Unit 160:   Signal Transmission in Digital Networks

Unit code: F/615/4155

QCF level: 4

Credit value: 15

● Aim

The aim of this unit is to develop an understanding of the principles of the operation of digital communications networks used for long-distance communication throughout Europe.

● Unit abstract

The unit covers network architectures and the switching and transmission techniques used for the public switched telephone network (PSTN) and the integrated services digital network (ISDN).

Learners will develop their understanding of network operations and will gain practical and theoretical experience of signalling and transmission techniques.

● Learning outcomes

On successful completion of this unit a learner will:

1   Understand the operation of PSTN and ISDN networks

2   Understand signalling and switching of messages over telecommunication networks

3   Understand the processes used for conveying analogue signals over digital networks

4   Understand the systems used for transmission, switching and signalling in modern digital exchanges.

Unit content

1 **Understand the operation of PSTN and ISDN networks**

PSTN: the analogue local loop; digital exchanges (local and trunk eg classes 4 and 5); hardware and software systems, eg digital switching systems (DSS), management statistics subsystem (MSS), man-machine interface subsystem (MMIS), digital subscriber switching system (DSSS), maintenance control subsystem (MCS), processor utility subsystem (PUS), test network subsystem (TNS), call processing subsystem (CPS), message transmission subsystem (MTS), network synchronisation subsystem (NSS), automatic announcement subsystem (AAS); digital trunk backbone eg optical fibre, coaxial cables, microwave radio links

ISDN: principles and architecture e.g. B, D and H channels, system connections and interfaces (R, S, T, U and V reference points), protocols; services eg basic rate and primary rate access, services and applications, circuit-switched and packet-switched data services; hardware and software requirements; the European memorandum of understanding

Numbering schemes: national and international numbering schemes; ITU-T (CCITT) recommendations eg E.164 and X.121; number portability issues

2 **Understand signalling and switching of messages over telecommunication networks**

Switching techniques: circuit, message and packet switching; switching in space and time; multiplexing techniques; stored programme control (SPC)

Control of telephone calls: the four phases of call control eg pre-selection, call completion, conversation, release; network functions eg scanning, signalling, routing, operation charging; signalling systems eg user signals, line signals, routing signals; common channel signalling

Signalling: signalling systems eg user signals, line signals, routing signals; common channel signalling

3 **Understand the processes used for conveying analogue signals over digital networks**

Digital transmission: advantages and features of digital techniques eg efficiency, cost factors, noise performance, multiplexing; analogue to digital conversion process; digital to analogue conversion process; build and test A-to-D and D-to-A circuits using either physical components or a computer simulation package

Pulse code modulation (PCM): the four stages eg sampling, pulse amplitude modulation, quantisation, encoding; minimum sampling frequency; aliasing; quantisation error (noise); dynamic range; companding; non-linear quantisation for voice (A law and μ law); demodulation; synchronisation; digital to analogue conversion

CEPT 30 channel PCM system: multiplex arrangement; frame and multi-frame alignment; synchronisation; common channel signalling information

4 **Understand the systems used for transmission, switching and signalling in modern digital exchanges**

Transmission systems: transmission media; multiplexing; digital multiplexing hierarchies (North American and European); the plesiochronous digital hierarchy (PDH); synchronous digital hierarchy (SDH); the synchronous transfer mode (STM) structure

Switching systems: switching capacity eg step-by-step switching, time and space switches, digital switch matrix, central processing, stored programme control (SPC)

Methods of signalling: in-channel/in-band, in-channel/out-band, loop and dual tone multifrequency (DTMF); access and trunk signals; channel-associated and common channel signalling, signalling systems no 5, no 6 and no 7

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Understand the operation of PSTN and ISDN networks	1.1 describe the hierarchical structure of the PSTN 1.2 compare the principles of and services provided by ISDN 1.3 evaluate the numbering schemes used for local, national and international calls
LO2 Understand signalling and switching of messages over telecommunication networks	2.1 compare the switching techniques used in telecommunication networks 2.2 explain the activities associated with the control of telephone calls 2.3 explain the need for signalling over telephone networks
LO3 Understand the processes used for conveying analogue signals over digital networks	3.1 evaluate the advantages and features of digital transmission 3.2 discuss the features of pulse code modulation (PCM) 3.3 critically evaluate the CEPT 30 channel PCM system for time division multiplexing
LO4 Understand the systems used for transmission, switching and signalling in modern digital exchanges	4.1 describe the transmission systems for telephone signals over the PSTN 4.2 explain the function of switching systems in the digital exchange 4.3 compare and contrast the functions and differences between the various methods of signalling on the PSTN

Information for tutors

Essential requirements

Learners will need access to the internet.

Delivery guidance

This unit can be delivered as a stand-alone package or integrated with other appropriate programme units. If delivered in an integrated way, care must be taken to provide tracking of evidence for the outcomes of learning. Centres should be aware that study and assessment at an individual outcome of learning level could lead to an assessment overload. Wherever possible, a practical approach should be adopted. Learning and assessment can be across units, at unit level or at individual outcome of learning level. Effort should be made to identify the relevance of the principles covered to engineering applications and system design.

Access to suitable laboratory equipment and test instrumentation is desirable but not essential. An industrial visit to a switching centre (exchange) would be of great benefit.

Assessment guidance

Evidence of outcomes of learning can be in the form of assignments, reports of practical activities, computer printouts, solutions to applied problems and/or the results of unseen tests/examinations.

Evidence can be accumulated by learners building a portfolio of activities or through a tutor-led combination of tests and assignments. In either case, the evidence must be both relevant and sufficient to justify the grade awarded.