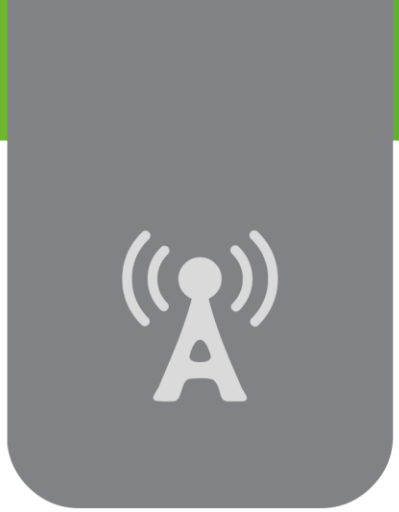

Antennas and Wave Propagation Course Definition File

1. Basic Information:

Course Name	Antennas and Wave Propagation
Course ID	CRF402
Contact Hours (Registered Sessions)	30
Contact Hours (Synchronized Sessions)	18
Mid Term Exam	There is not
Exam	1.5
Registered Sessions Work Load	30
Synchronized Session Work Load	18
Credit Hours	5

2. Pre-Requisites:

Course	ID
Electromagnetic Waves and Transmission Lines	CRF301

3. Course General Objectives:

This course's objective is to introduce the student to antennas, covering their principles of radiation, their basic parameters, (radiation resistance, radiation pattern, polarization, reciprocity, effective radiated power), their general types, and those commonly used in wireless systems. The student learns how to quickly analyse a communication link that uses standard antennas and suffers from the various effects of propagation. The course reviews Electromagnetic Theory and electromagnetic wave properties. The student also learns the various propagation mechanisms/impairments and the basic models of propagation. Atmospheric and weather effects are also reviewed. The student would be able to grasp the idea of link budget analysis and propagation calculations, including: antenna gain, efficiency and directivity calculations; free-space loss; diffraction and obstruction loss; rain loss; depolarisation loss; impedance mismatch loss; etc. The student would be able to apply this to determine the range of a wireless RF/microwave system, using what the student know about propagation mechanisms/impairments and the basic models of propagation to determine approximately the range of point-to-point system. The

student also learns the various techniques of diversity and combining methods to improve the system performance.

4. Intended Learning Outcomes (ILO):

Code	Intended Learning Outcomes
ILO1	Understanding the basic principles and radiation of antennas.
ILO2	Recognizing fundamental parameters of antennas.
ILO3	Overview of antennas types and applications in wireless systems.
ILO4	Knowing the basic propagation models and propagation mechanisms/impairments for radio waves.
ILO5	Performing link budget calculations and determining the maximum acceptable path loss.
ILO6	Performing link budget calculations including antenna gain, efficiency and directivity calculations, and propagation mechanisms/impairments losses to expect the maximum range upon the maximum acceptable path loss.
ILO7	Recognizing various techniques of diversity and combining methods to improve the system performance.

5. Course Syllabus (18 hours of total synchronized sessions)

- RS: Recorded Sessions; SS: Synchronized Sessions;

ILO	Course Syllabus	RS	SS	Type	Additional Notes
ILO1 ILO4	**Electromagnetic theory review and Properties of EM waves:** • Quick review of the meaning of Maxwell's Equations, • Plane Wave Properties, • Wave Polarization.	2		☒ Exercises ☐ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	
ILO1 ILO2	**Antenna types and their basic parameters** • Antenna Types • Basic parameters ▪ Antenna impedance ▪ Gain and directivity ▪ Antenna pattern ▪ Antenna polarization ▪ Other parameters	5	3	☒ Exercises ☒ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	
ILO2 ILO3	**Dipoles and Monopoles** • Antenna pattern ▪ Effects of conductor diameter ▪ Feed point impedance ▪ Effect of frequency on radiation pattern ▪ Folded dipole ▪ Vertical dipole • Monopoles ▪ Monopole characteristics ▪ Folded monopole	4	3	☒ Exercises ☒ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	
ILO3	**Array antenna, parabolic**	3	1.5	☒ Exercises	

	antenna, patch antenna • Log-Periodic Dipole Arrays • Parabolic antenna • Patch antenna			☒ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	
ILO3 **ILO4**	**Propagation mechanisms:** • Reflection, Refraction, and Transmission, • Scattering, • Diffraction.	4	3	☒ Exercises ☒ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	
ILO4 **ILO5** **ILO6**	**Basic propagation models:** • Definition of Path Loss, • Noise Modeling • Free-Space Loss, • Plane Earth Loss, • Link Budgets,	8	4.5	☒ Exercises ☐ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	
ILO7	**Propagation impairments and Performance enhancement Techniques:** • Atmosphere • Absorption • Attenuation due to Hydrometeors • Refractive Effects • Fading types and models • Diversity Techniques • Combining methods	4	3	☒ Exercises ☒ Assignments ☐ Seminars ☐ Projects ☐ Practices ☐ Others	

6. Assessment Criteria (Related to ILOs)

ISC	Interactive Synchronized Collaboration		Ex	Exams		Rpt	Reports
PF2F	Presentations and Face-to-Face Assessments		PW	Practice Work			

ILO Code	ILO	Intended Results	Assessment Type				
			ISC	PW	Ex	PF2F	Rpt
ILO1	Understanding the basic principles and radiation of antennas.		X	X	X		
ILO2	Recognizing fundamental parameters of antennas.		X	X	X		
ILO3	Overview of antennas types and applications in wireless systems.		X	X	X		
ILO4	Knowing the basic propagation models and propagation mechanisms/impairments for radio waves.		X	X	X		
ILO5	Performing link budget calculations and determining the maximum acceptable path loss.		X	X	X		
ILO6	Performing link budget calculations including antenna gain, efficiency and directivity calculations, and propagation mechanisms/impairments losses to expect the maximum range upon the maximum acceptable path loss.		X	X	X		
ILO7	Recognizing various techniques of diversity and combining methods to improve the system performance.		X		X	X	X

7. Practice Tools:

Tool Name	Description
HFSS	Electromagnetic simulation
mmana	Antenna simulation software

8. Main References

1. 'Antennas and Propagation for Wireless Communication Systems', 2nd edition, by Simon Saunders, Alejandro Aragón-Zavala, Wiley, 2007
2. "Antenna Theory: Analysis and Design', 3rd Edition, by Constantine A. Balanis, Wiley, 2005
3. 'Introduction to RF propagation', by John S. Seybold, Wiley, 2005

9. Additional References

1. "Microwave Engineering", 4th edition, by David Pozar, Wiley, 2012
2. 'Antenna Engineering Handbook', 4th Edition, by John Volakis, McGraw-Hill, 2007
3. 'Principles and Applications of Electromagnetic Fields', by Robert Plonsey and Robert E. Collin, McGraw-Hill, 1961
4. "Microwave Radio Links, from theory to design", by Carlos Salema, Wiley, 2003