

2.10 Electronic communications technology

2.10.1.1 Electronic communications, principles

Evidence shall show an understanding of principles of an electronic communications system to an extent indicated by the following aspects:

a) Requirements of a basic communications system

Note.

Examples are satellites, data communications, navigation, telecommunications, noise etc

b) Antennae and electromagnetic wave propagation

c) Reason for modulation

d) Amplitude and frequency modulation, difference, advantages and disadvantages

e) Simple transmitter and receiver circuits

Note.

Block diagram level

f) Optical communications principles

2.10.1.2 Electronic signals and systems

Evidence shall show an understanding of electronic signals and system to an extent indicated by the following aspects:

a) Signal types and their application

b) Functional blocks in electronic communication systems

c) Basic methods of signal generation, conditioning and transmission

2.10.1.3 Electronic communications, technologies

Evidence shall show an understanding of technologies in electronic communications to an extent indicated by the following aspects:

a) Concepts of a communication system encompassing:

- function of a block.
- radio wave.
- frequency bands of a radio wave in free space.
- signal transmission media

Note.

Examples are metal line, radio terrestrial to terrestrial, radio terrestrial to satellite to terrestrial, wave guide, optical fibre and the like

- effects of noise on communication system output.
- internal and external sources of noise.

b) Characteristics of signals in both the time and frequency domains encompassing:

- signals forms in time and frequency domain:
- periodic complex waveforms
- Fourier analysis

c) Modulated signals in the time and frequency domain encompassing:

- process of amplitude modulation (AM).
- bandwidth of an AM

- modulation index.
 - total power in an AM wave for one or more modulating tones
 - power rate of AM transmitters
 - modulation index using a CRO.
 - Amplitude modulator circuits.
- d) Demodulation of signals and baseband signal encompassing:
- diode detector.
 - operation of an AM demodulator
 - non-linear mixing and filtering or frequency down conversion
 - single sideband (SSB).
 - baseband output frequency
 - Frequency Modulation (FM)
 - limiting of FM signals and noise suppression.
- e) Time and frequency division multiplexing encompassing:
- frequency division multiplexing (FDM).
 - hierarchy of FDM as applied to telephony and broadcast stereo.
 - time division multiplexing (TDM).
 - hierarchy of TDM.
- f) Concepts and characteristics of a superheterodyne receiver system encompassing:
- crystal set circuit operation.
 - TRF receiver circuit.
 - disadvantages of a TRF receiver.
 - block diagram of a single conversion superheterodyne receiver.
 - shortcomings of the TRF
- g) Operation of transmitters encompassing:
- Amplitude Modulation (AM).
 - modulation technique (high or low level) and function of each block
 - single sideband (SSB) and function of each block.
 - frequency modulation (FM) and function of each block
- h) Concepts of digital encoding of baseband signals encompassing:
- analog signals quantised and digital form.
 - sampling analogue signals.
 - pulse-code modulation (PCM).
 - quantisation as applied to PCM.
 - quantisation noise as applied to PCM.
 - companding of PCM signals.
 - PCM encoding.
 - advantages that digital signals such as PCM
- i) Sources and effects of noise in a communication system encompassing:
- S/N ratio in communication systems.
 - noise figure, noise factor and noise equivalent temperature

2.10.2 Electronic communications, transmission principles

Evidence shall show an understanding of transmission principles to an extent indicated by the following aspects:

- a) Principles and operation of transmitters
- b) Types of transmitters, their features and characteristics
- c) Tuning, adjusting and testing.

2.10.3 Electronic communications, modulation

Evidence shall show an understanding of modulation in electronic communications to an extent indicated by the following aspects:

- a) Amplitude modulation including concepts, phasor representation, envelope, depth, power in sidebands, over modulation and splatter
- b) Sideband modulation and de-modulation techniques including single, double and vestigial types and frequency representation
- c) Frequency and phase modulation

2.10.4 Electronic communications, modulation circuits

Evidence shall show an understanding of modulation to an extent indicated by the following aspects:

- a) Amplitude modulation concepts

Note.

Examples include basic amplitude modulation fundamentals, phasor representation of carrier and sidebands, phase on modulation envelope, index and percentage modulation depth, power in carrier and sidebands, over modulation and "splatter"

- b) Sideband modulation terminology and techniques.

Note.

Examples include double-sideband (DSB), single-sideband (SSB), vestigial-sideband (VSB), frequency domain representation, double-sideband signal (DSB), single-sideband signal (SSB), demodulation requirements for DSB and SSB

- c) Frequency and phase modulation

Note.

Examples include, time and frequency domain representation, amplitude and frequency distribution of sidebands, frequency modulation (FM) production, phase modulation (PM) production, equivalent FM and PM – audio processing

- d) NBPM Armstrong method of producing (phasor description)

2.10.5 Electronic communications, receivers

Evidence shall show an understanding of receivers to an extent indicated by the following aspects:

- a) Receiver principles, types, construction and applications
- b) Polarisation
- c) Mixers
- d) Intermediate frequency amplification
- e) Demodulation
- f) Receiver systems, types and characteristics

2.10.6 Electronic communications, transmitters

Evidence shall show an understanding of transmitters to an extent indicated by the following aspects:

- a) Transmitter fundamentals
- b) Transmitter configuration
- c) Oscillators and oscillator circuits
- d) Frequency synthesisers
- e) Amplifier types and circuits
- f) Impedance matching networks
- g) Typical transmitter circuits

2.10.7 Electronic communications, digital techniques

Evidence shall show an understanding of digital communication techniques to an extent indicated by the following aspects:

- a) Data rates
- b) Current data communications standards
- c) Modulation schemes used in digital transmission
- d) Power levels and interference
- e) Error handling
- f) Applications like for example: USB, Ethernet, ADSL and BDSL, or any other current applications

2.10.8 Electronic communications, transmission lines

Evidence shall show an understanding of transmission lines to an extent indicated by the following aspects:

- a) Time domain reflectometry measurements
- b) Radio frequency characteristics of transmission lines
- c) Losses in transmission lines
- d) Radiation characteristics of antennae
- e) Directional antennae
- f) Antennae matching
- g) UHF and microwave antennae

2.10.9 Electronic communications, antennas and wave propagation

Evidence shall show an understanding of basic antenna and antennae systems and wave propagation to an extent indicated by the following aspects:

- a) Antenna fundamentals

Note.

Examples include and the characteristics of radio waves, antenna operation, antenna reciprocity and the basic antenna.

- b) Antenna types, feature and characteristics encompassing:

- Dipole antennas and characteristics

Note.

Examples include radiation resistance, dipole length, antenna resistance, antenna Q and bandwidth, conical antennas, dipole polarisation, radiation patterns and directivity, antenna gain and folded dipoles

- Marconi ground-plane vertical antenna features and characteristics

Note.

Examples include radiation pattern, ground plane radials and counterpoise, radiation resistance, antenna length and directivity,

- UHF and microwave antennas
- Relationship between directivity and gain
- Antenna arrays

Note.

Examples include parasitic arrays and driven arrays

- Impedance matching

c) Radio wave propagation characteristics

Note.

Examples include optical characteristic, propagation through space

d) Calculation of received power

e) Antenna selection and location

f) Transmission lines

2.10.10 Electronic communications, microwave

Evidence shall show an understanding of microwave communications to an extent indicated by the following aspects:

- a) Propagation of electromagnetic waves through the atmosphere, transmission lines and waveguides including characteristic impedance, impedance matching, standing waves, microwave frequency bands
- b) Microwave device parameters involving wavelength, phase, VSWR, impedance matching, circuit parameters, amplifiers, transmission, reception, oscillation, noise figure, noise temperature
- c) Microwave devices and components
- d) Microwave operational constraints and operating parameters such as power, bandwidth, gain, efficiency, operational life, electrical parameters, stability, cooling, size, testing and device selection
- e) Microwave measurements, test equipment and testing techniques
- f) EMI/EMC, generation, suppression and reduction

2.10.11 Electronic communications, satellite

Evidence shall show an understanding of satellite communications systems to an extent indicated by the following aspects:

- a) Types of satellite systems and sub-systems
- b) Earth station locality and antenna parameters
- c) Link specifications and link calculations
- d) Base band signalling processes
- e) Modulation and system access

2.10.12 Electronic communications, optical methods

Evidence shall show an understanding of optic methods of communication to an extent indicated by the following aspects:

- a) Optical principles
- b) Optical fibre cable principles, types construction and applications
- c) Optical transmitters, detectors and receivers
- d) Calculation of transmission losses in fibre optical cables and connectors

2.10.13 Television and video reception

Evidence shall show an understanding of reception signals and decoding to an extent indicated by the following aspects:

- a) Broadcast systems
- b) Basic operation of a TV cameras
- c) Basic operation of a TV receiver including tubes and displays and operating components
- d) Reception aerials and arrays
- e) Operation of a video cassette recorder including tape recording, helical scanning, mechanical principles and adjustments, electronic principles and adjustments, servo control loops

2.10.14 TV antenna systems

Evidence shall show an understanding of TV antenna systems to an extent indicated by the following aspects:

- a) The common difficulties associated with TV receptions
- b) Operating characteristics of common types of TV receiving antennas
- c) Selection of coaxial cable
- d) Multiple outlet TV aerial systems
- e) Operation of satellite receiving systems
- f) Performance testing and fault-finding on multiple outlet antenna systems

2.10.15 Antenna installation and servicing

Evidence shall show an understanding of antenna installation and servicing to an extent indicated by the following aspects:

- a) Propagation of radio waves from a transmitter to a receiver
- b) Characteristics of antenna systems
- c) Selection of antennae systems for various applications
- d) Installation techniques for antennae to receiver and antennae to transmitter transmission and distribution systems

2.10.16 Transmission lines and antennae

Evidence shall show an understanding of transmission lines and antennae to an extent indicated by the following aspects:

- a) Reflectometry minimum and maximum voltage and current values on a transmission line

carrying an RF signal

- b) Transmission line loss measured in decibels
- c) EH field directions in relation to antenna elements
- d) Differences between hertz and Marconi antennas
- e) Principles for microwave antennas used for terrestrial and satellite transmissions

2.10.17 Electronic communications, multiplexing and de multiplexing

Evidence shall show an understanding of multiplexing and de multiplexing to an extent indicated by the following aspects:

- a) Coding schemes (line coding, error coding, bit rate reduction)
- b) Multiplexing schemes (MPEG1&2)
- c) Spread spectrum (CDMA, COFDM)

2.10.18 Electronic communications, microwave antennas and wave guide fundamentals

Evidence shall show an understanding of microwave antennas and wave guides to an extent indicated by the following aspects:

- a) Antenna and wave guide principles and components
- b) Installation techniques for microwave communication systems
- c) Setting up techniques for microwave communication systems

2.10.19 Electronic communications, commissioning process

Evidence shall show an understanding of commissioning electronic communication systems to an extent indicated by the following aspects:

- a) Purpose of commissioning
- b) Commissioning planning and documentation
- c) Initial tests and adjustments
- d) Commissioning procedures

2.10.20 Electronic communications, sonar transducers and arrays

Evidence shall show an understanding of sonar transducers and arrays to an extent indicated by the following aspects:

- a) Hazards and risk control measures
- b) Transducer types, their operating principles and parameters
- c) Transducer array encompassing:
 - Types and their construction
 - Applications
- d) Transducer hull outfits
- e) Beam forming principles and requirements
- f) Transducer installation and operational maintenance

2.10.21 Electronic communications, sonar system operating principles

Evidence shall show an understanding of sonar system operating principles to an extent indicated by the following aspects:

- The purpose and application of sonar systems
 - Sonar equipment encompassing:
 - Types and their applications
 - Sub-system components (i.e. functional blocks) and their function encompassing:
 - Transducer
 - Input amplifier
 - Sonar interface unit
 - Beamforming network (transmit / receive)
 - Signal processing
 - Own Doppler nullification
 - Display system
 - Headset
 - Interfaces
 - Transmitter
 - T/R Switch
 - Timer/Timing
- e) Sonar operating parameters
- f) Sonar transmission characteristics

2.10.22 Electronic communications, sonar measurement and set up

Evidence shall show an understanding of sonar measurement and set up to an extent indicated by the following aspects:

- a) Sonar parameters and measurements
- b) Sonar physical parameters
- c) Constraints and Consequences

2.10.23 Electronic communications, secondary radar and related systems

Evidence shall show an understanding of secondary radar and related systems to an extent indicated by the following aspects:

- a) Secondary radar principles encompassing:
 - Role of secondary radar
 - Transponder operation
 - Operating principles
 - Signal processing
 - Pulse generation, transmission and detection
 - Mode generation, detection and response
 - Display symbol generation
 - Synchronisation with primary radar

- Advantages over primary radar with respect to: clutter;
- signal/noise ratio; transmit power required for operation

b) Interfaces to other systems providing information for transmission of mode data encompassing:

- Slaving/synchronisation to primary radar
- Clutter reduction/elimination
- Defruiting
- Degarbling
- Interfaces to other systems
- Range/ducting effects
- Advantages over primary radar
- Power supplies and UPS
- International standards
- National Curriculum
- Hot standby, cold standby

c) Application of secondary radar systems

Note.

Examples are Traffic Collision Avoidance System (TCAS), Selective Identification System (SIF), Air Traffic Control Radar Beacon System (ATCRBS), Instrument Landing System (ILS), Tactical Air Navigation (TACAN), Navigation Systems (VOR, GPS, DME), Radar Altimeter, Jamming, Electronic warfare, Second Time Round Returns (STRR), and Identification –friend or foe radar (IFF).

2.10.24 Electronic communications, radar and sonar displays devices

Evidence shall show an understanding of radar and sonar displays devices to an extent indicated by the following aspects:

a) Types and their applications

Note.

Examples are CRT, Plasma, LCD, Monochrome, Colour, and Touch screen.

b) Sub-system components (i.e. functional blocks) and their operating parameters encompassing:

- EHT transformers
- detectors
- video distribution
- time base generators
- phase locked loops
- microprocessors
- memory devices
- demodulators
- focusing/deflection devices
- delay lines
- bleed resistors
- HV generation

c) Calibration testing and maintenance procedures

d) Typical fault finding, their symptoms and cause

2.10.25 Electronic communications, radar fundamentals

Evidence shall show an understanding of radar fundamentals to an extent indicated by the following aspects:

- a) Hazards and risk control measures
- b) Purpose and uses of radar
- c) Environmental conditions affecting radar
- d) Design factors which affect performance
- e) Propagation of electromagnetic waves
- f) Pulse forming circuits
- g) Typical radar transmitter encompassing:
 - limitations and applications of each type
- h) Typical radar receivers encompassing:
 - Sub-system components (i.e. functional blocks) and their operating parameters
 - limitations and applications
- i) Radar antennae encompassing:
 - Types, application and radiation patterns
 - Note.
Examples are parabolic, phased array, log periodic, and cos q
 - antenna gain
 - efficiency
 - length and height factors
- j) Microwave techniques, devices and applications encompassing:
 - oscillators
 - amplifiers
 - modulators and demodulators
 - mixers and detectors
- k) Types and characteristics of various radar systems

2.10.26 Electronic communications, navigation systems

Evidence shall show an understanding of navigation systems to an extent indicated by the following aspects:

- a) Sub-system components (i.e. functional blocks) and their operating parameters
- b) Environment factors effecting system performance
- c) Typical faults, their symptoms and cause.
- d) Fault diagnosis procedures and testing
- e) Sub-system adjustments

2.10.27 Electronic communications, surveillance and observation

Evidence shall show an understanding of surveillance and observation to an extent indicated by the following aspects:

- a) Sub-system components (i.e. functional blocks) and their operating parameters
- b) Environment factors effecting system performance
- c) Typical faults, their symptoms and cause.

- d) Fault diagnosis procedures and testing
- e) Sub-system adjustments

2.10.28 Electronic communications, global positioning systems

Evidence shall show an understanding of global positioning systems to an extent indicated by the following aspects:

- a) Sub-system components (i.e. functional blocks) and their operating parameters
- b) Environment factors effecting system performance
- c) Typical faults, their symptoms and cause.
- d) Fault diagnosis procedures and testing
- e) Sub-system adjustments

2.10.29 Digital television transmission towers and equipment

Evidence shall show an understanding of digital television transmission towers and equipment to an extent indicated by the following aspects:

- a) The requirements of DTTB program input and monitoring equipment encompassing:

- basic system arrangement
Note.
Example is a central router connected to a number of control rooms.
- Terminologies
Note.
Examples are Vertical, Multi-level; Tie-line Routing and cross point
- typical signal types processed by a router.
- the purpose of "redundant CPU's and power supply units".
- common control protocols used in routers.
- typical analogue audio and video output voltage levels present at the router.
- typical specifications for digital data signals present at the router.
- function of various test equipment used in DTTB measurements.

- b) The operating characteristics of a digital television terrestrial broadcast (DTTB) transmitter encompassing:

- typical DTTB digital transmission system.
- safety precautions required when working with high power RF transmitters.
- operating characteristics of a typical MPEG encoder.
- operation of a coded orthogonal frequency division multiplex (COFDM) modulator.
- arrangement of subsystem components in a DTTB transmitter
- purpose of an up converter in a DTTB transmitter.
- typical characteristics of a DTTB power amplifier.
- advantages and disadvantages of air and liquid cooling systems used in transmitters.
- typical DTTB transmitter measurements techniques.

- c) The performance requirements of the DTTB combiner and antenna systems encompassing:

- minimum channel separation required between digital and analogue TV channels

- typical specifications of an antenna combiner system.
 - the need for combiner systems in DTTB systems.
 - typical system faults in combiners and antenna system.
- d) The requirements of remote monitoring and measurement equipment encompassing:
- purpose of control panel indicators and controls.
 - Process by which the system manages a critical failure.
- Note.
Example of component failure deemed as critical are power supplies and CPUs
- different system alarm signals.
 - periodic equipment self tests and diagnostic routines on DTTB systems.
 - DTTB systems fault diagnostic and rectification techniques.
 - function of the basic components of a DTTB system.
 - typical units of a DTTB Telemetry system

2.10.30 Wireless devices

Evidence shall show an understanding of wireless devices to an extent indicated by the following aspects:

- a) Types and applications
- b) Operating principles at sub-system level
- c) Programming functions
- d) Networking set up

2.10.31 Electrotechnology Communications Principles

Evidence shall show an understanding of Electrotechnology communications principles to an extent indicated by the following aspects:

- a) The basic electrical circuit
 - basic circuit components
 - function of basic circuit components
 - connection of components
 - measurement of circuit parameters
 - open-circuit, closed-circuit and short-circuits.
- b) Circuit parameter relationships
 - Ohms Law
 - calculation of voltage, current and resistance
 - power dissipated
 - calculation of power.
- c) Measurement instruments (voltage, current & resistance)
 - safe working procedures
 - handling and storing instruments
 - selecting and set up of instruments
 - connecting instruments
 - read analogue scales and digital readouts.

d) Effects of electrical current

- physiological effect
- heating effect
- magnetic effect
- chemical effect
- typical uses

e) EMF sources

- basic generator
- basic thermocouple
- photovoltaic cells
- piezo electric
- primary and secondary cells.

f) d.c. resistive circuits

- series circuits (set-up, measurement and calculations)
- parallel circuits (set-up, measurement and calculations)
- series-parallel circuits (set-up, measurement and calculations).

g) Capacitance

- construction of capacitors
- operation of capacitors
- units
- charge of a capacitor
- RC series circuit.

h) Magnetism and electromagnetic induction

- permanent magnets
- electromagnetism
- induced emf
- inductors
- principles of inductance
- unit of inductance
- electromagnetic radiation (EMR)
- cross talk.

i) a.c. principles

- generation of sinusoidal voltage
- a.c. circuit parameters – frequency, period, amplitude, instantaneous value, maximum value, peak value, peak to peak value and rms value
- calculation of frequency and rms values
- effects of frequency on inductors $(X_L = 2\pi f L)$
- effects of frequency on capacitors $\left(X_C = \frac{1}{2\pi f c}\right)$
- transformers construction and operating principles.

2.10.32 Amateur radio communication principles, practices, and technical overview

Evidence shall show an understanding of amateur radio communication principles, practices, and technical overview to an extent indicated by the following aspects:

a) Nature of Amateur Radio encompassing:

- Nature of Amateur radio
- Types of licences
- Allocation of frequency bands

b) Licence Conditions encompassing:

- Conditions of licences
- Purpose of the Amateur Service
- Communications by Amateur stations
- Distress and Urgency signals
- Station identification
- Amateur call signs
- Secret messages
- Entertainment not permitted
- Amateur frequency bands and emissions
- Permitted power output
- Notification of change of address
- Harmful interference
- Authorised use of Amateur stations
- Inspection of Amateur licences
- Restriction of operation to avoid interference
- Use of the Licence Condition Determinations

c) Mathematics used for Amateur radio operation encompassing:

- addition, subtraction, multiplication and division
- fractions, percentage, and decimal notation
- units and sub-units; (mega, kilo, UNIT, micro, and pico)
- calculations using simple formulae

d) Amateur radio technical basics encompassing:

- Mains power overview
- Mains power supplies overview
- Voltage and current overview
- Resistance overview
- Ohm's Law overview and the relationship between voltage, current and resistance
- Power in DC circuits overview including calculations related to power in a DC circuit using current and voltage, current and resistance or voltage and resistance.
- Capacitance overview
- Inductance overview

- AC circuits overview
- Impedance and reactance overview
- Tuned circuits overview
- Transformers overview
- Solid state devices overview

e) Transmitters and Receivers – basic overview encompassing:

- Block diagrams of simple transmitters
- Mixers
- Modulation
- Amplifiers
- Transmission quality
- Receiver parameters and terminology
- Simple block diagrams of a Receiver
- Frequency converters
- IF amplifier
- Automatic Gain Control
- Transceivers

f) Transmission lines and Antennas overview encompassing:

- Transmission line basics
- Baluns
- Standing waves
- Antenna Matching Units (ATU)
- Antennas
- Identification of common antennas
- Radiated Power

g) Propagation overview encompassing:

- Electromagnetic radiation
- Ionosphere

h) Interference and Electromagnetic Compatibility (EMC) overview encompassing:

- Interference - Points of entry into electronic equipment
- Filters
- EMC

i) Operating Practices and Procedures overview encompassing:

- Equipment practices
- Authorised frequencies and emissions
- Requirement not to transmit on frequencies in use
- Operating practices
- Operating through a repeater
- Make an all-stations call and change frequency
- Transmitter measurements

- Correcting simple equipment maladjustments
- Recognised abbreviations
- Phonetic alphabet

j) Safety overview encompassing:

- Dangerous voltages
- Electrical safety - equipment to be approved
- Awareness of State Electricity Authority requirements
- Electrical earthing
- Fuses
- Correct fuses to be used
- Replacing fuses
- Station layout for safety
- Power lead safety
- Know location and desirability of a mains OFF switch
- Actions to be taken in the event of an accident involving electricity
- Electric shocks
- Call for help – use of resuscitation techniques
- Battery safety
- Antennas and safety
- Radio waves can be dangerous
- Safe distance from an antenna
- Antenna erection
- Securing and siting antennas
- Lightning protection
- Safe use of headphones
- Station security

k) Measurements

- Frequency measurements
- RF Power measurements
- SWR measurements
- Multimeter measurements