AEEE511 - Antennas and Wave Propagation

Course Title	Antennas and Wave Propagation				
Course Code	AEEE511				
Course Type	Technical Elective				
Level	MSc (2nd Level)				
Year / Semester	1 or 2				
Teacher's Name	Assistant Prof Symeon Nikolaou				
ECTS	8	Lectures / week	3	Laboratories/week	0
Course Purpose	The aim of the course is to familiarize the students with the concepts and principles of antennas and radio propagation. The students should be in position to identify the antenna parameters, derive two-dimensional radiation patterns and gain diagrams for single elements and for linear arrays. They should be competent to define the radiated electromagnetic fields starting from the ac current distribution and through the use of the vector magnetic potential for the basic linear wire antenna elements. They should be in position to explain the array factor and provide graphical representation of the resulted radiation pattern depending on the feeding excitations and to analyze the input impedance of the driving elements depending on the neighboring radiators. They should also be in position to judge the preferred solution between competing technologies for example Bluetooth and WiMAX or between UHF ISM and 2.4 GHz ISM.				
Learning Outcomes	1. Manage the fundamental properties of antennas (gain, input impedance, bandwith, directivity, mutual coupling etc) in order to construct a wireless communication link. 2. Design an antenna array in order to achieve the required beamwidth for the desired specification and be able to use an antenna as part of a transceiver circuit. 3. Analyze the fluctuation over time, season, weather of the maximum propagation range and the link quality in order to improve the performance of the designed system. 4. Interpret the radio propagation conditions in a mobile or time variant environment considering the multipath, flat or frequency selective fading, using simple link budget models like Okumura or Hata models 5. Compare the frequencies used for satellite communications and appraise the potential improvement in the system's throughput, exploiting the concept of polarization and depolarization in satellite links, frequency reuse techniques and technical aspects for real life satellite communication applications such as satellite TV, GPS 6. Justify the constantly increasing need for developing special interest topics, in wireless communications, such as PAN networks using UWB and WiMAX technologies or AdHoc sensor/RFID networks				

Prerequisites	AEEE312	Corequisites	None
Course Content	• Antennas • Characteristics: Dimensions, gain (dB), polarization, F/B ratio, VSWR, radiation diagrams, input impedance. Types: Directional, omnidirectional , monopoles, dipoles, patch etc • UHF communications • Electromagnetic field. Ground and surface waves. Direct waves: Direct LOS, Fresnel theory, free space loss, Sky waves (Ionosphere) • Key concepts : Structure of the Ionosphere: D, E, F1, F2. Critical frequencies: MUF, LUF. Propagation effects: Daily, seasonal, geographic, sunspots, interference, weather, solar flares. Propagation indices: K, Ap, Solar flux, Sunspot number. Tropospheric waves • RF communications (WLAN, GSM) • Link Budget. Line-of-sight (LOS) path loss models. Fresnel zone. Path loss and free space path loss. Okumura model. Hata model. Antenna gain. Frequency considerations. Atmospheric, weather and rain attenuation. Terrain factors • Multipath loss. Rician and Raleigh fading considerations. Cochannel interference. Transmission line loss • A typical link budget calculation for a cellular network • Radio Propagation in a Mobile Environnent • Multipath fading. Rician, Raleigh and Nakagami fading. Threshold crossing rate and average fade duration. Delay spread. Doppler shift effects. Coherence time and coherence bandwidth. Local variability models • Satellite Communications Propagation • Frequency, rain, repeaters, tall buildings • Special topics of wireless communications • RFIDs/sensors networks • UWB/WiMAX communications		
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		
Bibliography	**(a) <u>Textbooks:</u>** • C. A. Balanis, Antenna Theory, Analysis and Design, 4th Wiley, 2016		

	(b) References: • D. Pozar, Microwave Engineering, 4th ed. J. Wiley, 2012 • M. Skolnik, Introduction to Radar Systems, New York, McGraw-Hill, 3rd Edition, 2001. • J. Joseph, George Carr (Bud) Hippisley, Practical Antenna Handbook, Fifth Edition. McGraw-Hill Education, 2012
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 60% and 40% 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. 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 40 % • Project 50 % Students are prepared for final exam, by revision on the matter taught, 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**