# AMATEUR OPERATOR'S CERTIFICATE OF PROFICIENCY (BEGINNERS) SYLLABUS AND EXAMINATION

Regulation 45 of the Electronic Communications Regulations, 2011, L.I.1991 defines the amateur radio service as a "type of radio communication service used for interconnection, leisure-time activity, testing and research". Article 1.56 of the Radio Regulations of the International Telecommunications Union (ITU) defines the amateur service as a "radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest".

Radio is a general term applied to the use of radio waves. Radio waves are electromagnetic waves of frequencies arbitrarily lower than 3000 GHz, propagated in space without artificial guide. When radio waves are used for communications by non-professionals for purposes such as self-training, communication for non-commercial purposes and for technical investigations, it is referred to as amateur radio. The amateur service is the oldest radio service and pre-dates regulation of radiocommunications.

Amateur radio is important to the country. The amateur services include self-training as an important purpose. This includes training of young people in radiocommunications. Radio amateurs have the opportunity of planning, designing, building, operating and maintaining a complete communications facility without pecuniary interest, which contributes to the telecommunication human resources development of a country. Participation in amateur radio could elicit interest for electronic communications in young people who could become gifted professionals in the future.

The National Communications Authority (NCA) in line with the provisions of Regulation 47b of the Electronic Communications Regulations, 2011, L.I.1991 has developed this Beginner's Amateur Syllabus. This Beginner's Syllabus is the curriculum for persons seeking the Amateur Class C Licence. Anyone who is fourteen (14) years or older can apply to sit for a beginner Amateur Radio Licence examination based on this syllabus.

The Beginner's Amateur Licence is considered to be the entry level for Amateur radio in Ghana. The syllabus and related examination for the Beginner's Amateur Licence correspondingly reflects the minimum level of knowledge, skills and experience required to safely assemble a Beginner's Amateur station and to operate it safely without interference to other users and services.

| ***TOPIC*** | ***ASSESSMENT OBJECTIVES*** | ***SPECIFIC OBJECTIVE*** |
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| ***1.0 THE NATURE OF THE AMATEUR RADIO*** | | |
| ***1.1 Purpose of Amateur radio services*** | 1.1.1 Amateur radio is intended for non-commercial purpose. | Recall that amateur radio is for: |
| | | 1.1.1.1 Self training in radio communications |
| | | 1.1.1.2 Experimentation |
| | | 1.1.1.3 Disaster communication |
| | | 1.1.1.4 Technical investigations |
| | | 1.1.1.5 Hobby (leisure time activities) |
| ***1.2 Types of radio communications services*** | 1.2.1 Amateur radio service operates on frequency bands allocated for Amateur use. | Other forms of radio communications services are: |
| | | 1.2.1.1 Citizens Band (CB). |

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| | Amateur service shares some frequency bands with other services. | 1.2.1.2 Land mobile |
| | | 1.2.1.3 Point-to-Point Links |
| | | 1.2.1.4 FM Radio Broadcasting |
| | | 1.2.1.5 Television Broadcasting |
| | | 1.2.1.6 Aeronautical Radio services |
| | | 1.2.1.7 Maritime Radio services |
| **1.3 Allocation of frequency bands** | | |
| | 1.3.1 Citizens Band (CB) | 1.3.1.1 27MHz |
| | 1.3.2 Land mobile | 1.3.2.1 136MHz – 174MHz |
| | 1.3.3 Point-to-Point Links | 1.3.3.1 350MHz – 380MHz |
| | 1.3.4 FM Radio Broadcasting | 1.3.4.1 87.5MHz – 108MHz |
| | 1.3.5 Television Broadcasting | 1.3.5.1 VHF: 174MHz – 230MHz ; UHF: 470MHz – 694MHz; Ku Band -Satellite; C- Band-Satellite |
| | 1.3.6 Aeronautical services | 1.3.6.1 108-137MHz |
| | 1.3.7 Maritime services | 1.3.7.1 156.000-162.025MHz |
| | 1.3.8 Amateur Radio | 1.3.8.1 1.81Hz -1.85MHz, 3.5MHz -3.8MHz, 28MHz-29.7MHz and 144MHz-146MHz |
| **2.0 COMMUNICATION LAWS AND REGULATIONS** | | |
| ***2.1 INTERNATIONAL*** | | |
| 2. 2 International Telecommunications Union (ITU) Radio Regulations | 2.2.1 International Telecommunications Union (ITU) is the United Nations Specialised agency for information and communications technologies-ICTs | 2.2.1.1 Recall that the ITU is a United nations agency |
| | | Recall that the ITU performs the following functions: |
| | | 2.2.1.2 allocate the global radio spectrum and satellite orbits |
| | | 2.2.1.3 Develop technical standards that ensure networks and technologies seamless interconnect |
| | | 2.2.1.4 strive to improve access to ICTs to underserved communities worldwide |
| | 2.2.2 ITU is made up of three sectors covering specific areas of ICT activity:<br><br>Radiocommunications (ITU-R)<br><br>Telecommunications Standards (ITU-T)<br><br>Telecommunications Development (ITU-D) | 2.2.2.1 Recall that the role of the Radiocommunication Sector (ITU-R) is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.<br><br>The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups. |
| | | 2.2.2.2 Recall that regulations of Amateur Radio Service falls under ITU-R |

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| | 2.2.3 Article 1.56 of the **Radio Regulations** (RR) defines the amateur service as: "A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest. | 2.2.3.1 Recall the definition of Amateur Service per Article 1.56 of the Radio Regulations |
| | | 2.2.3.2 Recall the purpose of Amateur Service per Article 1.56 of the Radio Regulations |
| | 2.2.4 Article 1.57 defines amateur-satellite service: A radiocommunication service using space stations on earth satellites for the same purposes as those of the amateur service. | 2.2.4.1 Recall the definition of Amateur- Satellite Service per Article 1.57 of the Radio Regulations |
| | | 2.2.4.2 Recall that the Amateur-Satellite Service is of the same purpose as the Amateur Service |
| | 2.25 Article 1.96 defines an amateur station as a station in the amateur service. | 2.2.5.1 Recall the definition of an Amateur Station. The station would be operated accordingly to the following conditions:<br>• Only the licensee, or a licensed amateur holder (holding NCA's Authorisation) operating under his or her supervision, may use the Radio Equipment.<br>• Identify allowable frequencies and power limits.<br>• Licensee shall notify the NCA of change of address.<br>• a person authorised by NCA has the right to inspect, require the modification, close down or restrict the operation of the amateur station<br>• Understand and apply the Schedule to the licence |
| 2.3 International Telecommunications Union, "Handbook on Amateur and amateur satellite services," Geneva, 2014. | 2.3.1 The amateur service is the oldest radio service and pre-dates regulation of radiocommunication per the International Telecommunications Union, "Handbook on Amateur and amateur satellite services," Geneva, 2014. | 2.3.1.1 Recall that amateur service is the oldest form of radio Service |
| | | 2.3.1.2 Recall that Amateur Service pre-dates regulations of radiocommunications |

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| 2.4 International Telecommunications Union – Recommendations (ITU-R M. 544) | 2.4.1 ITU-R M.1544 provides the Minimum qualifications of radio amateurs | 2.4.1.1 Recall that the beginner Amateur Syllabus is based on the ITU-R M.1544 |
| ***2.5 DOMESTIC*** | | |
| 2.6 National Communications Authority Act, 2008, Act 769 | 2.6.1 The National Communications (NCA) Act 2008, Act 769 establishes the NCA as the central body to license and regulate communications activities and services in Ghana. | Recall that the NCA has twenty-five (25) functions as per section (3) of Act 769, including: |
| | | 2.6.1.1 Establish and monitor the implementation of national communications standards and ensure compliance accordingly, |
| | | 2.6.1.2 grant communications licence, |
| | | 2.6.1.3 regulate and monitor licensees, holders of frequency authorizations in consultation with the National Media Commission where appropriate, |
| | | 2.6.1.4 ensure fair competition amongst licensees, operators of communications networks and service providers of public communications, |
| | | 2.6.1.6 establish a frequency plan and monitor any frequency allocated to the communications industry |
| | | 2.6.1.7 Certify and ensure the testing of communications equipment for compliance with international standards, and environmental health and safety standards. |
| 2.7 Electronic Communications Act, 2008, Act 775 | 2.7.1 The Electronic Communications Act, 2008, Act 775 is an act to provide for the regulations of electronic communications, the regulations of broadcasting, the use of electromagnetic spectrum and for related matters. | 2.7.1.1 Recall that the per section (2) of Act 775, the National Communications Authority shall regulate the radio spectrum designated or allocated for use by broadcasting organizations and providers of broadcasting services in accordance with the standards and requirements of the International Telecommunications Union and its Radio Regulations as agreed to or adopted by the Republic. |
| 2.8 Electronic Communications Regulations, 2011, L.I. 1991. | 2.8.1 In exercise of the powers conferred on the Minister responsible for Communications by section 97 of the Electronic Communications Act, 2008, (Act 775), The Electronic Communications Regulations, 2011, L.I. 1991 has been formulated as the principal guide for the electronic communications industry in Ghana | 2.8.1.1Recall that the operations under a beginner Amateur licence is subject to the provisions of the National Communications (NCA) Act 2008, Act 769, Electronic Communications Act, 2008, Act 775, The Electronic Communications Regulations, 2011, L.I. 1991. |
| | 2.8.2 Regulations 45 of the L.I. defines the amateur radio service as a type of radio communication service used for interconnection, leisure time activity, testing | 2.8.2.1 Recall that regulation 45 to 48 of the L.I. stipulates the licence conditions for amateur radio regulations in Ghana and its classifications are as follows:<br>• Amateur radio services |

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| | and research. and is classified according to its output as follows: | • Amateur radio operators<br>• Amateur radio licence<br>• Amateur radio examination and certificate |
| | 2.8.3 Class A | 2.8.3.1 **Class A stations:** that is stations which have an output power of not more than 1,000 watts |
| | 2.8.4 Class B | 2.8.4.1 **Class B stations:** that is, stations which have an out- put power of not more than 250 watts; and |
| | 2.8.5 Class C | 2.8.5.1 **Class C Stations:** that is, stations which have an out-put power of not more than 100 watts. |
| | 2.8.6 Regulations 46 of the L.I. classifies amateur radio operators as follows: | |
| | 2.8.7 Beginner | 2.8.7.1 Beginners, that is, persons authorised to operate Class "C" stations |
| | 2.8.8 Intermediate | 2.8.8.1 Intermediate, that is, persons authorised to operate Class "B" stations |
| | 2.8.9 Advanced | 2.8.9.1 Advanced, that is, persons authorised to operate Class "A" stations |
| | 2.9.0 Regulations 47 of the L.I. stipulates the conditions for the grant of the Amateur radio licence | The Authority may grant an Amateur radio licence to an applicant who: |
| | | 2.9.0.1 is fourteen (14) years of age or above |
| | | 2.9.0.2 has passed the radio amateur examination or possesses the requisite qualifications prescribed for the purpose; |
| | | 2.9.0.3 The holder of an amateur radio licence shall keep an accurate log of operations in the station which shall include the following:<br>• the date of operations;<br>• the time of commencement of each call made from the station including tests conducted or called;<br>• the time of establishing and of ending contact with each station;<br>• the frequency used;<br>• the type of emission which is to be entered only once until there is change in the type of emission;<br>• the signature of each licensed amateur radio operator and the name and signature of a person holding an amateur radio licence or amateur radio certificate recognized by the Authority who transmits by voice over a radiotelephone transmitter; and<br>• the time of closing down the station. |

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| | 2.9.1 Regulations 48 of the L.I. empowers the Authority to conduct an amateur radio examination at centres based on the syllabus determined by the Authority and other relevant details | Identify, using License Condition Determinations (LCDs) applicable to the Amateur Licence, specific license conditions as they apply to the Foundation License. |
| ***2.9 FORMAT OF CALL SIGNS*** | 2.9.2 Amateur Radio Call Signs are unique identifiers used to legally identify a station or operator | 2.9.2.1 Recall that Amateur Call Signs are allocated by the ITU |
| | | 2.9.2.2 Recall the categories of call signs used in the Ghanaian Amateur Service. Identify call sign suffixes applicable to each license category, prefixes and state designators |
| | | Recall that correct station identification is required at the beginning of a transmission, or series of transmissions, and at least every 10 minutes during a series of transmissions.<br><br>Recall that any transmission, even a test transmission, must contain station identification. |
| | | 2.9.2.2 Recall the format for Ghana's Call Sign:<br>• 9GA-9GZ<br>• Call Signs have a prefix of 9G<br>• The suffix of the Call Signs (to be determined by the NCA) |
| **3.0 *TECHNICAL BASIS*** | | |
| **3.1 Use of the International System of units (SI)** | 3.1.1 Units of measurement, abbreviations and multiple / sub-multiple prefixes<br>(***See Annex 1- SI Units and Prefixes***) | 3.1.1.1 Recall the units of, and abbreviations for, Voltage, Current, Resistance and Power.<br>Voltage (V) – Volts (V)<br>Current (I) – Ampere (A)<br>Resistance (R)- Ohms<br>Power (P) – Watts (W); *one Joule per second* |
| | | 3.112 Recall the engineering prefixes milli, Kilo, Mega, etc. |
| **3.2 Simple Circuit Theory** | 3.2.1 Meaning of Electric Circuits | 3.2.1.1 Understand that, in a metallic conductor, *an electric current is the flow of electric charge (electrons).*<br><br>3.2.1.2 Recall that a conductor allows the flow of electrical current and an insulator does not. |
| | | 3.213 Understand that metals such as copper, aluminum and brass are good conductors. |

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| | | 3.2.1.4 Plastics, wood, rubber, glass and ceramics are regarded as insulators. *Understand that water is a conductor, and that wet insulators can conduct electricity through the surface water.* |
| | 3.2.2 Ohm's Law | 3.221 Recall that Ohm's Law is relationship between Potential difference *(Voltage (V))* and Current *(I)* in an ideal conductor. The potential difference (V) across an ideal conductor is proportional to the current through it. The constant of proportionality is called Resistance.<br><br>3.2.2.2 Recall that resistance is the opposition to current flow (V=R×I, I=V/R, R=V/I) |
| | | 3.223 Recall that Electric Power (P) is the rate at which electrical energy is transferred by electric circuit. (P=V×I, I=P/V, V=P/I) |
| | 3.2.3 Excessive and incorrect polarity | 3.2.3.1 Recall that electronic circuits can be damaged by applying an excessive voltage or voltage of wrong polarity. |
| | 3.2.4 Meaning of DC and AC | 3.2.4.1 Recall what is meant by the abbreviations DC and AC:<br>Direct Current (DC); the electric charge (current) only flows in one direction<br>Alternating Current (AC); the electric charge flows in various directions periodically. |
| | | 3.2.4.2 Identify the various components of a circuit (*refer to attachment)* |
| | 3.2.5 Simple Calculations | 3.2.5.1 Recall the relationship between Voltage, Current, Resistance and Power. Calculate an unknown value given the value of the remaining components. |
| **3.3 The Electromagnetic Wave** | 3.3.1 Radio is a general term applied to the use of radio waves. Radio waves are electromagnetic waves of frequencies arbitrarily lower than 3000 GHz, propagated in space without artificial guide (***See Annex II - Radio spectrum)*** | 3.3.1.1 Recall the various range of frequencies described as electromagnetic spectrum.<br>*Recall that the Electromagnetic spectrum is the distribution of electromagnetic radio according to energy (frequency or wavelength).* |
| | 3.3.2 Frequencies used in power, audio and radio systems. | 3.3.2.1 Recall the range of frequencies described as Audio Frequency (AF) and Radio Frequency (RF). |

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| | | 3.3.2.2 Identify the graphic representation of a sine wave and recall that sine waves are produced by oscillators<br><br>3.3.2.3 Recall the frequency of the mains supply in Ghana - 50Hz at 220V<br><br>3.3.2.4 Recall the range of frequencies for normal hearing – 100Hz- 15kHz<br><br>3.3.2.5 Recall the range of frequencies for audio communication - 300Hz-3kHz.<br><br>3.3.2.6 Recall the frequency bands for HF, VHF, and UHF radio signals. |
| | 3.3.4 Meaning of AM and FM | 3.3.4.1 Recall what is meant by the abbreviations AM and FM. Describe how the radio frequency carrier is modified for AM and FM. |
| | 3.3.5 Wave Equation | 3.3.5.1 Understand the relationship between frequency (f) and wavelength (λ). Use a graph to convert from one to the other<br><br>Speed of a Wave (C)= Wavelength λ)/time (t)<br><br>F = 1/t hence c=λf |
| | 3.3.6 Unit of Frequency | 3.3.6.1 Recall that hertz (Hz) has been accepted for use in publications of the ITU, as the name for the unit of frequency |
| **3.4 The Sinusoidal Wave** | 3.4.1 The Sine wave or sinusoid is the mathematical curve that describes a smooth repetitive oscillations | 3.4.1.1 Recall the graphic representation of a sine wave and oscillators produce sine waves. |
| ***4.0 METHODS OF RADIOCOMMUNICATION*** | | |
| 4.1 Radiotelephony (RTF) | 4.1.1 A **radiotelephone** (or radiophone) is a communications system for transmission of speech over radio. **Radiotelephone** systems are not necessarily interconnected with the public "land line" telephone network<br><br>Radiotelephony (RTF) provides the means by which pilots and ground personnel communicate with each other. The information and instructions transmitted are | 4.1.1.1 The following transmitting techniques will assist in ensuring that transmitted speech is clear:<br>• Listen out on the frequency some seconds before transmitting to ensure that there will be no interference with a transmission from another station<br>• Press the transmit switch fully before speaking and do not release it until the message is completed. This will ensure that the entire message is transmitted<br>• Use a normal conversational tone, and speak clearly and distinctly and maintain the speaking volume at a constant level<br>• Make a slight pause before and after numbers will assist in making them easier to understand |

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| | of vital importance in the safe and expeditious operation of aircraft. | • Avoid using hesitation sounds such as "er"<br>• Suspend speech temporarily if it becomes necessary to turn the head away from the microphone<br>***(See Annex III for pronunciation of letters, numbers and usage of Q-signals during transmission)*** |
| 4.2 Radiotelegraphy | 4.2.1 Radiotelegraphy is radio communication by means of Morse Code or other coded signals. | 4.2.1.1 Recall that Morse Code is no longer required for the amateur licence |
| | | 4.2.1.2 Recall that data and image can be transmitted via radio |
| ***5.0 RADIO SYSTEM THEORY*** | | |
| **5.1 Transmitters** | 5.1.1 Simple block or "concept" diagrams of transmitters | 5.1.1.1 Identify the items in a simple transmitter block diagram and recall their order of interconnection: Microphone, audio (microphone) amplifier stage, frequency generation stage, modulator stage, RF power amplifier stage, feeder and antenna. ***(See Annex IV, a for transmitter Circuit Diagram)*** |
| | 5.1.2 Technical requirements of radio transmitters | 5.1.2.1 Recall that the frequency generation stage(s) (e.g. oscillator(s)) in a transmitter defines the frequency on which the transmitter operates<br><br>5.1.2.2 Recall that incorrect setting of these stages can result in operation outside the amateur band and interference to other users. ***(See Annex IV,a)*** |
| | | 5.1.2.3 Recall that the audio (or data) signal is modulated on to the radio frequency 'carrier' in the modulation stage of the transmitter.<br><br>5.1.2.4 Recall that modulation is by varying the amplitude or frequency of the "carrier", resulting in AM or FM modulation modes.<br><br>5.1.2.5 Recall that Single Sideband (SSB) is a form of Amplitude Modulation (AM). |
| | 5.1.3 Importance of proper transmitter adjustment | 5.1.3.1 Recall that improper adjustment of a transmitter can cause harmful interference to other radiocommunications users, both inside and outside the frequency bands allocated to Amateurs. |
| | 5.1.4 Identification of waveforms | 5.1.4.1 Identify, with the aid of supplied diagrams, a radio frequency carrier waveform, an audio frequency waveform and a modulated waveform. |
| | 5.1.5 Transmitter output matching | 5.1.5.1 Recall that the final power amplifier stage of a transmitter must be connected to a correctly matched transmission line and antenna to avoid possible damage to the transmitter and/or cause interference to other radiocommunications services. |

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| **5.2 Receivers** | 5.2.1 Simple block or "concept" diagrams of a receiver | 5.2.1.1 Identify the items in a simple receiver block diagram and recall their order of interconnection<br><br>*Antenna, feeder, radio tuning and RF amplification, detection/demodulation, audio amplification and loudspeaker or headphones.* ***(See Annex IV, b for Receiver Circuit Diagram)*** |
| | 5.2.2 Transceiver controls | 5.2.2.1 Recall, using a supplied diagram or physical transceiver, the purpose of the following controls: AF, RF, Squelch, Mode, VFO, RIT, Band and Carrier control. |
| | 5.2.3 Receiver terms | 5.2.3.1 Recall the meaning of the terms sensitivity, selectivity and stability as they apply to a receiver. |
| | 5.2.4 Technical requirements of radio receivers | 5.2.4.1 Recall that tuning of receiver is carried out in first stages of the receiver.<br><br>Recall that detection/demodulation (recovery of the original modulating signal) is carried out in the second stage of the block diagram and that audio amplification is achieved in the third stage of a receiver. |
| ***5.3 ANTENNAS AND TRANSMISSION LINES*** | | |
| **5.4 Transmission lines** | 5.4.1 Types of Transmission Lines | 5.4.1.1 Recall that transmission lines are used for purposes such as connecting radio transmitters and receivers with their antennas.<br><br>5.412 Identify, from a supplied diagram, photograph or physical examples, common co-axial and balanced transmission lines. Recall their typical characteristic impedance. |
| | 5.4.2 Co-axial connectors | 5.4.2.1 Identify, from a supplied diagram, photograph or physical examples, co-axial connectors commonly used in radiocommunications. |
| | 5.4.3 Testing of transmission lines | 5.4.3.1 Understand the reason for continuity and isolation testing a co-axial cable terminated with co-axial connectors. Describe the continuity testing procedure. |
| **5.5 Antenna Theory** | 5.5.1 Antenna purpose | 5.5.1.1 Recall that the purpose of an antenna is to convert electrical signals into radio waves, and vice versa. |

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| | 5.5.2 Antenna length to frequency | 5.5.2.1 Recall the relationship between the physical length of the antenna and the frequency of operation. |
| | 5.5.3 Identification of common antennas | 5.5.3.1 Identify, from supplied diagrams, a half-wave dipole, folded dipole, 1/4 wave ground plane, Yagi, and end-fed wire antenna. ***(See Annex V for Antenna Types)*** |
| | 5.5.4 Choice of Antenna | 5.5.4.1 Recall that the on-air performance of an amateur station can be improved significantly by the correct choice of antenna. Identify, using supplied reference material, the symbol for an antenna. |
| | 5.5.5 Antenna directional characteristics | 5.5.1.6 Recall the meaning of the terms polarization, omni-directional, and bi-directional, unidirectional and gain as they apply to antennas. |
| | 5.5.6 Polarization | 5.5.6.1 Recall that the polarization and directivity of an antenna is determined by its physical construction and orientation. |
| | 5.5.7 Effective Radiated Power (ERP) | 5.5.7.1 Recall, using supplied reference material, that ERP is the product of transmitter power and antenna gain. Recall that antenna gain is generally expressed in decibels. |
| | 5.5.8 Antenna Matching | 5.5.8.1 Recall the need to match an antenna to a transmission line and to minimize the Standing Wave Ratio (SWR). |
| | 5.5.9 Antenna Tuning Unit | 5.5.9.1 Recall the uses, purposes and adjustment of a typical manual ATU. |
| | | 5.5.9.2 Recall that, when feeding a balanced antenna with an unbalanced transmission line (co-axial cable), the preferred practice is to use a balun. |
| **5.4 Measurements** | 5.4.1 The comparison of unknown quantity with some standard quantity of the same rates is known as measurement | 5.4.2 Recall that measurement is the determination of the size or magnitude of something.<br><br>Recall that the current system of units has three standard units: The meter, kilogram, and second. These three units form the **mks-system** or the **metric system** |
| | 5.4.1 Standing wave ratios (SWR) | 5.4.1.1 Recall the correct placement, use and adjustment of an SWR Meter.<br><br>Recall that standing wave ratio (SWR) is a measure of impedance matching of Load to the characteristic impedance of the transmission line or waveguide |
| | 5.4.2 Acceptable SWR | 5.4.2.1 Recall that an SWR equal to, or less than 1.5 indicates a satisfactory antenna match. |
| | 5.4.3 Testing transmitters | 5.4.3.1 Recall that, when testing a transmitter, a non-radiating load (dummy load) is commonly used to prevent a signal from being radiated. |

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| | 5.4.4 Measuring Instrument | 5.4.4.1 Recall the uses of various electronic measuring instruments:<br><br>• Ammeter<br>• Ohmmeter<br>• Voltmeter<br><br>Understand that all the above are embedded in the Multimeter ***(See Annex VI for electronic components symbols)*** |
| ***6. PROPAGATION*** | | |
| **6.1 Propagation basics** | 6.1.1 Properties of Light | 6.1.1.1 Recall that radio waves travel in straight lines, unless diffracted, reflected or refracted. |
| | 6.1.2 Effect of distance on radio waves. | 6.1.1.1 Recall that radio waves get weaker with distance as they propagate from the antenna. |
| | 6.1.3 Communication Range | 6.1.3.1 Recall that communication range at VHF/UHF is dependent on antenna height, a clear path, transmitter power and receiver sensitivity. |
| | 6.14 Effect of obstacles and structures on VHF and UHF signals. | 6.141 Recall that VHF and UHF signals are obstructed by hills and large structures. |
| | Long distance communications on VHF and UHF. | Recall that unusual atmospheric conditions may at times provide extended range. |
| **6.2 The Earth's Atmosphere** | 6.2.1 Layers of the earth's atmosphere<br><br>*The **atmosphere of Earth** is the layer of gases, commonly known as **air**, that surrounds the planet Earth and is retained by Earth's gravity* | 6.2.1.1 From highest to lowest, the five main layers are:<br>• Exosphere: 700 to 10,000 km<br>• Thermosphere: 80 to 700 km<br>• Mesosphere: 50 to 80 km<br>• Stratosphere: 12 to 50 km<br>• Troposphere: 0 to 12 km |
| | 6.2.2 The Ionosphere<br><br>*Region of the atmosphere that is ionized by solar radiation.* | 6.2.2.1 Recall, using supplied reference material, that the ionosphere comprises layers of ionized gas at varying heights above ground.<br><br>During daytime hours, it stretches from 50 to 1,000 km and includes the mesosphere, thermosphere, and parts of the exosphere. |
| | 6.2.3 Factors affecting HF propagation | 6.2.31Recall that ionospheric propagation is dependent on time of day, season, frequency and solar activity. |
| | 6.2.4 Ionospheric Refraction. | 6.2.4.1 Recall that long-distance HF communication relies on propagation by ionospheric refraction. |

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| ***6.3 AVOIDANCE AND RESOLUTION OF RADIO FREQUENCY INTERFERENCE.*** | | |
| **6.4 Radio Frequency Interference** | 6.4.1 Electromagnetic interference (EMI), also called radio-frequency interference (RFI) when in the radio frequency spectrum, is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction | 6.4.1.1 Recall that RFI may degrade the performance of the circuit/ Network or even stop it from functioning. The interferences may be classified into:<br>• Permissible interference<br>• Acceptable interference<br>• Harmful interference |
| | 6.4.2 Sources of radio interference | 6.4.2.1 Recall that broadcast radio and television receivers can suffer interference from local sources other than radiocommunications transmitters. These sources include electrical and electronic equipment and high voltage electricity supply lines. |
| | | 6.422 Recall that interference to other radiocommunications services, including broadcast radio and television reception, can be caused by the faulty operation of radiocommunications transmitters. |
| | | 6.4.2.3 Recall that radiocommunications transmitters can be the source (but not necessarily the cause) of interference to nearby electronic and radio equipment. Recall that technical solutions can generally resolve the interference. |
| | 6.4.3 Transmission modes and interference | 6.4.3.1 Recall that some transmission modes are more likely than others to cause objectionable interference to broadcast radio and television reception and to telephones. |
| | 6.4.4 Harmful Interference | 6.4.4.1 Recall that a licensee must not operate an Amateur station if its operation causes harmful interference to other users or services. |
| 6.5 Interference & Electromagnetic Compatibility (EMC) | 6.5.1 EMC | 6.5.1.1 Recall that the ability of electronic or radio equipment to operate properly, without interference, in the presence of electromagnetic radiation, such as radio communications transmissions, refers to the EMC of the equipment.<br>This is also known as the equipment's radiofrequency immunity. |
| | 6.5.2 Amateur transmissions and EMC | 6.5.2.1 Recall that interference resulting from EMC problems may be dependent on the power, frequency and type of emission of the radiocommunications transmitter and its distance from the affected equipment. |
| | 6.5.3 Antenna location and EMC | 6.5.3.1 Recall that interference resulting from EMC problems can be minimized by careful selection and siting of antennas. |
| | 6.5.4 Filters | 6.5.4.1 Recall that the immunity of most types of equipment can be increased by fitting suitable filters in external cabling such as antenna, power supply or interconnections between equipment. Recall that the filters should be fitted as close to the affected devices as possible. |
| | 6.5.5 Simple 'choke' filter | 6.5.5.1 Recall how to construct a simple RF choke using ferrite rod or toroid. |
| | 6.5.6 RF Earthing | 6.5.6.1 Recall that the function of the RF earth connection in an Amateur station is to provide a path to ground to minimize RF currents entering the mains earth system and |

| *TOPIC* | *ASSESSMENT OBJECTIVES* | *SPECIFIC OBJECTIVE* |
|---|---|---|
| | | causing interference to other electronic equipment. Identify, from supplied diagrams, the symbol representing an earth connection. |
| | 6.5.6 Diplomacy and EMC | 6.5.6.1 Recall that EMC problems have the potential for causing neighbourhood disputes. Understand the need for diplomacy, the sources of advice available and the role of the NCA. |
| ***7. RADIO EMISSION SAFETY*** | | |
| **7.1 Electrical safety** | 7.1.1 Dangerous voltages | 7.1.1.1 Recall that high voltages and high currents are dangerous. |
| | 7.1.2 Equipment must not be modified | 7.1.2.1 Recall that the Foundation Licensee must not make modifications to any Amateur radio transmitting equipment. |
| | 7.1.3 Equipment to be approved | 7.1.3.1 The Electricity Company must approve any mains operated equipment sold, hired or supplied. Recall that approved equipment will have an approval label. |
| | 7.1.4 Awareness of State Electricity Authority requirements | 7.1.4.1 Recall that it is necessary to check relevant requirements regarding unqualified persons wiring and testing mains operated equipment. This includes leads, plugs and sockets connected to the household mains supply. |
| | 7.1.5 Electrical Earthing | 7.1.5.1 Recall why most mains operated equipment should have a safety earth connection. |
| | 7.1.6 Fuses | 7.1.6.1 Recall that fuses prevent excessive currents that may cause heat damage or fires. |
| | 7.1.7 Correct fuse to be used | 7.1.7.1 Recall that a correct fuse must be fitted to all electrical equipment. |
| | 7.1.8 Replacing fuses | 7.1.8.1 Recall the precautions to be taken when replacing faulty fuses including the selection of a fuse rated in accordance with an equipment manufacturer's specifications or electricity supply authority requirements. |
| **7.2 Physical Safety and Operating Practices** | 7.21 Station layout for physical safety | 7.2.1.2 Recall that the layout of an Amateur station should take account of physical safety issues. Recall that trailing cables are trip hazards and dangerous. |
| | 7.2.2 Power lead safety | 7.2.2.1 Recall that frayed or damaged power leads are dangerous and should be replaced or repaired by an Authorized person. |
| | 7.2.3 Know location and desirability of a Mains OFF switch | 7.2.3.1 Recall the desirability for a clearly marked switch to turn off all station equipment in case of emergency. |
| | 7.2.4 Actions to be taken in the event of an accident involving electricity | 7.2.4.1 Recall that, in the event of an accident involving electricity, the first action is to safely switch off the power. |
| | 7.2.5 Electric shocks | 7.2.5.1 Recall that a casualty of electric shock must not be touched unless the power has been switched off. |
| | 7.2.6 Call for Help– use of resuscitation techniques | 7.2.6.1 Recall that emergency services need to be called immediately and that Cardio Pulmonary Resuscitation (CPR) may need to be administered. |
| | 7.2.7 Battery safety | 7.2.7.1 Recall that batteries contain chemicals and emit fumes and may explode if punctured or exposed to flames or sparks. |
| **7.3 Propagation Safety** | 7.3.1 Antennas and safety | 7.3.1.1 Recall that it is important for all persons (and animals) to be kept at a safe distance from antennas |

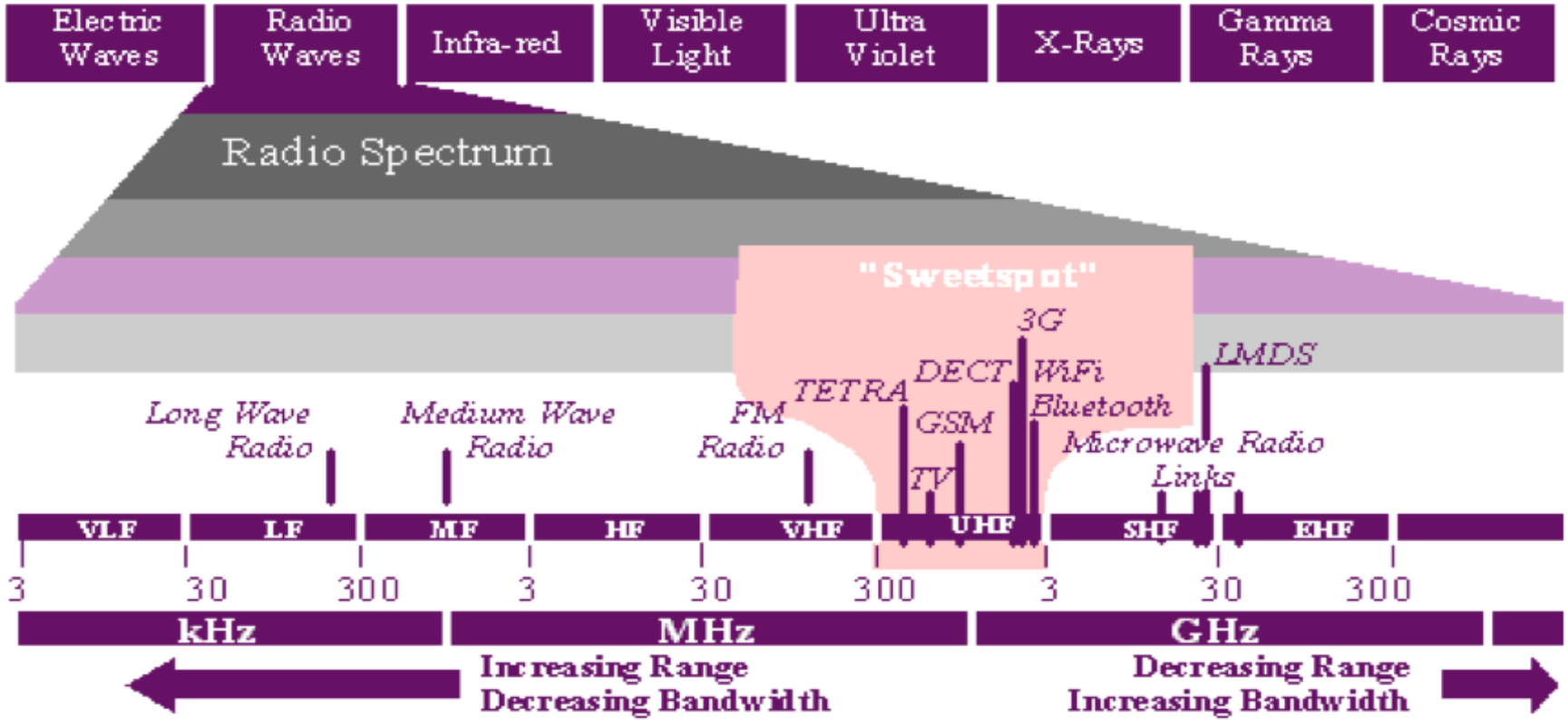
| *TOPIC* | *ASSESSMENT OBJECTIVES* | *SPECIFIC OBJECTIVE* |
|---|---|---|
| | 7.3.2 Radio waves can be dangerous<br><br>Antenna erection<br><br>Securing and siting antennas | 7.3.2.1 Recall that electromagnetic radiation (EMR) can be dangerous. Higher frequencies and power levels increase the danger. |
| | | 7.3.2.2 Recall that the distance from an antenna that is a safe distance depends on the ERP, operating frequency, antenna type and orientation. |
| | | Recall that antenna erection is potentially dangerous and should be carried out by suitably experienced persons. |
| | | Recall that antennas and their fittings must be suitably located and secured and must never be connected to, or sited close to, mains poles and lines. |
| | 7.3.3 Lightning protection | 7.3.3.1 Recall that it is good practice to install lightning protection on antennas, disconnect antennas from any radio equipment prior to a thunderstorm and never operate during a thunderstorm. |
| | 7.3.4 Safe use of headphones | 7.3.4.1 Recall that excessive volume when wearing headphones can cause damage to human hearing. |
| | 7.3.5 Station Security | 7.3.5.1 Recall that an operable Amateur station must not be accessible to unauthorized persons. |

***Annex I - SI UNITS & PREFIXES***

| QUANTITY | UNITS OF MEASUREMENT | SYMBOL |
|---|---|---|
| POWER | WATTS | W |
| VOLTAGE | VOLTS | V |
| ELECTRIC CURRENT | AMPERE | A |
| RESISTANCE | OHMS | Ω |
| LENGTH | METER | m |
| MASS | KILOGRAM | kg |
| TIME | SECOND | s |
| THERMODYNAMIC TEMPERATURE | KELVIN | K |
| AMOUNT OF SUBSTANCE | MOLE | mol |
| LUMINOUS INTENSITY | CANDELA | cd |

| FACTOR | NAME | SYMBOL | FACTOR | NAME | SYMBOL |
|---|---|---|---|---|---|
| $10^{-1}$ | DECI | d | $10^{1}$ | DEKA | da |
| $10^{-2}$ | CENTI | c | $10^{2}$ | HETA | h |
| $10^{-3}$ | MILLI | m | $10^{3}$ | KILO | k |
| $10^{-6}$ | MICRO | µ | $10^{6}$ | MEGA | M |
| $10^{-9}$ | NANO | n | $10^{9}$ | GIGA | G |
| $10^{-12}$ | PICO | p | $10^{12}$ | TETRA | T |
| $10^{-15}$ | FEMTO | f | $10^{15}$ | PETA | P |
| $10^{-18}$ | ATTO | a | $10^{18}$ | EXA | E |
| $10^{-21}$ | ZEPTO | z | $10^{21}$ | ZETTA | Z |
| $10^{-24}$ | YOCTO | y | $10^{24}$ | YOTTA | Y |

***Annex II - RADIO SPECTRUM***




***Annex III***

| ***Q-SIGNAL*** | ***CODE USED AS A QUESTION*** | ***USED AS AN ANSWER OR STATEMENT*** | ***Q-SIGNAL*** | ***CODE USED AS A QUESTION*** | ***USED AS AN ANSWER OR STATEMENT*** |
|---|---|---|---|---|---|
| QRK | What is the readability of my signals? ... | The readability of your signals is | QRZ | Who is calling me? | You are being called by… |
| QRM | Are you being interfered with? | I am being interfered with | QRV | Are you ready? | I am ready |
| QRN | Are you troubled by static? | I am troubled by static | QSB | Are my signals fading? | Your signals fading |

| | | | | | |
|---|---|---|---|---|---|
| QRO | Shall I increase transmitter power? | Increase transmitter power | QSL | Can you acknowledge receipt? | I am acknowledging receipt |
| QRP | Shall I decrease transmitter power? | Decrease transmitter power | QSO | Can you communicate with direct? | I can communicate with direct |
| QRS | Shall I send more slowly? | Send more slowly | QSY | Shall I change frequency? | Change to another frequency |
| QRT | Shall I stop sending? | Stop sending | QTH | What is your location? | My location is…. |

***Others***

| | | | |
|---|---|---|---|
| BK | Signal used to interrupt a transmission on progress | PSE | Please |
| CQ | General call to all stations | R | Received |
| CW | Continuous wave or Morse code | RX | Receiver |
| DE | From, used to separate the call sign of the station called from that of the Calling station | TX | Transmitter |
| K | Invitation to transmit | UR | You |
| MSG | Message | | |

***Transmission of letters***

Each letter in the call sign shall be spoken separately using the phonetic spelling.

| CHARACTER | MORSE CODE | LETTER CODE | PRONUNCIATION |
|---|---|---|---|
| A | • – | Alfa | AL-FAH |
| B | – • • • | Bravo | BRA-VOH |
| C | – • – • | Charlie | CHAR-LEE |
| D | – • • | Delta | DELL-TAH |
| E | • | Echo | ECK-OH |
| F | • • – • | Foxtrot | FOKS-TROT |
| G | – – • | Golf | GOLF |

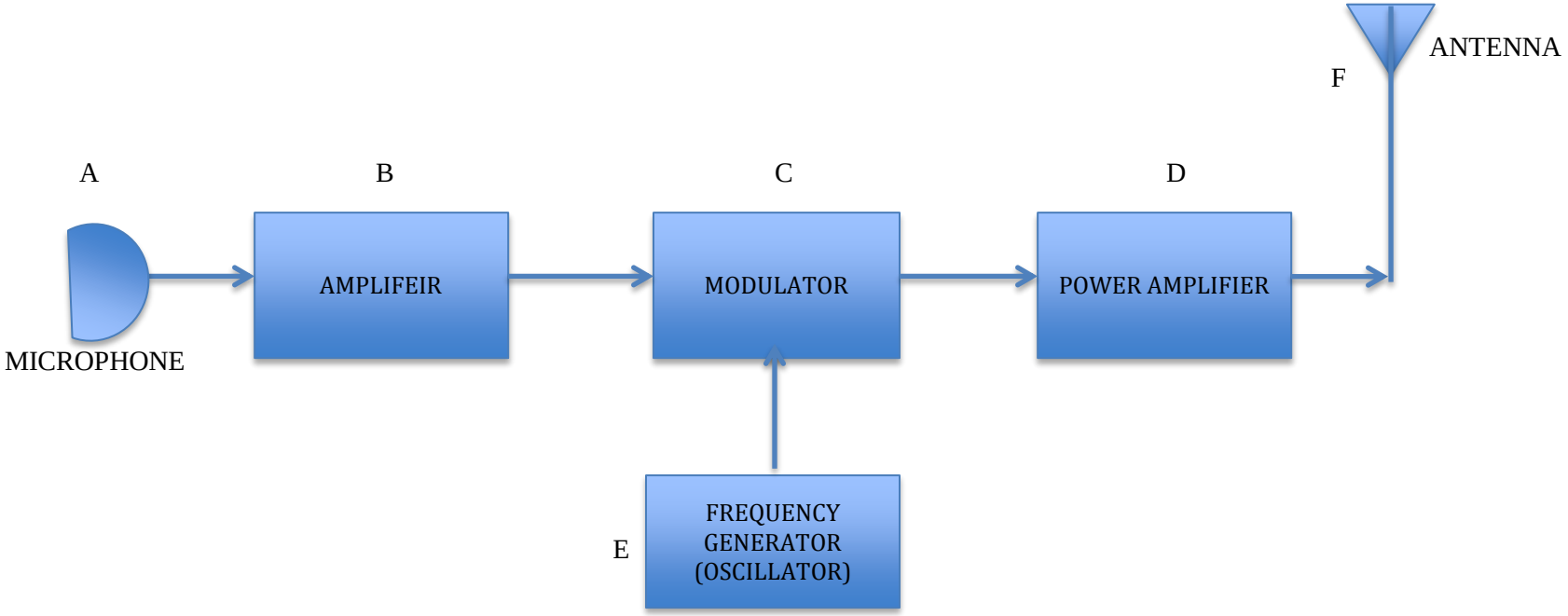
| | | | |
|---|---|---|---|
| H | • • • • | Hotel | HOH-TELL |
| I | • • | India | IN-DEE-AH |
| J | • – – – | Juliet | JEW-LEE-ETT |
| K | – • – | Kilo | KI-LOH |
| L | • – • • | Lima | LEE-MAH |
| M | – – | Mike | MIKE |
| N | – • | November | NO-VEM-BER |
| O | – – – | Oscar | OSS-CAH |
| P | • – – • | Papa | PAH-PAH |
| Q | – – • – | Quebec | KEH-BECK |
| R | • – • | Romeo | ROW-ME-OH |
| S | • • • | Sierra | SEE-AIR-RAH |
| T | – | Tango | TANG-GO |
| U | • • – | Uniform | YOU-NE-FORM |
| V | • • • – | Victor | VIK-TAH |
| W | • – – | Whiskey | WISS-KEY |
| X | – • • – | Xray | ECKS-RAY |
| Y | – • – – | Yankee | YANG-KEY |
| Z | – – • • | Zulu | ZOO-LOO |

***Transmission of numbers***

The numbers shall be transmitted using the following pronunciation:

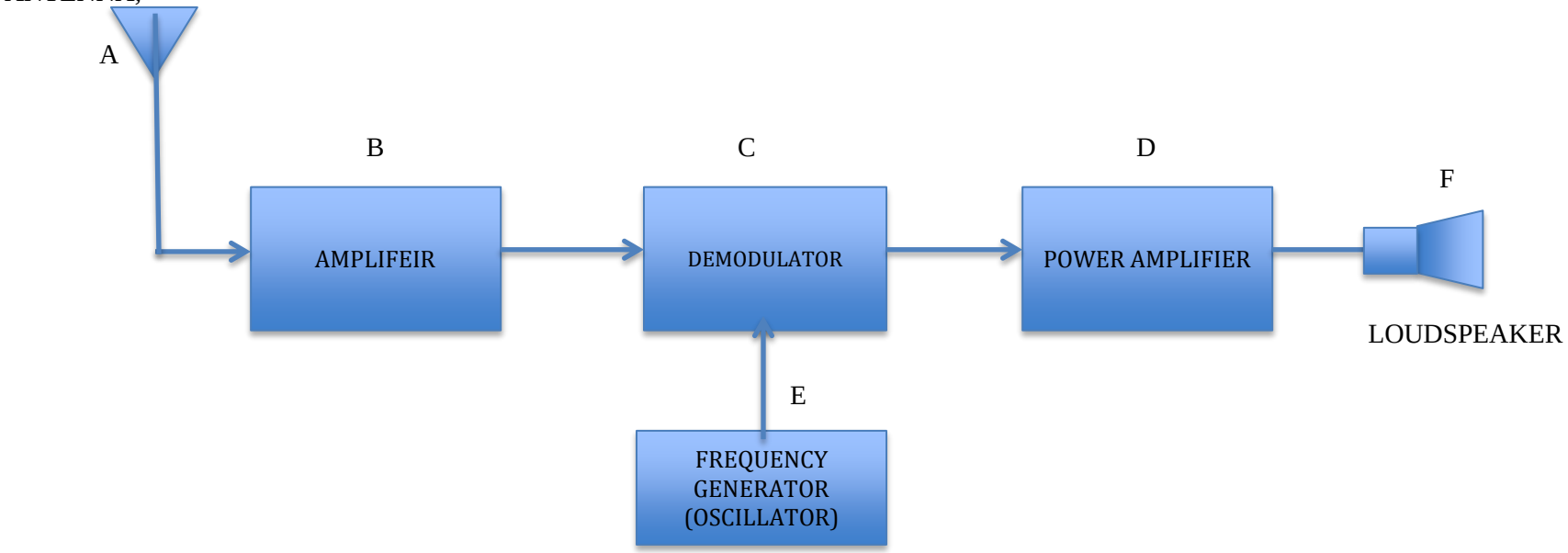
| **NUMERAL ELEMENT** | **PRONUNCIATION** |
|---|---|
| 0 | ZE-RO |
| 1 | WUN |
| 2 | TOO |
| 3 | TREE |
| 4 | FOW-er |
| 5 | FIFE |
| 6 | SIX |
| 7 | SEV-en |
| 8 | AIT |
| 9 | NIN-er |
| '.' or decimal | DAY-SEE-MAL |
| 100 or hundred | HUN-dred |
| 1000 or thousand | TOU-sand |

***Annex IV, a - TRANSMITTER CIRCUIT***

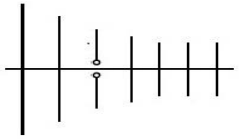
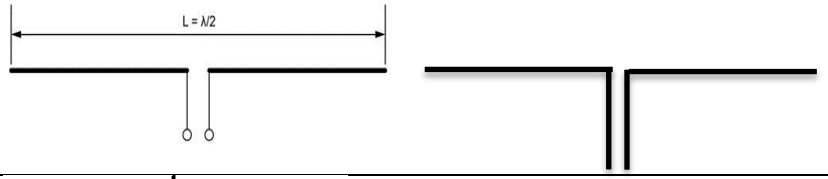
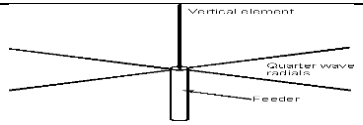



***Annex IV, b - RECEIVER CIRCUIT***

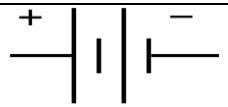
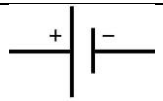
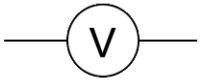
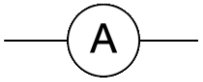
ANTENNA,

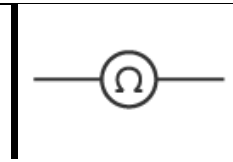
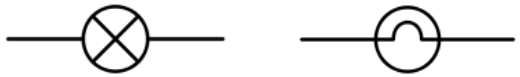
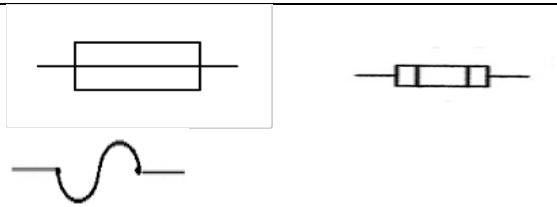
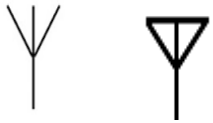


***Annex V - ANTENNA TYPES***

| ***DESCRIPTION*** | ***SYMBOL*** |
|---|---|
| YAGI |  |
| DIPOLE |  |
| 1/4 λ GROUND PLANE |  |

***Annex VI- ELECTRONIC COMPONENTS***

| **DESCRIPTION** | **SYMBOLS** | **DESCRIPTION** | **SYMBOLS** |
|---|---|---|---|
| BATTERY |  | DIODE |  |
| CELL |  | VOLTMETER |  |
| SWITCH |  | AMETER |  |

| | | | |
|---|---|---|---|
| RESISTOR |  | OHMMETER |  |
| LAMP |  | LOUDSPEAKER |  |
| FUSE |  | ANTENNA |  |
| MICROPHONE |  | EARTH/GROUND |  |