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PAC: Transmission fundamentals

Online course specification

Target audience:
This course is designed for those who require an introduction to the fundamental technical concepts that underpin modern telecommunications. The course is suitable for those joining the industry in a technical role especially those in an apprenticeship.

Course aim:
To describe the characteristics, capabilities and applications of copper, optical fibre and wireless transmission media.

Course level: Introductory
An explanation of PTT course levels is given at the end of this document

Pre-requisites:
An understanding of the basic properties of analogue and digital signals, electrical circuit theory and the effects of signal impairments. It is recommended that the PTT courses “Analogue and digital signals” and “Signal impairments” are studied before attempting this course.

Course structure:
The course consists of the following four modules:
1. Power transfer
2. Line transmission
3. Optical transmission
4. Wireless communications

Module 1: Power transfer

Module aim: To explain the conditions for maximum power transfer over a copper cable with reference to its characteristic impedance and describe the use of logarithmic units to express power loss and level.

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

- explain the importance of achieving maximum power transfer over a transmission line.
- describe the equivalent circuit model of a transmission line in terms of resistance, capacitance and inductance.
- explain the concept of characteristic impedance.
- state the conditions for maximum power transfer between a source and a load.
- list typical values of characteristic impedance for various types of cable including co-axial cable and twisted pairs.
- explain the terms power level, loss, and gain.
- explain the importance of confirming the power level of a signal.
- define the units “decibel” (dB) and “dBm” and compare their relevance and use.
- calculate the output power of a circuit in dBm units from the individual losses in the circuit (in dB) and a given input power (in dBm).

Module 2: Line transmission
Module aim: To describe and compare the characteristics and applications of twisted pair and coaxial copper cable.

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

- compare the configuration of an unbalanced pair of wires to a balanced pair.
- explain how a balanced pair of wires provides a higher immunity to interference with reference to the common mode rejection (CMR) of induced signals.
- give examples of the use of balanced pairs in communications systems.
- explain that the twists in a twisted pair of wires enhance CMR.
- define, and explain the relevance of, nominal velocity of propagation (NVP) and "delay skew".
- describe and compare the basic construction of unshielded and shielded twisted pair cables, compare their capabilities and give typical applications.
- describe the basic construction of coaxial cable and give typical applications.
- explain the importance of matching the impedances of all components of a transmission link.

Module 3: Optical transmission

Module aim: To explain the principles of the transmission of information over optical fibres.

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

- describe the basic structure of an optical fibre in terms of its core and cladding and explain how optical energy propagates down a fibre.
- define the term "acceptance angle" and explain its relevance to the choice of optical source.
- describe the capabilities of optical fibre compared with copper wires and give typical applications of optical fibre.
- describe and compare the structure and characteristics of singlemode and multimode fibre.
- explain the causes of loss in optical fibre in terms of scattering and absorption and describe how the choice of operating wavelength depends on the loss characteristics of a fibre.
- compare the characteristics and applications of LEDs and optical lasers in optical communications systems
- give examples of the use of optical fibre cables in telecommunications systems.
- describe the role of the components of an optical fibre cable.

Module 4: Wireless communications

Module aim: To describe the characteristics and applications of transmissions in the various frequency bands of the electro-magnetic spectrum.

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

- describe the relationship between the frequency and wavelength of a radio signal.
- explain the factors that influence the choice of radio frequency for a particular application.
- describe applications of the various electro-magnetic spectrum frequency bands from low frequency (LF) band to to extremely high frequency (EHF) band.
- describe the various propagation modes of electromagnetic radiation (EMR) with reference to line of sight and groundwave propagation, ionospheric refraction, tropospheric scattering, reflection and diffraction.
- explain that each type of radio system depends on a particular EMR propagation mode or a combination of modes.
- describe the factors that affect the reception of the high frequency radio frequencies used by mobile systems.
- describe the characteristics of antennae in terms of polarisation and gain, and describe the relationship between element length and operating wavelength.
- describe the characteristics, capabilities and typical applications of point to point microwave links and satellite links.

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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