Foundation Licence
Training Part 1

Gateway to Amateur Radio
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VK3DAC
Introduction

- The foundation licence has been introduced to act as an entry point into amateur radio.
- The study for the foundation licence involves radio theory and practice.
- The requirements for the licence are defined in the Licence Conditions Determination (LCD). All Amateurs should have a copy of the LCD.
- The content for the training is defined by the foundation licence syllabus document.
Introduction

- The syllabus has 9 sections. These are:
  - Nature of Amateur Radio
  - Licence Conditions
  - Technical Basics
  - Transmitters and Receivers
  - Transmission Lines and Antennas
  - Propagation
  - Interference
  - Safety
  - Operating Practices and Procedures
Introduction

To study for the Foundation Licence you should obtain the following documents:

- Foundation licence syllabus document
- The Foundation Licence Conditions Determination (LCD)
- The Foundation Licence Manual, that covers the required radio theory
Introduction

- The documentation can be obtained from the WIA web site [www.wia.org.au](http://www.wia.org.au) and [www.acma.gov.au](http://www.acma.gov.au)
- You will also need to arrange for assessment. This is via a WIA accredited assessor, usually associated with a radio club. For an assessor near you look at [www.silvertrain.com.au/assessors](http://www.silvertrain.com.au/assessors)
- The WIA Office will be able to assist with the assessment details, (03)9729 0400
Introduction

- This program is intended to assist those attempting this licence, as well as to be a guide to instructors providing the training for this licence.
- The information in this program can be found in the Foundation Licence Manual.
- The foundation licence manual should be studied in conjunction with this training program.
This Program

- This program will follow the 9 sections in the foundation licence syllabus document.
- Questions, that are typical of the type of question asked in the theory examination, are included at the end of each section of this program.
- Section 8 of the syllabus, the practical, is not included in this presentation as it must be studied and then assessed “hands on”
This Program

The foundation licence exam has the following specified number of questions:

- Section 1 and 2 combined – 7 questions
- Section 3 – 2 questions
- Section 4 – 2 questions
- Section 5 – 2 questions
- Section 6 – 2 questions
- Section 7 – 5 questions
- Section 8 – Practical
- Section 9 – 5 questions
This Program

- The theory exam duration is 30 minutes and includes both regulations and theory.
- The theory exam consists of 25 multiple choice questions.
- You must answer 18 of the 25 questions correctly to be assessed as competent for the theory i.e. 70%.
This Program

- The practical is covered in section 8 of the Foundation Licence Syllabus
- The duration of the practical is 30 to 40 minutes
- All sections of the practical must be attempted and answered correctly. This means the candidate must achieve 100%
- Practical requires “hands on” activity
Section 1 The Nature of Amateur Radio
Section 1 Nature of Amateur Radio

- Amateur radio facilitates the hobby of amateur radio
- All radio amateurs must have a licence
- There are other forms of licence such as CB, Marine, Point to Point Links and Broadcasting
- Amateurs operate on bands that are allocated for amateur use
- Amateurs must not operate outside the allocated bands
Section 1 Nature of Amateur Radio

- The amateur service shares frequencies with other band users
- Other users such as aeronautical, broadcasting and maritime have bands allocated to them for their purposes
- Amateur operators must not operate on bands allocated for other purposes
- The Licence Conditions Determination (LCD) indicate the bands allocated for amateur operation – use the LCD’s to look up a Foundation Licence frequency allocation
Amateur Band Plan

- Amateur band plans help amateurs make best use of the frequency spectrum and provide for better on-air operating.
- The band plans are an agreed position between amateurs and the WIA
- Band plans can be found in the Foundation Licence manual
Section 1 Nature of Amateur Radio

The following is a typical question you may be asked in the foundation licence theory exam:
A Radio Amateur’s licence allows the amateur to operate on the:

A. Marine band
B. Broadcast band
C. Amateur band
D. Aeronautical band
Section 1 Nature of Amateur Radio

- The answer is:
- C. An amateur’s licence allows them to operate only on the allocated amateur bands
Section 2 Licence Conditions

- Foundation Licence holders are subject to conditions that are defined in four government documents. These documents are:
  - Radiocommunications Act 1992
  - Radiocommunications Regulations 1993
  - Radiocommunications Licence Conditions (Apparatus Licence) Determination 2003
Section 2 Licence Conditions

- The primary function of an Amateur Licence is to authorise a person to:
  - Self train in radio communications
  - Communicate with other amateur radio operators
  - Conduct technical investigations into radio communications
Section 2 Licence Conditions

- An amateur licence allows intercommunication between other radio amateurs. The exception being when:
  - There is an emergency or distress situation
  - Where authorised by a Radio Inspector
Section 2 Licence Conditions

- Radio Amateurs are permitted to send “third party” messages to other amateurs in Australia on behalf of a third person provided it is not for gain, commercial purpose an advertisement or entertainment or relate to the business or financial affairs of any person.

- Australian amateurs are permitted to send third party messages via amateurs in other countries unless the foreign government has given notice of its objection to such messages.
Section 2 Licence Conditions

- A ‘Mayday’ is a distress message and has priority over all other communications.
- Mayday messages must be passed to the appropriate authorities.
- Urgent messages are associated with ‘Pan Pan’ calls.
- ‘Pan Pan’ calls should receive priority and should be reported to the appropriate authority.
Section 2 Licence Conditions

- Radio Amateurs must provide correct station identification at the beginning and end of each transmission.
- Identification must be given at least every 10 minutes during transmissions.
- Identification requirements apply to all transmissions including test transmissions.
Section 2 Licence Conditions

- Callsigns in the Australian Amateur Service must be able to be identified.
- VK = Australia
- 0 through 9 indicates the state or territory
- The following letters are personal identification
- Foundation licence holders have a prefix plus a four letter callsign commencing with F (FXXX)
- Standard licence holders have a prefix plus a three letter callsign commencing with H, L, M, N, P or V(XX)
- Advanced licence holders have a prefix plus a two or three letter callsign.
Section 2 Licence Conditions

- Transmission of messages that are encoded for the purpose of obscuring their meaning are not permitted, except for the purposes specified in the amateur LCD.
- Transmissions containing any form of commercial entertainment are not permitted.
- Foundation Licence holders are only allowed to use specified frequency bands and emission modes. These are specified in the Licence Conditions Determination.
- Foundation Licence holders are not permitted to use “digital modes.”
A Foundation Licence holder is limited to a maximum of 10 watts peak envelope power on SSB and 10 watts average power on AM, FM and CW.

Equipment used by Foundation Licence holders is limited to commercially made transmitting equipment.

Foundation licence holders are not permitted to build or modify transmitting equipment.
Section 2 Licence Conditions

- Any Amateur Operator’s change of address must be notified to the ACMA.
- Radio Amateurs must not operate an Amateur station to cause harmful interference to radiocommunications.
- In order to avoid interference the ACMA has the right to restrict the operation of an Amateur Station.
Section 2 Licence Conditions

- Radio inspectors have a right to require an Amateur to produce their licence
- A Foundation Licensee can allow a suitably licenced person to operate their station.
- Otherwise the station should be kept locked and secure to prevent unlawful operation
- Every radio amateur including foundation licence holders should have a copy of the Licence Conditions Determination and have a general understanding of the LCD contents
Section 2 Licence Conditions

- Foundation licence holders are not permitted to operate an amateur station in an automatic mode or a computer controlled mode.
- Foundation licence holders are not permitted to operate an amateur station connected to the public telephone network including internet.
- A foundation licence holder can operate using IRLP or Echolink but not permitted set up a node for others to use.
Section 2 Licence Conditions

- An amateur station licence authorises radio amateurs to use radio communication as specified by the LCD
Section 2 Licence Conditions

The bands that radio amateurs are allocated are:
A. To make use of manufactured radio equipment
B. To allow use of the bands independent of the sun spot cycle
C. To minimize the likelihood of interference to other services
D. Totally eliminate interference
Section 2 Licence Conditions

- A Foundation Licence holder may allow other persons operate their station if the person:
  A. Is another licenced amateur
  B. Is an Australian citizen
  C. Has a Commonwealth passport
  D. Is a member of the same family
Section 2 Licence Conditions

- An amateur with a call sign VK4NSW would indicate:
  A. A New South Wales amateur
  B. A Victorian amateur with a full call licence
  C. A Queensland amateur with a standard licence
  D. A Queensland amateur with a Foundation licence
Section 2 Licence Conditions

What authorises amateur radio activities in Australia:

A. the LCD
B. the WIA
C. certificate 3 in Electrotechnology
D. an amateur licence
Section 2 Licence Conditions

- While listening to a frequency not in the amateur band you hear a mayday call. You must:
  A. Tune to another frequency
  B. Contact an advanced amateur
  C. Report and provide assistance
  D. Advise the person to change to an amateur frequency
Section 2 Licence Conditions

Who can require you to produce your amateur licence:

A. State police
B. WIA
C. ACMA Radio Inspectors
D. a person receiving interference
Section 2 Licence Conditions

- The transmitting equipment that a Foundation Licence holder should use is:
  
  A. commercial equipment, unmodified
  B. surplus military equipment
  C. equipment that meets a commercial specification
  D. Mains operated equipment only
Section 3 Technical Basics
The universe is made up of matter.
All matter is made of atoms. Atoms are made up of electrically charged particles called protons and electrons.
These charged particles give rise to electricity as we understand it, and apply in today's electronic applications including Amateur Radio.
Section 3 Technical Basics

Static Electricity

Static electricity is produced by moving electrons from one place to another by applying a force.

We often see or feel the result of static electricity such as:

- The slight electric shock when we cross a carpet or get out of a car
- Lightning
When two bodies are charged to different potentials there is an electric potential between the bodies.

- Like charges repel
- Unlike charges attract
Section 3 Technical Basics

Electric Current
An electric current is an ordered movement of electrons from the negative terminal to the positive terminal of an electricity source, such as a battery.

Current is measured in amperes (amps).
Section 3 Technical Basics

- The battery produces an abundance of electrons from a chemical reaction.
- The battery produces a voltage called an electromotive force (EMF).
Conductors and Insulators

- Metal wires that join circuits are conductors
- Most metals are good conductors in particular aluminium and copper
- A small amount of electrical pressure (voltage) can make electrons move along a conductor
Section 3 Technical Basics

Conductors and Insulators

- Insulators do not allow electric current to pass easily
- Insulators are plastics, dry wood, ceramic, porcelain, glass etc
- Very large electrical pressure (very high voltage) must be applied to move electrons in insulators
- These voltages usually damage the insulating material
Section 3 Technical Basics

- **Direct current (DC)**: Electrons flow in one direction, direct current comes from a battery.

- **Alternating current (AC)**: The electrons flow in one direction, stop, and then flow in the other direction. Alternating current comes from an alternator and is the type of electricity that is the 240v mains power.
Section 3 Technical Basics

- The amount of electrons that can move down a wire is dependent on how thick the wire is and how long it is.
- The thicker the wire the lower the resistance to the electrons.
- The longer the wire the higher the resistance to the electrons.
- If the electrical pressure is increased more electrons can be made to flow along a given conductor.
Section 3 Technical Basics

- Current is measured in Amperes (Amps), abbreviation A symbol I
- Electrical pressure is measured in Volts, abbreviation V or E
- Electrical resistance is measured in Ohms, the symbol is the Greek capital letter Omega
Section 3 Technical Basics

Mathematically:

where:  \( I = \) the current in amperes  
        \( E = \) the EMF in volts  
        \( R = \) resistance in ohms.

Formula transposition:

\[ E = I \times R \]

If \( I \) is unknown, cover \( I \) and find remaining.
Therefore,  \[ I = \frac{E}{R} \]

If \( R \) is unknown, cover \( R \) and find remaining.
Therefore,  \[ R = \frac{E}{I} \]
Section 3 Technical Basics

Symbols

- Cell or battery
- Fuse
- Open and closed switch
- Resistor
- Antenna
- Earth
- Microphone
- Speaker
Section 3 Technical Basics
Section 3 Technical Basics

- Resistance is the opposition to current flow
- Resistors are components that exhibit resistance
- Resistor colour code
- Size related to power dissipation
Section 3 Technical Basics

- Power is the rate at which energy is changed from one form to another or work is done
- There are three power formulas

\[ P = \text{power in Watts} \]
\[ P = I^2R \]
\[ P = \frac{E^2}{R} \]
\[ P = E \times I \]
\[ E = \text{volts} \]
\[ I = \text{current} \]
\[ R = \text{resistance} \]
Section 3 Technical Basics

- Unit of power is the watt
- 1 volt applied to a circuit causing 1 amp of current to flow will cause 1 watt of power to be dissipated
Section 3 Technical Basics

- $22kV = 22000$ Volts
- $2mV = \text{two thousandths of a volt}$
- $22kOhms = 22$ thousand Ohms
- $1MOhm = \text{One million Ohms}$
- $15mA = 15$ thousandths of an amp
- $120\text{micro amp} = 120$ millionths of an amp

Note that there a number of multiple and submultiple units. Those most often used in radio and electronics are shown below.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Numerical Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>giga (G)</td>
<td>$1,000,000,000 = 10^9$</td>
</tr>
<tr>
<td>mega (M)</td>
<td>$1,000,000 = 10^6$</td>
</tr>
<tr>
<td>kilo (k)</td>
<td>$1,000 = 10^3$</td>
</tr>
<tr>
<td>milli (m)</td>
<td>$0.001 = 10^{-3}$</td>
</tr>
<tr>
<td>micro (μ)</td>
<td>$0.000001 = 10^{-6}$</td>
</tr>
<tr>
<td>nano (n)</td>
<td>$0.000000000001 = 10^{-12}$</td>
</tr>
<tr>
<td>pico (p)</td>
<td></td>
</tr>
</tbody>
</table>
Section 3 Technical Basics

- Frequency is measured in Hertz, abbreviation Hz.
- Hertz is the number of cycles an AC has per second.
- The 240 volt electricity supply is 50 Hz.
- Audible frequency range 20Hz to 15kHz.
- Voice frequency for radiotelephony 300Hz to 3kHz.
Section 3 Technical Basics

Radio Frequencies

- 300kHz to 3MHz Medium frequency (MF)
- 3MHz to 30MHz High frequency (HF)
- 30MHz to 300 MHz Very high frequency (VHF)
- 300MHz to 3000MHz Ultra high frequency (UHF)
Section 3 Technical Basics

- Frequency
- Period
- Wavelength
- Cycle
- Radio waves travel at the speed of light, abbreviation C, which is 300 million metres per second
Section 3 Technical Basics

- Converting frequency to wavelength and vice versa

![Conversion chart - frequency to wavelength](chart.png)
Section 3 Technical Basics

Electric current is:

A. The voltage applied to a conductor
B. The opposition offered to electrons in a circuit
C. Movement of electrons from negative to positive
D. The rate at which electrical energy is changed to light energy
Section 3 Technical Basics

Good conductors are:

A. Silicon and germanium
B. Glass and porcelain
C. Wood and Ceramic
D. Copper and Aluminium
Section 3 Technical Basics

If 10 volts is applied to a circuit consisting of a resistance of 5 ohms the resultant current will be:

A. 0.5 amp
B. 2 amp
C. 15 amp
D. 20 amp
Section 3 Technical Basics

1000 volts is often represented as:

A. 1mV  
B. 1MV  
C. 1nV  
D. 1kV
Section 4 Transmitters and Receivers
Section 4 Transmitters and Receivers

- Foundation licence holders are not permitted to build or modify transmitters
- Radio transmitters generate high frequency electrical energy
- The generated energy is radiated by the antenna as an electromagnetic wave
Section 4 Transmitter and Receiver

- The basis of the transmitter is the oscillator.
- The oscillator generates radio frequency energy at a specific frequency.
- The radio frequency is called the carrier.
- Turning the oscillator on and off with a key allows Morse Code to be sent.
Section 4 Transmitter and Receiver

- **POWER SUPPLY**
- **MORSE KEY**
- **OSCILLATOR**
- **ANTENNA**
Section 4 Transmitter and Receiver

Modulation

- Voice over radio is “Radio Telephony”
- Superimposing the voice frequencies onto the carrier wave is called modulation
- Superimposing the voice onto the amplitude of the carrier is called amplitude modulation
- Superimposing the voice frequency onto the frequency of the carrier is called frequency modulation
Section 4 Transmitter and Receiver

Figure 1: Amplitude Modulation

Audio - voice from microphone
Carrier wave - from Oscillator
Amplitude modulated carrier wave

Figure 2: Frequency Modulation

Audio - voice from microphone
Carrier wave - from Oscillator
Frequency modulated carrier wave
Section 4 Transmitter and Receiver

![Diagram of a transmitter and receiver system]

- Microphone
- Audio Amplifier
- Modulator
- Oscillator
- Power Amplifier
- Antenna
Section 4 Transmitter and Receiver

- Single Sideband (SSB) is a form of amplitude modulation
- The power transmitted on SSB is dependent of the volume of the operator's voice
- The level of the voice signal fed into the transmitter is controlled by the microphone gain control
Section 4 Transmitter and Receiver

- Foundation licence holders are permitted to transmit no more than 10 watts on SSB.
- On SSB the voice peaks (loudest volume) should not cause the transmitter to exceed 10 watts.
- This power is 10 watts peak envelope power (PEP)
Section 4 Transmitter and Receiver

- With **Frequency** Modulation (FM) the output power remains constant independent of voice level.
- A 10 watt FM transmitter will transmit 10 watts at all times.
- The **frequency** of the carrier changes when voice signals are fed into the transmitter.
- The amount of **frequency** change is called deviation.
- Deviation is FM modulation.
Section 4 Transmitter and Receiver

- The amount the carrier deviates is dependent on the level (volume) of the voice signal.
- The more deviation the greater the bandwidth required to transmit the signal.
- Either AM or FM carriers that are over modulated may cause distorted output and interference to adjacent frequencies.
Crystal Receiver

Diagram of Crystal Receiver:

- Antenna
- C1
- C2
- Diode
- C3
- R
- Earth
- 1N34A
- High Impedance Head Phones

Antenna Tune
Detector Tune
Capacitance and Resonance
This is additional information

- The symbol in the crystal set consisting of two parallel lines is a capacitor.
- The capacitors with the arrow are variable.
- The capacitor is two plate separated by an insulating material called a dielectric.

- The capacitor can store electrical energy in electric lines of force the form of a charge.
- This charge behaves like a small battery.
- As the capacitor discharges the energy is depleted.
Capacitance and Resonance
This is additional information

- Resonance is a very special electrical condition
- Resonance occurs at a specific frequency
- A resonant circuit consists of a capacitor and a coil (inductor)
- At resonance energy is transferred between the capacitor and the inductor
- The capacitor stores the energy in its electric field and the inductor in its magnetic field
- At resonance current and voltages can be very high – many times higher than the supply voltage
- Many radio circuits are tuned to resonance.
The receiver is designed to select the required signal, detect the modulation and amplify the voice signal. The receiver converts the voice signal back to the way it was when spoken. A simple receiver is the tuned radio frequency receiver. The circuit that converts the modulated signal back into audio is called a detector. FM detectors are called discriminators.
Section 4 Transmitter and Receiver
Section 4 Transmitter and Receiver

- Receiver sensitivity is the ability of the receiver to receive weak signals.
- Receiver selectivity is the ability of the receiver to select between stations that are close together in frequency.
- Stability is the ability of the receiver to stay on the same frequency over long periods of time where there are significant changes in temperature.
Section 4 Transmitter and Receiver

FM stands for:

A. Frequency modulation
B. Fine modulation
C. Forced modulation
D. Flat modulation
Section 4 Transmitter and Receiver

The device that generates the carrier in a transmitter is the:

A. Audio amplifier
B. Modulator
C. Power supply
D. Oscillator
Section 4 Transmitter and Receiver

If a transmitter is over modulated it is likely to:

A. Get hot
B. Generate FM instead of AM
C. Generate SSB
D. Cause interference
Section 4 Transmitter and Receiver

The ability of a receiver to receive weak signals is called the receivers:

A. sensitivity
B. selectivity
C. stability
D. super-heterodyne
Section 5 Antennas and Transmission Lines
Section 5 Antennas and Transmission Lines

- The transmission line connects the transmitter to the antenna.
- The transmission line is sometimes called a "feeder" because it feeds the radio frequency to the antenna.
- The size of the antenna is dependent on the frequency to be transmitted.
Section 5 Antennas and Transmission Lines

- There are two basic types of feedline. These are coaxial and parallel.
- Coaxial cable used in radio is unbalanced and is usually 50 ohm impedance.
- Parallel line is balanced transmission line usually 300 or 600 ohm impedance.
- Impedance can be considered as resistance to AC.
Section 5 Antennas and Transmission Lines
Section 5 Antennas and Transmission Lines

- The balun is a type of transformer that can connect a balanced antenna to an unbalanced transmission line.
- The balun can also be used to match impedances of transmission lines and antennas.
Section 5 Antennas and Transmission Lines

- The antenna (aerial) couples power from the transmitter to the space around the antenna.
- The antenna radiates an electromagnetic wave by converting electrical signals to radio waves and vice versa.
- The antenna should be resonant at the frequency to be transmitted/received.
- The antenna that radiates well also receives well.
- Antennas are affected by their height above ground and proximity to buildings, trees etc.
Section 5 Antennas and Transmission Lines

- The electromagnetic wave radiated from an antenna is made up of electric lines of force and magnetic lines of force.
- Generally the orientation of the antenna with respect to the ground will indicate the polarisation.
- Generally vertical antennas produce vertically polarised signals and horizontal antennas produce horizontally polarised signals.
- Transmitter and receiver antenna should be the same polarisation for best results.
Section 5 Antennas and Transmission Lines

- The dipole is a half wavelength long and fed at the centre
- This is a broadside antenna (bi-directional)
Section 5 Antennas and Transmission Lines

- The quarter wave antenna is the shortest of the full size antennas
- The driven element is a quarter wavelength long
- The inner of the coaxial cable is connected to the driven element and the braid connected to the ground plane
Section 5 Antennas and Transmission Lines

- The folded dipole has the characteristic of being a broad band antenna
- Fed with 300 ohm TV ribbon
A Yagi antenna is unidirectional and sends signals and receives signals in the direction the antenna is pointed.
Section 5 Antennas and Transmission Line

- Antennas such as Yagi’s have gain, and are unidirectional. This means the electromagnetic wave is concentrated into one direction.
- Gain of antennas is measured in decibels.
- The directivity of antennas has a similar effect as using a higher powered transmitter.
- The effective radiated power (ERP) of the transmitting system is increased.
End fed antennas are usually fed with open wire transmission line and require an antenna tuning unit to match the antenna to the output of the transmitter.
Section 5 Antennas and Transmission Lines

Antenna Schematics

- Half wavelength antenna schematic
- Quarter wavelength antenna schematic
- Reflectors, directors, boom, and maximum radiation schematic
- Ground plane radials schematic
Section 5 Antennas and Transmission Lines

Antenna Schematics

End fed antenna

\[ \frac{\lambda}{2} \] or longer in quarter wavelength multiples.

to transceiver via the antenna tuning unit

Diagram of an antenna with a length of \( \frac{\lambda}{2} \) and an insulator.
Section 5 Antennas and Transmission Lines

- Antenna impedance is measured in ohms
- Impedance can be considered AC resistance
- Most modern transmitting equipment has an output impedance of 50 or 75 ohms
- The output impedance of the transmitter should be matched (have the same impedance) as the transmission line and the antenna.
- Mismatched transmitter outputs, transmission line and antenna will cause power to be reflected back and forth along the transmission line
- The reflected wave is called a standing wave
A standing wave ratio (SWR) meter is used to measure how well the antenna system is matched.

SWR meter is connected between the output of the transmitter and the antenna.

SWR should be checked each time you change frequency.

Checking the SWR on a transmission line using a SWR meter is a component of the practical for the Foundation Licence.
Section 5 Antennas and Transmission Lines

- Checking SWR allows for the adjustment of your antenna to bring the antenna closer to resonance by lengthening or shortening the antenna.
- An SWR of more than 2:1 is likely to indicate a fault in the antenna system.
- A good SWR on an antenna system is 1.5:1 or less.
- An SWR greater than 1.5:1 may indicate the antenna needs tuning or a fault condition is developing.
Section 5 Antennas and Transmission Line

- An Antenna Tuning Unit (ATU) sometimes called a Transmatch can be used to provide the correct operating impedance for the transmitter.
- The ATU tunes the antenna system allowing operation on multiple bands using the one antenna.
- Adjusting the ATU is **not** a requirement for the practical component of the Foundation Licence but knowing its purpose and location between the transmitter output and the antenna is a requirement.
Section 5 Antennas and Transmission Line
Section 5 Antennas and Transmission Line

- A dummy load is a resistor typically the same output impedance as the transmitter ie 50 ohms.
- The dummy load allows the transmitter to be tested with minimal radiation ie not tested “on air” via the aerial.
- The dummy load also allows the output power of the transmitter to be adjusted.
Section 5 Antennas and Transmission Line

- The power for SSB is 10 watts PEP. For CW, FM and AM average power is not to exceed 10 watts.
- Some power meters can be very inaccurate. Care must be taken in the selection of a power meter to measure output power.
Section 5 Antennas and Transmission Line

The purpose of an antenna is to:

A. Let people know you are a radio amateur
B. Provide a convenient place for birds to land
C. Allow balanced transmission lines to be used
D. Convert electrical signals into radio waves and visa versa.
Section 5 Antennas and Transmission Line

The longer the antenna:

A. The higher the frequency of operation
B. The lower the frequency of operation
C. The better the antenna will work
D. The more vertical polarisation will be obtained
Section 5 Antennas and Transmission Line

The reason the antenna and transmission line are matched in impedance to the transmitter output is to:

A. Increase the SWR  
B. Eliminate the use of a dummy load  
C. Keep SWR to a minimum  
D. Keep the transmitted power to 10 watts.
Section 5 Antennas and Transmission Line

An antenna with a 3 dB gain operating with a 10 watt transmitter will result in an effective radiated power (ERP) of:

A. 3 watts  
B. 10 watts  
C. 20 watts  
D. 30 watts
Section 6 Propagation
Section 6 Propagation

- Radio waves are electromagnetic waves
- How these waves travel from the transmitting antenna to the receiving antenna is called propagation
- Radio waves travel in straight lines although they can be reflected, refracted or diffracted
- The further the radio wave gets from the transmitting antenna the weaker it becomes
- Any time a radio wave travels through anything other than “free Space” it will travel slower and lose strength
Section 6 Propagation

- The height of the ionospheric layers is approximate.
- The sun ionises or charges the air particles.
- When radio waves hit the ionosphere they can be bent back to earth.
- The bending is dependent on the layer, its density and the frequency of operation.
Section 6 Propagation

- The ionosphere refracts the radio wave
- The amount of refraction is dependent on:
  - Sun spot activity
  - Time of day
  - The season
- The ionosphere is reliant on ultraviolet radiation from the sun
- Sunspots are in an 11 year cycle
Section 6 Propagation

- A signal travelling from the transmitter to the receiver via two paths can cause multipath fading.
- Selective fading occurs when the frequency components that make up the signal are refracted by different amounts.
Section 6 Propagation

- VHF, UHF and frequencies above UHF are dependent on an almost clear line of sight path from transmitter to receiver
- VHF and UHF are generally obstructed by hills and other large structures
- VHF and UHF signals can be bent or diffracted over some obstacles
- Temperature changes in the troposphere results in ducts that can cause VHF and UHF signals to be propagated over long distances
Section 6 Propagation

- **Incident Wave**
- **Diffracted Waves**
- **Small amounts of signal are diffracted down behind obstacles**

**Knife Edge Diffraction**

- **Hill or Obstacle**
- **Transmitter**
- **Receiver**

**Tropospheric Ducting of VHF/UHF Radio Signals**

- **Cold air above**
- **Warm air trapped by two layers of cold air**
- **Radio wave enters and is trapped in Tropospheric Duct**

- **Cold air below**
- **Distance may be many thousands of kilometers and the receiver signal can be very strong**

- **Radio wave is emitted from duct**
Section 6 Propagation

As a radio wave is radiated from the antenna. As the wave travels further it becomes:

A. Stronger
B. Weaker
C. Ionised
D. Ducted
Section 6 Propagation

Long distance HF propagation is a result of:

A. Ground wave
B. Knife edge diffraction
C. Tropospheric ducting
D. Ionospheric refraction
Section 6 Propagation

VHF and UHF signals can be obstructed by:

A. Large obstacles
B. Transmission during night time
C. Strong north winds
D. Transmission over water
Propagation

- VHF and UHF long distance communication is possible mainly due to:
  - A. Magnetosphere conditions
  - B. Atmospheric conditions
  - C. F1 or F2 layer ionisation
  - D. VHF or UHF waves skipping off the upper atmosphere
Section 7 Interference
Section 7 Interference

- Interference can generally be resolved by introducing technical solutions, however these can be complex and a qualified person should be sought to resolve these problems.
- Electronic equipment can operate within an electromagnetic field without interference. This is called Electromagnetic Compatibility (EMC) or radio frequency immunity.
Section 7 Interference

- An amateur station must not cause harmful interference to radio communications including:
  - Other users
  - Other services

- EMC issues are likely to cause neighbourhood disputes. To resolve a dispute:
  - Discuss the problem with the person concerned, obtain dates and times of interference
  - Try and identify the source of interference
  - Seek advice and where necessary involve the ACMA

- It may be necessary to shut down your station for a time to identify the interference source but this is **not mandatory**, unless the interference is deemed to be harmful, in which case transmission must cease until the problem is resolved.
Section 7 Interference

There are many sources of potential RF noise generation that can interfere with broadcast radio and television receivers. These sources of man made noise include:

- Power tools
- Computers
- Arc Welders
- Power lines etc
Section 7 Interference

- Interference can be caused to:
  - Telephones – mobile and fixed
  - Television
  - Radio reception
  - Audio equipment
  - Computers
  - Vehicle electronic equipment
  - Blasting devices
Section 7 Interference

- There are sources of natural noise that can cause interference such as lightning, electrostatic build-up etc.
- Amateur stations can cause interference to other radio communication services and television services.
- The cause of the interference from an amateur station is often as a result of incorrect operation of amateur transmitting equipment.
Section 7 Interference

- Potential reasons for interference from an amateur station is:
  - Over modulation -- excessive microphone gain
  - Incorrectly tuned antennas – high SWR
  - Breakthrough on FM or SSB – close proximity of transmit antenna to receiving antenna
  - Mains fed interference – signals fed by the 240 volt mains supply
Section 7 Interference

- Interference as a result of EMC issues is dependent on:
  - Transmitted power
  - Frequency of operation
  - Type of emission from the transmitter ie AM, SSB, FM etc
  - Distance the transmitter is from the affected equipment – selection and location of antennas can significantly reduce the likelihood of interference.
Section 7 Interference

- Filters can be used to reduce the likelihood of interference
- Other filters can be used in the power supply or interconnections between the equipment
- Filters must be fitted as close to the affected device as possible
Ferrite rods with wire wound onto them can be used to make effective RF filters. These filters are sometimes called coils or chokes.
Section 7 Interference

- Toroids can also be used as RF filters
- For the practical you will be required to make an RF filter using a toroid or a ferrite rod
- The RF is blocked by the filter
Section 7 Interference

- An RF earth connection in an amateur station is to provide a path to minimise RF ground currents entering the mains earth system and causing interference.
- Note the earth symbol.
Section 7 Interference

EMC problems are dependent on four factors; transmitted power, frequency and type of emission the fourth is:
A. Brand of radio transmitter
B. Weather
C. Distance from the affected equipment
D. Sun spot cycle
Interference

- Objectionable interference from your amateur station to domestic television reception can vary with:
  A. The zodiac cycle
  B. The solar cycle
  C. Weather
  D. Mode of operation
Interference

- Interference to domestic equipment may be reduced by:
  A. Changing the transmission mode
  B. Overmodulating the transmitter
  C. Reducing your receivers RF gain control
  D. Waiting until after dark to transmit when the D layer has dispersed
Interference

You amateur station is causing harmful interference to other radio services, you must:

A. Stop transmitting until the problem is resolved
B. Transmit during the hours that the affected station is off air
C. Contact ACMA and tell them that they have a problem
D. Advise the affected station that you have a licence to transmit and they should contact ACMA
Section 7 Interference

One way interference can be fed into nearby electronic equipment via:

A. The 240 volt mains
B. Moist atmosphere
C. PVC gas pipes
D. RF chokes wound on toroids
Section 7 Interference

Interference resulting in EMC problems can be minimised by:

A. Only using dipoles
B. Using vertically polarised antennas
C. Careful selection and locating of antennas
D. Only operating from a base station
Section 7 Interference

Interference resulting in EMC problems can be minimised by:

A. operating at different times of the day or night
B. Reducing power and increasing the distance between the transmitter and affected equipment
C. Changing from lower to upper sideband on 80m
D. Reducing power and reducing the distance between the transmitter and the affected equipment
Section 8 Operating Practices and Procedures

- This is the practical section and will be covered by your instructor where you will be required to compete practical exercises.
- See practical assessment checklist
Section 9 Safety
The dangers in amateur radio include:

- High voltages
- High currents
- Electromagnetic fields
- High sound levels
- Working at heights
- Working with chemicals

The Foundation licence does not permit modification to your transmitting equipment.

Foundation licence transmitting equipment must be commercially manufactured.
Section 9  Safety

Electrical safety

- 12mA of current can kill
- 240v mains can provide the voltage and current to electrocute a person
- Vacuum tube equipment will have high voltages present
Section 9 Safety

- Always treat the circuit as if it is live
- Never remove the covers from any equipment
- Beware of old equipment, it may not be up to current safety standards
- Look up and live when installing antennas
- Never remove an earth from a piece of equipment
- Always replace fuses with exactly the same type and rating of fuse, as per the manufacturers specifications
Section 9 Safety

Protective Earth

- The Australian 240 volt mains system has an earth (ground) to protect against electric shock, short circuits and faults.
- The earth wire is usually green/yellow or green in some older installations.
- The protective earth shall never be removed other than by a qualified electrician.
Section 9 Safety

- Power supplies have a protective earth via a standard 3 pin plug
- Some power supplies such as plug packs are double insulated and the earth pin is not connected
- Never connect earths to gas pipes
Section 9 Safety

Switch Off
Or
Remove From The Power
Section 9 Safety

Electric Shock

- Check for danger – hazards, risks, safety
- Responsive – if not call 000
- Open Airway – look for signs of life
- Give 2 initial breaths
- Give 30 chest compressions then 2 breaths
- Defibrillate as soon as possible
- Continue CPR until qualified person arrives or life signs return

Australian Resuscitation Council
Section 9 Safety

Fuses

- Fuses are to protect from high currents
- Fuses have a predetermined current melt and open the circuit
- High currents can burn
- Replacement fuses must always be the same type and current rating as per the manufacturers specifications
Section 9 Safety

- Earth leakage breakers are sensitive to fault conditions and will trip
- Most often installed in switchboards
- Approved mains operated appliances in Australia will have a manufacturers label
- All states have regulations for maintenance of mains operated equipment and the requirements in relation to the qualifications of those who can work on such equipment.
Section 9 Safety

Batteries

- Some batteries have toxic or corrosive chemicals or produce gases
- Never short circuit a battery
- Never dispose of a battery in a fire
- Use protective fuses with batteries
- Children should not play with batteries
Radiation Safety

- Electromagnetic radiation may be harmful if concentrated into a narrow beam of very high power
- Electromagnetic radiation may burn or heat parts of the human body or organs
- Keep distance between you and electromagnetic radiation
Section 9 Safety

Other safety issues:
- Slips trips and falls
- Lightning
- Headphones and loud tones
- Voltages and currents on antennas
- RF earthing
Section 9 Safety

Fuses are placed in circuits to protect against:

A. High currents
B. High voltage
C. High resistance
D. High frequency
Section 9 Safety

Batteries should be disposed of correctly because of the environmental issues the chemicals in them can cause. Batteries can also:

A. Produce electromagnetic radiation
B. Go flat very quickly if unused
C. Make loud noises
D. Explode or emit fumes if punctured
Section 9 Safety

Protective mains earths:

A. Should be removed during fault finding
B. Are not necessary in amateur radio stations
C. Can only be removed or replaced by qualified persons
D. Are always represented by a purple wire
Interference

- As well as EMR risk when working around functioning antennas another significant danger is:
  A. A person falling while working at heights
  B. Potential high voltages and currents
  C. Sharp objects that can cause lacerations
  D. Ice on antenna elements can make them fall
Interference

- High voltages and currents can be present around operating antennas. It is important that:
  A. Earth mats are used at the antenna base
  B. All wiring is insulated
  C. People and animals are kept at a safe distance
  D. Earth straps are used to conduct lightning away
IRLP

A Simple IRLP Block Diagram

Worldwide Communications

IRLP links repeaters together over the internet.
Continuous Tone Coded Squelch System (CTCSS)

- This system is designed to reduce annoying signals and will assist in masking co-channel interference
- A tone is transmitted each time the press to talk button is pressed that is detected in the receiver and allows the mute (or squelch) to open.
- The transmitted tone is in the 67 to 257Hz range and often referred to as a sub-audible tone
Dual Tone Multiple Frequency (DTMF)

- DTMF is used for telephone signaling over a medium such as a telephone line or radio link.
- DTMF is the signal produced by your mobile phone keypad.
- Two voice frequency tones of different frequencies are transmitted simultaneously.
- Often used to switch on or off and control remote equipment.
Repeater Operation

- **Duplexer**
  - **Rx**
  - **Tx**
  - **Control**

**Hill-top Repeater**

- **Mobiles:** 147.9 MHz transmit 147.3 MHz receive

- **A**
  - 147.9 MHz receive
  - 147.3 MHz transmit

- **B**
  - 147.9 MHz transmit
  - 147.3 MHz receive