Training course outline

ITU and African Advanced Level Telecommunications Institute

Title	OM-2 Spectrum Engineering Fundamentals
Modality	Online instructor led
Dates	2 – 27 May 2022
Duration	4 weeks
Registration deadline	1 May 2022
Training fees	USD 200
Description	This course covers spectrum engineering foundations in order for students to be able to perform link budget calculations, interference analysis, and provide understanding of 3D propagation modelling for radio communications services frequency planning. This is intended to support modern spectrum management.
Course code	22OI500010MUL-E-D

1. LEARNING OBJECTIVES

The aim of this course is to provide students with spectrum engineering foundations in order to be able to perform link budget calculations, interference analysis, and provide understanding of 3D propagation modelling for radio communications services frequency planning. This is intended to support modern spectrum management.

2. LEARNING OUTCOMES

It is expected that upon completion of the training session, participants will be able to:

Have knowledge of

- Knowledge of essential technical foundations on radio wave propagation phenomena and behavior.
- Knowledge to perform link budget calculations and interference analysis.
- Knowledge to analyze the spectrum space occupied by radiocommunications systems.
- Knowledge to evaluate spectrum usage efficiency.
- Knowledge to identify the main characteristics of most used modulations schemes.

An understanding of

- Understanding the historical perspective of radio spectrum usage, its evolution, and the

behavior of radio waves to support planning, assigning and controlling different services emission parameters for optimum radio spectrum exploitation.

They should have the ability to

- Ability to perform free-space loss calculations.
- Ability to perform link budget calculations.
- Ability to audit EIRP levels from on the radio power level measurements.
- Ability to calculate electric and magnetic fields intensities from a power level measurement to evaluate non-ionizing radiation emissions.
- Ability to use propagation modelling software and understand propagation criteria to apply the right algorithms.
- Ability to perform C/N and C/I calculations to define frequency re-use.
- Ability to perform frequency planning tasks.

3. TARGET POPULATION

This training is targeted those who are entering the regulatory environment and are interacting with technologies as operators, developers or managers. It is targeted at those aiming to understand workings of various technologies with a view to developing a general overview of trends.

This may include professionals working in the telecommunications industry, lawyers, regulatory staff across all departments.

Besides that, other institutions and individuals that are dedicated to building their capacity related to new technologies are welcome to participate.

4. ENTRY REQUIREMENTS

No prior knowledge or qualification in Spectrum Management is required, however it is important for participants to be working for a regulator, or in the ICT/Telecoms sector as a provider or consultant.

5. TUTORS/INSTRUCTORS

NAME OF TUTOR(S)/INSTRUCTOR(S)	CONTACT DETAILS
Eng. Martin Mwaura	Email: martinmwaura@live.com Tel: +254715721798
Jonathan Mwakijele	Email: Jmwakijele@afralti.org Tel: +254718860897

6. TRAINING COURSE CONTENTS

S/n	*Topic*
1	The Radio Spectrum: History (Maxwell, Hertz, Marconi), its discovery and evolution.
2	The radio spectrum characteristics: Reflection, refraction, scattering, diffraction and absorption, ground, sky and space waves, how it is classified
3	Telecommunications Units, where the dB came from, operations using logarithms, general rules, dBv, dBW, dBm.
4	Modelling the three dimensional space using the sphere: Angle, solid angle, calculations of the solid angle of a sphere, the meaning of 4π in link budget formulas.

5	Basic antenna parameters: Radiation patterns, beam efficiency, driving impedance, antenna operation bandwidth, directivity and gain, directivity and resolution, apertures.
6	Modelling the antenna with effective aperture and directivity, link budget formula, free space loss formula, EIRP concept, antenna K Factor calculation, REC ITU-R 525, examples
7	Polarization, antenna isolation, and frequency reuse.
8	General concepts on radio communications planning tools, processes involved in radio propagation simulation, 3D digital cartography.
9	ITU-R recommendations series P, propagation models classification: Frequency band restrictions, typical used algorithms for coverage and interference analysis in point-to-multipoint and point-to-zone services.
10	Medium and high resolution digital cartography, DTM, DCM, clutters, coordinates, datum.
11	Amplitude modulation, frequency modulation, digital modulation schemes, spread-spectrum and OFDM.
12	Interference, C/I and I/N.
13	Broadcasting services network design and coverage analysis using a planning tool with variable EIRP, height, antenna patterns.
14	Cross-border frequency coordination principles and international agreements (such as HCM).
15	EMF human exposure limits, calculation and evaluation of exposure to non-ionizing radiation.

7. TRAINING COURSE SCHEDULE

Week / Topic	Activity	Exercises and Interactions
Week 1 • The Radio Spectrum • The radio spectrum characteristics • Telecommunications Units Modelling the three dimensional space using the sphere	Read week 1 course materials and references. Participate in forum discussion. Attempt assignment 1.	**Forum topic 1: Is Spectrum a limited resource? Do you see the glass as half full or half empty?** **Live lecture & discussion 1:** Monday and Wednesday from 1500 Hours to 1700 Hours EAT. **Assignment 1:** Wednesday **Assignment 2:** Friday
Week 2 • Basic antenna parameters: Radiation patterns, beam efficiency, driving impedance, antenna operation bandwidth, directivity and gain, directivity and resolution, apertures. • Modelling the antenna Polarization, antenna isolation and frequency reuse	Read week 2 course materials and references. Participate in forum discussion. Attempt assignment 2	**Forum topic 2: How essential is an understanding of propagation models for deployment of communications?** **Live lecture & discussion 2:** Monday and Wednesday from 1500 Hours to 1700 Hours EAT. **Assignment 3:** Wednesday **Assignment 4:** Friday

Week 3 • General concepts on radio communications • ITU-R recommendations • Medium and high resolution digital cartography, DTM, DCM, clutters, coordinates, datum. Amplitude modulation, frequency modulation, digital modulation schemes, spread-spectrum and OFDM	Read week 3 course materials and references. Participate in forum discussion. Attempt assignment 3.	**Forum topic 3: Discuss the feasibility of Digital Radio migration in your territory** **Live lecture & discussion 3:** Monday and Wednesday from 1500 Hours to 1700 Hours EAT. **Assignment 5:** Wednesday **Assignment 6:** Friday
Week 4 • Interference, C/I and I/N • Broadcasting services network design and coverage analysis • Cross-¬border frequency coordination principles and international agreements EMF human exposure limits, calculation and evaluation of exposure to non-ionizing radiation	Read week 4 course materials and references. Participate in forum discussion. Attempt assignment 4 and End of course assignment.	**Forum topic 4: EM Exposure. To what extent is this an area of enforcement as a regulator** **Live lecture & discussion 4:** Monday and Wednesday from 1500 Hours to 1700 Hours EAT. **End of Course Assignment:** Friday

8. METHODOLOGY (Didactic approach)

- Instructor-Led online learning with presentations, case studies, exercises and assignments.
- Live lectures and discussions through ZOOM every Monday and Wednesday from 1500 Hours to 1700 Hours EAT.

9. EVALUATION AND GRADING

The evaluation is based on:

- Participation in all 4 Forums (10%)
- Assignment 1 (10%)
- Assignment 2 (10%)
- Assignment 3 (10%)
- Assignment 4 (10%)
- Assignment 5 (10%)
- Assignment 6 (10%)
- End of Course Assignment (30%)

Participants should score an overall mark of 60% to receive ITU Certificate.

10. TRAINING COURSE COORDINATION

AFRALTI Coordinator:	**ITU Coordinator:**
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