psychrometrics. Psychrometric charts. Air cooling. Sensible cooling. Cooling and dehumidification. Changes in latent and sensible heat. Moisture removal. Air mixture at different conditions.
- Topic 8: Ventilation. Concept and objectives of ventilation in livestock farms. Bases for the calculation of the needs of air renewal in winter and in summer for the different animal species. Static or natural ventilation. Types of static ventilation ? horizontal and vertical. Calculation of the air inlet and outlet sections and their relation with speed. Forced ventilation. Types of fans. Ventilation by depression or extraction, with natural or pre-treated air intake. Calculation of the air inlet section. Ventilation by overpressure. Calculation of the airspeed at the level of animals. Automation of ventilation. Continuous or proportional regulation of ventilation.
- Topic 9: Heating and cooling. Calculation of heating needs. Types of heating for livestock farms. Selection criteria for heating systems. Cooling in livestock housing facilities. Foundations of evaporative cooling. Cooling by a panel or by nozzles. Bases for the calculation and the expected reduction of temperature.
- Topic 10 (*): Energy saving and efficiency in livestock facilities (in line with target 9.4). Energy needs. Measures for energy efficiency improvement: watertightness and insulation of livestock housing buildings, regulation of the air conditioning and illumination equipment, revision and maintenance of the equipment. Integration of renewable energies (aligned with SDG 7). Energy valorization of livestock waste (aligned with SDG 12). Energy audits in livestock housing facilities: implementation protocols. Practical cases.

Section III: Facilities and buildings for different livestock

- Topic 11: Design and dimensioning of housing for pigs. Types of accommodations. Systems for the distribution of food and water. Systems for the elimination of droppings. Complementary and auxiliary material. Waste management.
- Topic 12: Design and dimensioning of confinement houses for egg-laying hens and buildings for broilers. Systems for the distribution of food and water. Systems for the elimination of droppings. Complementary and auxiliary material. Waste management.
- Topic 13: Design and dimensioning of buildings for dairy and beef cattle. Types of buildings. The milking machine. Milking rooms for dairy cattle. Systems for the distribution of food and water. Systems for the elimination of droppings. Complementary and auxiliary material.
- Topic 14: Design and dimensioning of sheep housing. Types of buildings. Advantages and disadvantages. Food distribution systems. The milking parlor. Tools. Waste management.
- Topic 15: Design and dimensioning of goats housing. Types of buildings. Advantages and disadvantages. Food distribution systems. The milking parlor. Tools. Waste management.
- Topic 16: Design and dimensioning of buildings for rabbits. Types of buildings. Advantages and disadvantages. Food distribution systems. Tools. Waste management.

(*) Note: Topic 10 will be taught after topics 11 and 12, once the contents corresponding to pig and poultry farming facilities have been covered, since energy saving measures are especially relevant in these two intensive livestock farming sectors.

Practical sessions:

- Animal welfare control in a livestock house

- Practical handling of animals according to their welfare
- Visit of a livestock farm
- Exercises related to the calculation of insulation and the design of ventilation and air conditioning systems in livestock housing facilities. These exercises will be covered in an integrated manner with the theoretical contents, interspersed in the corresponding sessions.
- Exercises related to the dimensioning of livestock farming facilities. These exercises will be addressed in an integrated manner with the theoretical content, interspersed in the corresponding sessions.

4.4. Course planning and calendar

Schedule:

Week	Theoretical sessions	Practical sessions	Syllabus
1	2	2	Introduction to animal welfare
2	2	2	
3	2	2	
4	2	2	Insulation and air conditioning in livestock farming
5	2	2	
6	2	2	
7	2	2	Facilities and buildings for different livestock
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**	

Student workload distribution:

Face-to-face			**Non-contact**
Theory sessions	**Problem-solving and practical sessions**	**Assignments**	
30	25	5	90

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 information concerning 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 CALLEJO RAMOS, A. Cow comfort?: El bienestar de la vaca lechera. [s. l.]: Servet, 2009. ISBN 9788492569205.

BB FORCADA MIRANDA, F. Ganado porcino?: diseño de alojamientos e instalaciones. [s. l.]: Servet, 2009. ISBN 9788492569076.

BB Fuentes Yagüe, José Luis. Climatización de alojamientos ganaderos. José Luis Fuentes Yagüe. Madrid : Ministerio de Agricultura, Pesca y Alimentación, Publicaciones de Extensión Agraria, 1985

BB García-Vaquero Vaquero, Emilio. Diseño y construcción de alojamientos ganaderos / Emilio García-Vaquero Vaquero. 3a. ed. rev. y amp. Madrid : Mundi-Prensa, 1987

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BC Aland, A., Banhazi, T. (2013). Livestock housing: Modern management to ensure optimal health and welfare of farm animals. Wageningen Academic Publishers [english friendly]

BC Alojamientos e instalaciones. I / Coordinador y director, Carlos Buxadé Carbó ; con la participación de 12 autores. Madrid [etc.] : Mundi-Prensa, 1997

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BC Curtis, S.E. (1983). Environmental management in animal agriculture. Iowa State University Press [english friendly]

BC Flanders, F., Gillespie, J.R. (2016). Modern Livestock & Poultry Production, 9th Edition. Cengage Learning [english friendly]

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BC GONZALEZ, C. Diseño y cálculo de instalaciones de climatización. [S. l.] : Cano Pina, 2015. ISBN 978-84-15884-76-7.

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BC Housing of Animals Construction and Equipment of Animal Houses. In: Developments in Agricultural Engineering, Volume 6. A. Maton, J. Daelemans, J. Lambrecht (Eds.) Elsevier, 1985 [english friendly]

BC Livestock housing / edited by C.M. Wathes and D.R. Charles. Wallingford : Cab Internacional, cop. 1994 [English Friendly]

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BC MIRANDA, Á. L. Técnicas de climatización. 2ª ed. [s. l.]: Marcombo, 2008. ISBN 9788426714763.

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BC TOBAJAS, M. C. Energía solar térmica para instaladores (5a. ed.). [S. l.] : Cano Pina, 2017. ISBN 978-84-17119-37-9.

LISTADO DE URLs:

Animal Production and Health, FAO
[http://www.fao.org/Ag/AGAInfo/resources/en/pubs_aprod.html]

Mrmema, G.C.,et al. (2011). Rural structures in the tropics: Design and development. FAO
[http://www.fao.org/docrep/015/i2433e/i2433e.pdf]

The updated recommended bibliography can be consulted in:
http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28928