

## **MJB: Mobile radio communications**

### **Online course specification**

#### **Target audience:**

This e-learning course is designed for those who are, or intend to be, involved in the planning, installation, provisioning or maintenance of mobile systems. It is suggested this course is studied with its companion course “Introduction to mobile systems” as preparation for the other PTT courses covering mobile networks.

#### **Course aim:**

This online course describes the operation of the radio access network (RAN) of a mobile system with emphasis on radio communications between a mobile and a base station, and the evolution of mobile systems towards 5G to meet the demand for reliable and secure, high speed data communications.

#### **Course level:** Intermediate

*An explanation of PTT course levels is given at the end of this document*

#### **Pre-requisites:**

You will get the most out of this course if you already have a basic understanding of the operation of a cellular mobile system and the role of the various elements of a mobile network. It is recommended that the PTT course “Introduction to mobile systems” is studied before attempting this course.

#### **Course structure:**

The course consists of the following five modules:

1. Propagation fundamentals
2. Fading and countermeasures
3. Multiple access methods
4. Use of radio spectrum
5. Security over the air interface

#### **Module 1:** Propagation fundamentals

Module aim: To explain how a radio wave is affected by its environment and to introduce terminology for discussing radio wave propagation.

After completing this module, a trainee will be able to:

- define the air interface as the link between a user’s equipment and the network infrastructure.
- describe factors that affect a conventional radio path including distance, obstructions, reflections and scattering/absorption.
- describe the factors that are particularly important to a mobile radio path including Doppler shift, multipath and limited power output.
- explain the terms loss, gain, cochannel and adjacent channel interference and delay.

## **Module 2: Fading and countermeasures**

Module aim: To discuss different types of fading, their causes and methods used to reduce their effects.

After completing this module, a trainee will be able to:

- define slow fading and its causes.
- define fast fading and its causes.
- describe how multipath propagation can cause fading and dispersion.
- explain the principles of space and frequency diversity and their practical application in mobile systems.
- describe the various ways in which Multiple In Multiple Out (MIMO) aerial techniques can improve the performance of radio transmissions.
- explain the principles of ARQ (Automatic Repetition reQuest).
- explain the principles of FEC (Forward Error Correction) and HARQ and their application in mobile systems.

## **Module 3: Multiple access methods**

Module aim: To describe methods for providing access to and from a base station by many mobiles.

After completing this module, a trainee will be able to:

- explain the need for multiple access methods.
- describe and compare FDMA and TDMA multiple access methods and explain their combination.
- explain the principles of WCDMA and how it differs fundamentally from FDMA/TDMA.
- Describe how 3G (UMTS) mobile devices are granted transmission opportunities.
- explain the principles and advantages of OFDM as used in LTE (4G) systems.
- describe how radio frequencies and transmission opportunities are shared between LTE mobile users
- explain that modifications to OFDM resource sharing provide higher data transfer rates and lower latency for 5G systems compared with LTE systems.
- explain that mobile devices communicate with base stations over a variety of radio channels each having a specific purpose.

## **Module 4: Use of radio spectrum**

Module aim: To review frequency bands in use, frequency allocation methods and considerations affecting the choice of frequency band for mobile communications.

After completing this module, a trainee will be able to:

- describe the factors that determine the maximum capacity and data transfer rates of a mobile radio access network.
- explain the relationship between the choice of carrier frequency for a mobile service and the maximum cell size and data transfer rate.
- describe the frequency bands used for mobile services with reference to geographical factors.
- explain Frequency Division Duplex (FDD) and Time Division Duplex (TDD), their relative advantages and paired and unpaired bands.
- describe the measures taken to provide sufficient radio spectrum for the expansion of mobile services.
- describe the use of carrier aggregation to maximise data transfer rates.
- explain the role of the ITU, the ECC and national regulators in the allocation of radio frequencies for mobile services.
- explain methods of allocating frequency bands including auctions.

## **Module 5: Security over the air interface**

Module aim: To describe the need for, and methods of, implementing secure communications over the air interface.

After completing this module, a trainee will be able to:

- explain the vulnerabilities of mobile communications to various forms of attack.
- explain the use of IMEIs (International Mobile Equipment Identities) and EIRs (Equipment Identity Registers) in tracking stolen or lost mobiles.
- describe the role of authentication, encryption and integrity checking.
- describe the process of user and serving network authentication with reference to the role of, and relationship between, authentication tokens and security keys.
- describe the role of the various security keys in protecting communications between a mobile device and the mobile network with reference to the relationship between those keys.
- compare the security of four generations of mobile system from 2G to 5G.

**Course access requirements:**

To access the course, a computer running a browser such as Google Chrome, Safari etc is required. The computer should have Internet access. A screen resolution of at least 1024x768 is necessary.

**Learning facilities:**

This online course employs interactive simulations, hypertext links to an online glossary and multiple-choice question sessions to fully involve the trainee in the learning experience. Each module provides revision links to previously studied, relevant topics. A record of progress and level of achievement is recorded for each trainee. Once studied as a structured, assessed course, the content can be browsed for revision or reference.

**PTT course levels:**

PTT online courses are categorised by one of three levels according to the depth of treatment they provide:

**1. Introductory:**

PTT Introductory courses are designed for those with no previous experience or knowledge of telecommunications. These courses provide an overview of telecommunications or discuss the fundamentals of electronic communications. The study of general science at secondary (high) school is a typical pre-requisite for PTT Introductory courses.

PTT Introductory courses are suitable for those joining the telecommunications sector particularly those in an apprenticeship programme.

**2. Intermediate:**

PTT Intermediate courses are designed for technicians and engineers requiring an understanding of a certain aspect of telecommunications. Those planning to study an Intermediate course should have an understanding of the basic principles of electronic communications.

The depth of treatment provided by Intermediate courses is typically equivalent to level 3 of a UK national vocational qualification (NVQ). PTT Intermediate courses can be used to support the attainment of a Communications Technology NVQ at level 3.

**3. Advanced:**

PTT Advanced courses are designed for those who require an in-depth treatment of a certain aspect of telecommunications. Such courses are suitable for system designers as well as those who will be responsible for the maintenance of the system described in the course.

Those planning to study a PTT Advanced course should have a background in telecommunications, and an understanding of telecommunications fundamentals and the principles of the type of telecommunications system described in the course.

PTT  
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