AEEE321 - Communication Systems I

Course Title	Communication Systems I				
Course Code	AEEE321				
Course Type	Compulsory				
Level	BSc (Level 1)				
Year / Semester	3rd / 2nd				
Teacher's Name	Associate Prof Symeon Nikolaou / Associate Prof. Haris Haralambous				
ECTS	6	Lectures / week	3	Laboratories/week	1
Course Purpose	The aim of the course is to familiarize the students with the concepts and the principles of analogue communication systems, the mathematical analysis in time and frequency domain of the modulated signals and the circuit implementation in system level. The students should be in position to derive the analytical expressions of AM, FM and PM modulated signals and make calculations and reach qualitative conclusions regarding the preferred modulation scheme for different conditions. They are expected to handle and assess the effect of noise in electronic systems designed for the aforementioned modulations.				
Learning Outcomes	By the end of the course, students must be able to: 1. Analyze continues systems and signals in time and frequency domain and determine the concepts of instantaneous and time-averaged value 2. Construct AM communication systems and combine system units to assembly DSB-AM, SSB-AM and DSB-SC-AM modulation, transceivers. 3. Determine the structural units of angle modulation systems and modify proposed communication systems to accommodate the need for PM, FM and NBFM modulation considering the frequency domain limitations. 4. Compare and argue the performance of AM and PM communication systems and assess the effect of noise in the transceiver's complexity and modulation's effectiveness. 5. Experiment with the taught communication units using the available simulation packages at the laboratory and justify the selection of a communication system upon the application.				
Prerequisites	AEEE310, AEEE238	Corequisites	None		

Course Content	• **Signal description in time and frequency domain** Get introduced to Fourier Series and Fourier Transform as tools for the frequency domain description of signal. Make energy and power spectral densities calculations. Use the mathematical tools towards the fundamental concepts of modulation theory • **Amplitude Modulation** Study and analyze Amplitude Modulation (AM) systems, DSB-AM, Modulation index and efficiency, carrier frequency, side-frequencies, spectrum and spectrum plots. Single tone and multi-tone modulation. Over-modulation and distortion. Spectrum. Other forms of AM, DSB-SC-AM, SSB-AM and Vestigial Sideband. Spectra. AM transmitters. Demodulation schemes of AM signals. Study the super-heterodyne receiver and the Costas Loop. Operation of the mixer, the envelope detector and the product detector. Costas Loop. SSB-AM demodulation. Phasing and filtering method. • **Angle Modulation** Phase Modulation, PM. Phase function and complex envelope. Phase deviation, modulation index, spectrum and bandwidth. Tone modulation. Carson's rule. Plots. Frequency Modulation, FM. Instantaneous frequency and frequency deviation. Sensitivity and modulation index. Bandwidth and Carson's rule. Spectrum of single tone modulation using Bessel functions. Narrowband and wideband FM. Generation and demodulation. Pre-emphasis and de-emphasis systems. Frequency Division Multiplexing transmitter, receiver and spectra. • **Noise in Communication Systems** Noise. Signal-to-Noise ratio. Noise figure. Cascaded devices. Friis' theorem. Link budget evaluation. Define the characteristics of band-pass noise and compare the performance analysis of AM, DSB-SC systems with and without noise. • **Laboratory Experiments** ***1.1*** Introduction to Communications Information, information sources, analog and digital. Deterministic and random signals. Channels. Communication systems. Frequency allocation. Instantaneous power and average power, rms value, Decibel. Signal to Noise ratio. Spectrum. Overview of Fourier series, Fourier Transform and spectrum of signals. *Amplitude Modulation (AM)*

	General form of bandpass signals. Complex envelope. Amplitude Modulation. DSB-AM, SSB-AM and DSB-SC-AM. Modulation index and efficiency, carrier frequency, side-frequencies, spectrum and spectrum plots. Over-modulation and distortion. Average power and peak envelope power. Envelope detector. Multi-tone modulation. Power of AM signals. Generation and demodulation of AM. Costas Loop. Super-heterodyne receiver. *Angle Modulation* Phase Modulation, PM. Phase function and complex envelope. Phase deviation, modulation index, spectrum and bandwidth. Tone modulation. Carson's rule. Frequency Modulation, FM. Instantaneous frequency and frequency deviation. Sensitivity and modulation index.. Bandwidth and Carson's rule. Spectrum of single tone modulation using Bessel functions. Narrowband and Wideband FM. Generation and demodulation. Pre-emphasis and de-emphasis. Frequency division multiplexing. ***1.2*** Noise in Communication Systems Noise. Signal-to-Noise ratio. Noise factor and noise figure. Cascaded devices. Friis' theorem. Link budget evaluation.
Teaching Methodology	Students are taught the course through lectures (3 hours per week) in classrooms or lectures theatres, by means of traditional tools or using computer demonstration. Topic notes are compiled by students, during the lecture can also be downloaded from the lecturer's webpage. Students are also advised to use the subject's textbook or reference books for further reading and practice in solving related exercises. Tutorial problems are also submitted as homework and these are solved during lectures or privately during lecturer's office hours Laboratory experiments are carried out in small groups and lab reports are required two weeks after the laboratory class resulting in a cumulative mark. Students who fail the lab are marked as Incomplete and they are required to complete the laboratory work to pass the course.
Bibliography	**(q) Textbooks:** • Leon W. Couch II, Digital and Analog Communication Systems, 7th ed. Prentice Hall, 2007 **(r) References:** • S. Haykin, Communication Systems, 5th edition, John Wiley and Sons, 2009. • John Proakis and Masoud Salehi, Communication Systems Engineering, Second edition, Prentice Hall, 2002.
Assessment	The Students are assessed via continuous assessment throughout the duration of the Semester, which forms the Coursework grade and the final

	written exam. The coursework and the final exam grades are weighted 40% and 60%, respectively, and compose the final grade of the course. Various approaches are used for the continuous assessment of the students, such as mid-term written exam, quizzes, and laboratory assessment based on laboratory experiments and reports. The assessment weight, date and time of each type of continuous assessment is being set at the beginning of the semester via the course outline. An indicative weighted continuous assessment of the course is shown below: • Assignments/Quizzes 10% • Mid-Term written exams 50% • Laboratory Work 40% Students are prepared for final exam, by revision on the taught material, problem solving and concept testing and are also trained to be able to deal with time constrains and revision timetable. The criteria considered for the assessment of each type of the continuous assessment and the final exam of the course are: (i) the comprehension of the fundamental concepts and theory of each topic, (ii) the application of the theory in solving related problems and (iii) the ability to apply the above knowledge in more complex design problems. The above criteria are weighted 20%, 60% and 20%, respectively. The final assessment of the students is formative and summative and is assured to comply with the subject's expected learning outcomes and the quality of the course.
Language	**English**