Unit Title:	**Telecommunication principles**
OCR unit number:	22
Unit reference number:	D/601/3254
Level:	3
Credit value:	10
Guided learning hours:	80

Unit aim

The aim of this unit is that learners will:

- Understand the principals of alternating current (AC) circuits
- Understand the effects of line impairments on a transmitted signal
- Apply the characteristics of transmission lines
- Understand the transmission of digital signals over transmission media
- Understand the process of modulating an analogue carrier frequency using digital signals
- Be able to apply the process of multiplexing digital and analogue signals over transmission media

Learning Outcomes	**Assessment Criteria**	**Knowledge, understanding and skills**
The Learner will: 1 Understand the principles of alternating current (AC) circuits	**The Learner can:** 1.1 Explain: • reactance in circuits • impedance in terms of resistive and reactive components 1.2 Describe the characteristics of series and parallel resonant circuits 1.3 Calculate the resonant frequency of a circuit	• circuit properties as follows: - behaviour of inductance - capacitance and resistance in alternating current (AC) circuits - concept of reactance - concept of impedance in terms of resistive and reactive components - characteristics of parallel and serial resonant circuits - statement of the formula for determining resonant frequency in terms of resistance - capacitance and inductance

Learning Outcomes	Assessment Criteria	Knowledge, understanding and skills
2 Understand the effects of line impairments on a transmitted signal	2.1 Explain: • decibel (dB) as a unit of loss • dBm as a unit of power 2.2 Define signal-to-noise ratio as applied to transmission lines 2.3 Calculate using dBs and dBms the • total loss of a system from individual losses • total loss of a system from input and output signal levels • output signal level from total loss and input signal level • signal-to-noise ratio	• the concept of Decibel (dB) as a unit of loss dBm as a unit of power • the concept of signal-to noise ratio applied to transmission lines • how to calculate the following using dBs and dBms: - total loss of a system from individual losses - total loss of a system from input and output signal levels - output signal level from total loss and input signal level - signal-to-noise ratios
3 Apply the characteristics of transmission lines	3.1 Explain the effect of the primary line constants R, G, L & C on the characteristic impedance of transmission lines 3.2 Define the concept of angular frequency as applied to transmission lines 3.3 Calculate, using the primary line constants, the characteristic impedance of: • finite and infinite line lengths • a parallel pair of wires • co-axial cable 3.4 Produce an equivalent circuit model of a transmission line in terms of resistance, capacitance and inductance 3.5 Calculate the bandwidth of a transmission line in terms of frequency between half power points	• the characteristics of transmission lines: - equivalent circuit of model of a transmission line in terms of resistance, capacitance and inductance - concept of characteristic impedance - conditions of maximum power transfer between a source and a load - typical values of characteristics impedance for various types of cable e.g. co-axial cable, twisted pairs - definition of bandwidth of a line in terms of the frequency range between half power points

Learning Outcomes	Assessment Criteria	Knowledge, understanding and skills
4 Understand the transmission of digital signals over transmission media	4.1 Demonstrate the following representations of binary information and explain the advantages of each type: • non-return to zero (NRZ) digital encoding from given values • return to zero (RTZ) digital encoding from given values • bi-phase digital encoding (Manchester) from given values • bi-phase digital encoding (Differential Manchester) from given values 4.2 Explain the concepts of bit rate and bit error rate (BER) 4.3 Explain digital signal impairments in terms of: • delay • jitter • binary errors 4.4 Demonstrate the effects of delay, limited bandwidth and jitter on the extraction of binary information from a digital signal	• digital signals in relation to: - representation of binary information using non-return to zero (NRZ) and return to zero (RZ) waveforms - the advantage of RZ in terms of extracting clocking information - digital signal impairments e.g. jitter, delay, binary errors - effects of delay - limited bandwidth and jitter on the attraction of binary information from a digital signal - definition of bit rate and bit error rate (BER)
5 Understand the process of modulating an analogue carrier frequency using digital signals	5.1 Explain the following methods of digital modulation using analogue frequency carriers: • amplitude shift keying (ASK & OOK) • frequency shift keying (FSK) • phase shift keying (PSK) • bi-polar shift keying (BPSK) • quadra-phase shift keying (QPSK) • quadrature amplitude shift keying (QAM) 5.2 Describe the purpose of, and produce constellation diagrams	• modulation techniques including: - reasons for modulation of electrical signals - concepts of modulating signal and carrier - principles of amplitude modulation (AM) - frequency modulation (FM) and phase modulation (PM) in terms of the effect of the modulating signal on the properties of the carrier e.g. phase, amplitude, frequency - the properties of AM, FM and PM signals e.g. bandwidth requirement, relative noise immunity, transmission of binary code using on-off keying

Learning Outcomes	Assessment Criteria	Knowledge, understanding and skills
	5.3 Calculate the practical channel capacity using: • Shannon-Hartley formula ?log2(S/N+1) • Shannon formula 2?log2(n) 5.4 Explain the need for filters and their effect on digitally modulated signals 5.5 Calculate the Baud rate of a given link states using given values	- amplitude shift keying (ASK) (both types of ASK & OOK) - frequency shift keying (FSK) - phase shift keying (PSK) - bi-polar shift keying (BPSK) - quadra-phase shift keying (QPSK) - quadrature amplitude shift keying (QAM) • constellation diagrams • how to calculate the practical channel capacity using Shannon-Hartley formula ?log2(S/N+1) states using given values • how to calculate the channel capacity using Shannon formula 2?log2(n) where n is the number of signal states using given values
6 Be able to apply the process of multiplexing digital and analogue signals over transmission media	6.1 Explain the following type of multiplexing: • frequency division • synchronous time division • asynchronous time division • digital time division • code division • Wavelength (coarse and dense) division	• the concept of frequency and time division multiplexing including: - principles e.g. transmitting traffic from various sources at different frequencies, reference to transmission timeslots - benefits of multiplexing e.g. reduction in number of links in a network, reduction in operating and equipment costs

Assessment

The qualification has been designed to develop knowledge, understanding and skills in the full range of functions involved in the planning and control, hardware, software and systems installation, software solutions and the production of customer support materials. It also provides opportunities for learners to study towards system and network management, to specialise in one or more specific programming languages in addition to being able to take units that are vendor specific.

Each unit within the specification is designed around the principle that candidates will build a portfolio of evidence relating to progression towards meeting the unit assessment criteria.

The unit assessment criteria reflect the demands of the learning outcomes for each unit.

In order for candidates to be able to effectively progress towards meeting the requirements of each assessment criteria, tutors must make sure that the supporting knowledge, understanding and skills requirements for each criteria are fully addressed. The identified knowledge, understanding and skills are not exhaustive and may be expanded upon or tailored to particular contexts to which the unit is being taught and the assessment criteria applied.

We recommend that teaching and development of subject content and associated skills be referenced to real vocational situations, through the utilisation of appropriate industrial contact, vocationally experienced delivery personnel, and real life case studies.

All the learning outcomes and assessment criteria must be clearly evidenced in the submitted work, which is externally moderated by OCR.

Results will be Pass or Fail.

Guidance on assessment

Candidates do not have to achieve units in any particular order and tutors should tailor learning programmes to meet individual candidate needs. It is recommended that, wherever possible, centres adopt a holistic approach to the delivery of the qualification and identify opportunities to link the units.

Centres are free to deliver this qualification using any mode of delivery that meets the needs of their candidates. Whatever mode of delivery is used, centres must ensure that learners have access to appropriate resources and consider the candidates' complete learning experience when designing learning programmes. This is particularly important in relation to candidates studying part time alongside real work commitments where candidates may bring with them a wealth of experience that should be utilised to maximum effect by tutors and assessors.

It is difficult to give a detailed answer to how much evidence is required as it depends on the type of evidence collected and the judgement of assessors. The main principles, however, are as follows: for a candidate to be judged competent in a unit, the evidence presented must satisfy:

- all the items listed, in the section 'Learning Outcomes'
- all the areas in the section 'Assessment Criteria'

Questioning the candidate is normally an ongoing part of the assessment process, and is necessary to:

- test a candidate's knowledge of facts and procedures
- check if a candidate understands principles and theories *and*
- collect information on the type and purpose of the processes a candidate has gone through
- candidate responses must be recorded

The quality and breadth of evidence provided should determine whether an assessor is confident that a candidate is competent or not. Assessors must be convinced that candidates working on their own can work independently to the required standard.

Additional information

For further information regarding administration for this qualification, please refer to the OCR document '*Admin Guide: Vocational Qualifications'* on the OCR website www.ocr.org.uk .