COURSE OUTLINE

1. GENERAL

SCHOOL	School of Agricultural Sciences		
ACADEMIC UNIT	Agriculture		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	AGRI_EX24	**SEMESTER**	7th or 9th
COURSE TITLE	Thermal - Cooling Machines for the Preservation of Agricultural Products		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	2	
Tutorials	0	
Laboratory	2	
TOTAL	**4**	**5**
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General knowledge
PREREQUISITE COURSES:	There are no prerequisite courses.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek .-For Erasmus students in English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course, the student will be able to

- Understand the principles of conduction, convection and radiation
- Understand the principle of various heat and refrigeration cycles.
- Understand the refrigeration, refrigerant properties and analyze the design of refrigeration system.
- Understand the principle of psychometric processes and air conditioning.
- Analyze the principle and operation of cold storage plant.
- Apply the knowledge of drying and dehydration in food industries
- Analyze the different drying and dehydration models for various food commodity
- Compute the drying and dehydration behavior for different food commodity
- Select the appropriate dryer for selected food commodity
- Analyze the economic aspects of storage and understand storage condition for various fruits and vegetables under cold and storage system.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*…..…*
Production of new research ideas	*Others…*
	……

In general, upon completion of this course the student will have further developed the following general skills (from the list above):
Search, analysis and synthesis of data and information, using the necessary technologies
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Respect for the natural environment
Exercise criticism and self-criticism

3. SYLLABUS

1. Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow process. Carnot cycle, Carnot theorem.
2. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. Principles of refrigeration, - units, terminology, and air refrigerators working on reverse Carnot cycle and Bell Coleman cycle, open air refrigeration cycle, merit demerit of air refrigeration. Vapour refrigeration-mechanism, P-V, P-S, P-H diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling.
3. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement.
4. Psychometric chart and its use, elementary psychometric process. Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods.
5. Fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications,
6. Food preservation, Domestic refrigerators, commercial refrigerators, method of Food freezing. Study of cold storage for fruits and vegetable, freezing load and time calculations for food materials, study of window air conditioners repair and maintenance of refrigeration and air conditioning systems and chilling or ice making and cold storage plants
7. Moisture content and methods for determination, importance of EMC and methods of its determination, EMC curve and EMC model, principle of drying, theory of diffusion, mechanism of drying- falling rate, constant rate, thin layer, deep bed and their analysis, critical moisture content, drying models.
8. Calculation of drying air temperature and air flow rate, air pressure within the grain bed, Shred's and Hukill's curve, different methods of drying including puff drying, foam mat drying, freeze drying, etc.
9. Study of different types of dryers- performance, energy utilization pattern and efficiency, study of drying and dehydration of agricultural products.
10. Types and causes of spoilage in storage, conditions for storage of perishable products, functional requirements of storage, control of temperature and relative humidities inside storage, calculation of refrigeration load; modified atmospheric storage and control of its Environment, air movement inside the storage,
11. Storage of grains: destructive agents, respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through natural ventilation, mechanical ventilation, artificial drying, traditional, improved and modern grain storage

structures, warehouse - design and control of environment

12. Storage of cereal grains and their products, storage of seeds, hermetically sealed and air cooled storages refrigerated, controlled atmosphere, modified atmospheric and frozen storages.
13. Storage condition for various fruits and vegetables under cold and CAP storage system. Economic, aspects of storage

Lab. Exercises

1. Determination of the various components of drying systems
2. Determination of the various components of refrigeration systems
3. Experiments on working details of a cold storage plant and air conditioning unit
4. Experiment on humidifier for the determination of humidifying efficiency- dehumidifying efficiency
5. Storage condition for various fruits and vegetables under cold and drying storage system.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures in the classroom and laboratory
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of ICT (power point) in Teaching • Use of ICT (power point) in Laboratory Training • Use of ICT in Communication with students (Learning process support through the electronic platform e-class).
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non directed study according to the principles of the ECTS*	

Activity	***Semester workload***
Lectures	26
Laboratory	26
Writing short reports of laboratory exercises	13
Final Exams	3
Study hours and preparation for the laboratory exercises and the final examination	57
Course total	**125**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. The laboratories participate by 30% in the final grade. In order to be examined in theory, the student must have completed all the laboratories and have been successfully examined in them. 2. The laboratories participate by 30% in the final grade. In order to be examined in theory, the student must have completed all the laboratories and have been successfully examined in them. 3. The main assessment criteria focus on understanding and correlating the knowledge that students gain from the course with other knowledge. Particular emphasis is placed on whether they have developed the ability to apply this knowledge to crop selection and to assess the impact of these changes on the environment. Emphasis is also placed on demonstrating critical ability and justifying the choices they make in each problem. 4. Evaluation is dynamic. It mainly involves problem solving. is done orally or in writing or with a combination of the two, with or without pre-examination on the basic principles of the course, with

	or without exculpatory advances and with other test or inventive methods, depending on the composition of the dynamics and the needs of the audience. 5. The above are done in the Greek language. For foreign language students (eg Erasmus students) conducted in English

5. RECOMMENDED LITERATURE

Suggested bibliography:

- ΘΕΡΜΑΝΣΗ -ΚΛΙΜΑΤΙΣΜΟΣ (ΕΠΙΤΟΜΟ) Κωδικός Βιβλίου στον Εύδοξο: 13169965 Έκδοση: 3/2002 Συγγραφείς: Β. ΣΕΛΛΟΥΝΤΟΣ ISBN: 9608257042 Τύπος: Σύγγραμμα Διαθέτης (Εκδότης): ΣΕΛΚΑ - 4Μ ΕΠΕ https://service.eudoxus.gr/search/#a/id:13169965/0

- Η τεχνολογία της ψύξης Κωδικός Βιβλίου στον Εύδοξο: 22829 Έκδοση: 1η έκδ./2007 Συγγραφείς: Αλέξης Γιώργος Κ. ISBN: 9789603517290 Τύπος: Σύγγραμμα Διαθέτης (Εκδότης): ΕΚΔΟΣΕΙΣ ΣΤΑΜΟΥΛΗ ΑΕ

-Complementary bibliography:

- ΘΕΡΜΑΝΣΗ - ΨΥΞΗ – ΚΛΙΜΑΤΙΣΜΟΣ Κωδικός Βιβλίου στον Εύδοξο: 59303648 Έκδοση: 1/2016 Συγγραφείς: ΔΗΜΗΤΡΙΟΣ ΚΑΤΣΑΠΡΑΚΑΚΗΣ ISBN: 978-960-603-339-1 Τύπος: Ηλεκτρονικό Βιβλίο Διαθέτης (Εκδότης): Ελληνικά Ακαδημαϊκά Ηλεκτρονικά Συγγράμματα και Βοηθήματα - Αποθετήριο "Κάλλιπος"