COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_K420**	**SEMESTER**	**4**
COURSE TITLE	PRINCIPLES OF TELECOMMUNICATION SYSTEMS		

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	3	
Seminars / Practice exercises	0	
Laboratory	1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	4	5

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Special background
PREREQUISITE COURSES:	No. It is suggested that students have already attended the course: ECE_K340 Signals and Systems
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No.
COURSE WEBSITE (URL)	https://www.ece.uop.gr/

(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*

This course aims to introduce students to the scientific and technological fields of telecommunications, with particular emphasis on the analog modulation/demodulation techniques, such as amplitude modulation (AM), frequency and phase modulation (FM/PM), as well as pulse code modulation (PCM). In the context of the course a theoretical study of the signals and of the modulations is carried out both in the time and the frequency domain using Fourier transform. Also, signal multiplexing both in time and frequency domain is studied. The course includes laboratory exercises aiming at the study of the basic modulation and demodulation techniques as well as the effect of basic parameters on their efficiency.

Keywords: analog communications, amplitude modulation, angle modulation, amplitude/phase spectrum, analog to digital conversion, pulse modulation, AM, DSB, SSB, VSB, FM, PM, NB-FM, FDM, TDM, DM, ADM, PCM, DPCM, ADPCM.

At the end of this course the students should:
At the knowledge level:

1. Know the representation of signals at the frequency domain.
2. Know the basic concepts of analog communication systems.
3. Have understood the operation principles of analog modulation/demodulation.
4. Have understood the frequency and time domain multiplexing.
5. Know the stages of analog-to-digital conversion
6. Have understood the sampling theorem.
7. Have understood the operation principles of pulse modulations.
8. Have become familiar with the experimental study of telecommunication systems
9. Know the effect of modulation parameters to the efficiency of the communication systems.

At the skill level - abilities:

1. Calculate and draw the magnitude/phase spectrums of the information, carrier, modulated and demodulated signals of both amplitude and angle modulations.
2. Calculate the modulation index and the bandwidth of all types of amplitude and angle modulations.
3. Explain the differences between coherent (synchronous) and incoherent (asynchronous) demodulators.
4. Evaluate the effect of phase and/or frequency shift on coherent demodulators.
5. Calculate the parameter values for analog-to-digital conversion, the quantization error and the bit rate of the PCM signal.

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…*
	…….

- Search, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently.
- Teamwork (at the laboratory).
- Working in an international environment.
- Production of free, creative and inductive thinking.

(3) SYLLABUS

Lectures

1. **Introduction to telecommunications**

   Introduction to communication systems, structure and entities of communication systems, electromagnetic spectrum.

2. **Signals at the time domain**

   Continuous- and discrete-time signals, analog and digital signals, periodic and non-periodic signals, energy and power signals, average and rms value, average power, energy.

3. **Signals at the frequency domain**

   Frequency domain, Fourier Series and Fourier Transform, spectral density, frequency response, amplitude and phase spectrum.

4. **Fourier analysis**

   Fourier analysis of periodic signals, representation in orthogonal, polar and complex exponential form, frequency spectra.

5. **Amplitude modulation double-sideband**

   Types of analog modulation, double-sideband (DSB) modulation/demodulation, effect of phase and frequency error on synchronous DSB demodulation.

6. **Ordinary amplitude modulation**

   Ordinary AM modulation/demodulation (AM), sinusoidal AM (tone modulation), modulation index, efficiency, modulators/demodulators.

7. **Amplitude modulation single- and vestigial-sideband**

   Single-sideband (SSB) and vestigial-sideband (VSB) modulation/demodulation.

8. **Super-heterodyne receiver – frequency-division multiplexing**

   Super-heterodyne AM receiver, frequency conversion and mixing, frequency-division multiplexing (FDM).

9. **Angle modulation**

   Phase modulation (PM), Frequency modulation (FM), frequency spectra.

10. **Angle modulation**

    Narrowband angle modulation, sinusoidal (tone modulation), narrowband PM and FM (NB-PM, NB-FM), bandwidth, Bessel functions, modulation index, frequency deviation, modulators/demodulators

11. **Digital transmission of analog signals**

    Sampling theorem, quantization, quantization error, encoding.

12. **Digital transmission of analog signals**

    Pulse-code modulation (PCM), Differential PCM (DPCM), Delta modulation (DM), Adaptive delta modulation (ADM).

13. **Time-division multiplexing (TDM)**

    Time-division multiplexing of PCM signals (TDM-PCM), bandwidth of TDM systems.

Laboratory exercises

1. **Signal types and signal characteristics**

   Signal types (continuous- and discrete-time, analog, digital), periodic signals, signal characteristics (amplitude, frequency, phase), calculation of rms value, instantaneous/average power.

2. **Signal analysis**

   Fourier analysis, signal representation in orthogonal, polar and complex exponential form, signal

symmetries, Fourier synthesis of periodic signals, amplitude and phase spectrum.

3. Amplitude modulation

AM modulation/demodulation, sinusoidal AM, calculation of bandwidth, average power of carrier and sidebands, modulation index, modulation efficiency and frequency spectrum.

4. Frequency modulation

FM modulation/demodulation, sinusoidal FM, narrow- and wide-band FM, Bessel functions, calculation of modulation index, bandwidth, average power of carrier and sidebands and frequency spectrum.

5. Pulse-code modulation

Pulse-code modulation (PCM), sampling theorem, quantization, encoding, calculation of quantization levels, quantization error and PCM bit rate.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	• Face-to-face in the class and in the laboratory. • Distance learning through the e-Class platform.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• PowerPoint presentations (pptx) of the course lectures, which have been uploaded to the e-Class page of the course. • Laboratory guide, at the e-Class page of the course. • Support of educational procedure through the e-Class platform for discussion and solving of relevant problems. • Software for the laboratory exercises, installed per student PC.
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*	
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.*	(a) Final written exam of the theoretical part of the course. (b) Laboratory grade which consists of: - laboratory report grade (40%) - final laboratory exam (60%) The laboratory exercises are mandatory. The final grade of the course is derived as follows: Grade = (a)*60% +(b)*40% Evaluation language: Greek

Activity	***Semester workload***
Lectures	39
Laboratory exercises	13
Preparation for the laboratory exercises	13
Personal study	60
Course Total	***125 hours (5 ECTS)***

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. B.P. Lathi, Zhi Ding, Σύγχρονες Αναλογικές και Ψηφιακές Επικοινωνίες, 4η έκδοση, εκδόσεις Τζιόλα, 2018.
2. Hsu Hwei P., Αναλογικές και ψηφιακές επικοινωνίες, εκδόσεις Τζιόλα, 2002.
3. H. Taub, D. Schilling, Αρχές τηλεπικοινωνιακών συστημάτων, εκδόσεις Τζιόλα, 2006.
4. Α. Κανάτας, Εισαγωγή στις Τηλεπικοινωνίες, 2η έκδοση, εκδόσεις Τζιόλα, 2018.
5. Γ. Καραγιαννίδης, Κ. Παππή, Τηλεπικοινωνιακά Συστήματα, 4η έκδοση, εκδόσεις Τζιόλα, 2017.
6. Α. Νασιόπουλος, Τηλεπικοινωνίες, Πανεπιστημιακές εκδόσεις Αράκυνθος, 2007.
7. J. G. Proakis, M. Salehi, Digital communications, McGraw-Hill, 2007.