African Advanced Level Telecommunications Institute

Spectrum Management Training Programme

Online Training on

OM-2 Spectrum Engineering Fundamentals

8 November – 3 December 2021

TRAINING COURSE OUTLINE

COURSE DESCRIPTION

Title	**OM-2 Spectrum Engineering Fundamentals**
Method of delivery	Online
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.
Date	**8 November – 3 December 2021**
Duration	4 weeks
Registration deadline	**7 November 2021**
Training fees	**USD 200**
Course code	**21OI27748MUL-E**
Course Domains	- The Radio Spectrum: History (Maxwell, Hertz, Marconi), its discovery and evolution. - The radio spectrum characteristics: Reflection, refraction, scattering, diffraction and absorption, ground, sky and space waves, how it is classified - Telecommunications Units, where the dB came from, operations using logarithms, general rules, dBv, dBW, dBm. - 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. - Basic antenna parameters: Radiation patterns, beam efficiency, driving impedance, antenna operation bandwidth, directivity and gain, directivity and resolution, apertures.

Reference	Roger L. Freeman, "Fundamentals of Telecommunications". Second Ed. John Wiley & Sons, Inc., Publication. ISBN 0-471-71045-8. 2005. https://www.itu.int/rec/R-REC-P.1546-4-200910-I/en http://hcm.bundesnetzagentur.de/http/englisch/verwaltung/index_europakarte.htm M. B. Tabakcioglu, D. Ayberkin, A.Cansiz, "Comparison and Analyzing Propagation Models". 2012 IEEE Asia-Pacific Conference on Antennas and Propagation. 978-1-4673-0668-3. IEEE 2012. http://www.cplus.org/rmw/english1.html http://www.seamcat.org/ http://www.lx.it.pt/cost231/final_report.htm http://archive.org/details/electricandmagne01maxwrich &

DESCRIPTION OF THE TRAINING COURSE

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.

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.

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.

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.

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

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.

TRAINING SCHEDULE AND CONTENTS / AGENDA

Agenda (for online training)

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	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

exposure to non-ionizing radiation		

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.

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.

TRAINING COORDINATION

AFRALTI Coordinator:	**ITU Coordinator:**
Jonathan Mwakijele Head, Management, Policy and Regulatory Unit African Advanced Level Telecommunications Institute (AFRALTI), Nairobi, Kenya Tel : +254 718 860 897 Email: jmwakijele@afralti.org	Emmanuel Niyikora Programme Officer ITU Area Office for West Africa, Dakar Tel : +250 788312939 Email: emmanuel.niyikora@itu.int

REGISTRATION AND PAYMENT

Registration on ITU Academy Portal

Please note that to be able to register for the course you MUST first create an account in the ITU Academy portal at the following address: https://academy.itu.int/user/register

Training Registration
When you have an existing account or created a new account, you can register for the training online at the following link: https://academy.itu.int/training-courses/full-catalogue/smtp-om2-spectrum-engineering-fundamentals-0

You can also register by finding your desired course in our training catalogue https://academy.itu.int/training-courses/full-catalogue.

Payment

   1. **On-line payment**

      A training fee of USD 200 per participant is applied for this training. It is encouraged to make payment via the online system using the link mentioned above for training registration https://academy.itu.int/training-courses/full-catalogue/smtp-om2-spectrum-engineering-fundamentals-0   .

   2. **Payment by bank transfer**

Where it is not possible to make payment via the online system, select the option for offline payment to generate an invoice using the same link as above. Download the invoice to make a bank transfer to the ITU bank account shown below. Then send the proof of payment/copy of bank transfer slip and the invoice copy to Hcbmail@itu.int and copy the course coordinator. **All bank transaction fees must be borne by the payer**.

   3. **Group payment**

Should you wish to pay for more than one participant using bank transfer and need one invoice for all of them, create an account as **Institutional Contact. Institutional Contacts** are users that represent an organization. Any student can request to be an institutional contact or to belong to any existing organization.

To do this, head to your profile page by clicking on the **"My account"** button in the user menu. At the bottom of this page you should see two buttons:

   a. If you want to **become an institutional contact**, click on the "**Apply to be an Institutional Contact"** button. This will redirect you to a small form that will ask for the organization name. After you fill the name of the organization you want to represent, click on **"continue"** and a request will be created. An ITU Academy manager will manually review this request and accept or deny it accordingly.

   b. If you want to **belong to an existing organization**, click on the **"Request to belong to an Institutional Contact"** button. This will redirect you to a small form that will ask you to select the organization you want to join from an organization list. After you select the correct organization, click on **"continue"**, a request will then be created. The Institutional Contact that represents that organization will manually accept or deny your request to join the organization.

Failure to submit the above documents may result in the applicant not being registered for the training.

ITU BANK ACCOUNT DETAILS:	
Name and Address of Bank:	UBS Switzerland AG Case postal 2600 CH 1211 Geneva 2 Switzerland
Beneficiary:	Union Internationale des Télécommunications
Account number:	240-C8108252.2 (USD)
Swift:	UBSWCHZH80A
IBAN	CH54 0024 0240 C810 8252 2
Amount:	USD 200
Payment Reference:	21OI27748MUL-E - P.40635.1.01