Amateur Operator's Certificate of Proficiency **Advanced** Syllabus and Examination.

The Amateur Licence (amateur advanced station) [the Advanced Amateur Licence] may be obtained by persons holding the Amateur Operator's Certificate of Proficiency (**Advanced**) AOCP(A).

The Advanced Amateur Licence is applicable for persons wishing to operate at the highest level of Amateur radio. The syllabus and related examination for the AOCP(A) correspondingly reflects the level of knowledge, skills and experience required to safely assemble an Advanced Amateur station and to operate it safely without interference to other users and services.

This syllabus assumes that persons contesting the AOCP(A) are also familiar with the knowledge necessary to obtain the Amateur Operator's Certificate of Proficiency (Standard).

Syllabus	Section	Assessment Objectives
1. Nature of Amateur Radio		
Nature of Amateur Radio	1.1	Recall that Amateur radio is intended to facilitate hobby radiocommunications.
Types of licences	1.2	Recall that Amateur radio activities are authorised under an amateur licence. Other forms of licences authorise types of radiocommunications such as Citizens Band (CB), Land mobile, Point to Point Links and Broadcasting.
Allocation of frequency bands	1.3	Recall that the Amateur Service operates on frequency bands allocated for Amateur use. Recall that the Amateur Service shares some frequency bands with other services. Recall that services such as the broadcasting, aeronautical and maritime services are allocated frequency bands appropriate to their purpose.
2. Licence Conditions		
Licence conditions	2.1	Recall that operation under an Amateur Licence is subject to conditions in the *Radiocommunications Act 1992*, the *Radiocommunications Regulations 1993*, the *Radiocommunications Licence Conditions (Amateur Licence) Determination No. 1 of 1997*, the *Radio Licence Conditions (Apparatus Licence) Determination 2003* and any printed on the licence.
Purpose of the Amateur Service	2.2	Recall that an Amateur Licence primarily authorises the operation of an Amateur station for self-training in radiocommunications, intercommunications between Amateurs and technical investigations into radiocommunications.
Communications by Amateur stations	2.3	Recall that, except in relation to a distress or emergency situation, or where authorised by an Inspector, an Amateur Licence only authorises Amateur-to-Amateur communications.

	2.4	Recall that particular conditions apply to the transmission of messages on behalf of a third party or messages to Amateurs in another country.
Distress and Urgency signals	2.5	Recall that Emergency and Distress Communications are signalled by the use of 'Mayday' and that these communications have priority over all other communications.
		Recall that all persons hearing a Mayday call are responsible for passing the information on to appropriate authorities.
		Recall that some urgent situations not warranting the use of 'Mayday' are signalled by the use of 'PAN PAN'. These calls should receive priority and should be reported to the appropriate authority.
Station identification	2.6	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. Recall that any transmission, even a test transmission, must contain station identification.
Amateur callsigns	2.7	Identify the categories of callsigns used in the Australian Amateur Service. Identify callsign suffixes applicable to each licence category, callsign prefixes and state designators.
Secret messages	2.8	Recall that the transmission of secret coded or encrypted messages is generally not permitted.
Entertainment not permitted	2.9	Recall that the transmission of any form of entertainment is not permitted.
Amateur frequency bands and emissions	2.10	Recall that an Amateur Licence authorises operation on certain frequency bands and the use of certain emission modes. Recall in what document the bands and modes are specified.
		Identify emission characteristics from an emission mode designator (e.g. 4K00J3E)
Permitted power output	2.11	Recall the maximum transmitter output power permitted under an Amateur Licence.
Notification of change of address	2.12	Recall the requirement to notify the Australian Communications and Media Authority (ACMA) of any change of address.
Harmful interference	2.13	Recall that a licensee must not operate an Amateur station if its operation causes harmful interference to other radiocommunications stations.
Authorised use of Amateur stations	2.14	Recall that an Amateur licensee may authorise a suitably qualified person to operate the Amateur station.
		Recall that a person without Amateur qualifications may communicate via an Amateur Advanced or Standard Station provided the station is under full control at all times of a qualified person.
Inspection of Amateur licences	2.15	Recall that Inspectors have the right to require an Amateur to produce his or her Amateur licence.

Restriction of operation to avoid interference	2.16	Recall that the ACMA, in order to avoid interference involving an Amateur station, has the right to restrict the operation of the Amateur station.
		Recall that, in order to avoid interference involving an Amateur station, an Inspector may give directions to a licensee about the installation, maintenance and operation of the Amateur station.
Use of the Licence Condition Determinations	2.17	Recall specific licence conditions from the Radiocommunications Licence Conditions Determinations applicable to the Amateur Licence.

3. Mathematics

	3.1	Understand addition, subtraction, multiplication and division.
		Understand fractions, proper, improper and decimal.
		Understand powers of 10 (scientific notation).
		Recall units and sub-units; (tera, giga, kilo, UNIT, milli, micro, nano, pico) and conversion to and from each.
		Understand squaring and square roots.
		Understand reciprocals.
		Understand graphs and be able to interpret them.

4. Technical Basics

Mains power	4.1	Recall the voltage and frequency of the mains supply used in Australia.
		Recall the voltages and relationship between the Active, Neutral and Earth in a single phase mains.
		Recall the colour code of mains wiring.
		Understand the reason for the Earth connection (if provided) on mains operated equipment.
		Recall the purpose of the fuse and switch being in the Active lead of mains operated equipment.
Potential Difference and Electromotive Force	4.2	Understand the difference between potential difference (PD) and electromotive force (EMF).
		Understand the concept of source resistance (impedance) and voltage drop due to current flow.
		Understand the relationships between voltage, current, resistance and power. Calculate any one when any two other elements are known.
Resistance	4.3	Understand and apply the formulae for calculating the combined values of resistors in series and/or parallel.
	4.4	Identify the value and tolerance of a resistor using the resistor colour code.
Potential dividers	4.5	Recall that two or more resistors can be arranged to act as a potential divider.
		Understand how to calculate the values of resistors required to obtain a particular output voltage.

Capacitance	4.6	Understand that the capacitance of a capacitor is influenced by the area and separation of the plates and the permittivity of the dielectric. Understand the formula C=KA/d.
	4.7	Understand that capacitors have a breakdown voltage and that they need to be used within that voltage.
	4.8	Recall that different dielectrics are used for different purposes. Recall that with some dielectrics, losses increase with increasing frequency.
	4.9	Understand the formula for time constant (T=CR) in relation to the charge and discharge of a capacitor in a CR circuit.
	4.10	Recall the dangers of stored charges on large or high voltage capacitors. Recall that large value resistors can be used to provide leakage paths for these stored charges.
	4.11	Understand and apply the formulae for calculating the combined values of capacitors in series and in parallel and in series-parallel combinations.
Inductance	4.12	Understand the term 'self inductance' and recall that a 'back EMF' is produced as current flow changes in an inductor.
	4.13	Recall that the inductance of a coil increases with increasing number of turns, increasing coil diameter and decreasing spacing between turns. Understand the use of high permeability cores and slug tuning.
	4.14	Understand the formula for time constant (T=L/R) in relation to the rise and fall of current in an LR circuit.
	4.15	Understand and apply the formulae for calculating the combined values of inductors in series
AC circuits	4.16	Understand that the root mean square (RMS) value of a sine wave has the same heating effect as a direct current of the same value and that it is equal to 0·707 of its peak value.
	4.17	Recall that the period (time) of a sine wave is equal to 1/f seconds and that the frequency of a sine wave is equal to 1/T (where f = frequency in Hertz and T = time in seconds).
	4.18	Understand that AC waveforms are expressed in degrees and that a complete cycle is equal to 360 degrees.
Phase and impedance	4.19	Recall that for a resistor, the PD and current are in phase. Recall that current lags potential difference by 90°in an inductor and that current leads by 90° in a capacitor.

		Recall that the term 'reactance' describes the opposition to current flow in a purely inductive or capacitive circuit where the phase difference between E and I is 90°. Understand and apply the equations for inductive and capacitive reactance. Understand the application of the formulae; $X_L = 2\Pi FL$ and $X_C = 1/2\Pi FC$
	4.20	Understand that impedance is a combination of resistance and reactance and apply the formulae for impedance and current in a series CR or LR circuit.
	4.21	Understand the use of capacitors for AC coupling (DC blocking) and decoupling AC signals including radio frequency (RF) bypass to ground.
Tuned circuits	4.22	Understand the formula for resonant frequency and that, at resonance, $X_C = X_L$. Apply the formula to find values of; f, L or C from given data.
	4.23	Identify resonance curves for series and parallel tuned circuits.
	4.24	Understand the concept of the magnification factor Q as applied to the voltages and currents in a resonant circuit. Understand and apply the formula for Q factor given circuit component values. Recall the definitions of the half power point and the shape factor of resonance curves. Recall and apply the equation for Q given the resonant frequency and the half power points on the resonance curve.
	4.25	Understand the meaning of impedance of series and parallel tuned circuits. Understand the effect of damping resistors in a tuned circuit.
	4.26	Recall the equivalent circuit of a crystal. Recall that circuits using crystals may exhibit series or parallel resonance characteristics.
	4.27	Recall that voltages and circulating currents in tuned circuits can be very high and understand the implications for component rating.
Transformers	4.28	Understand the concept of mutual inductance. Understand and apply the formulae relating transformer primary and secondary turns to primary and secondary potential differences and currents.
	4.29	Understand and apply the formula relating transformer primary and secondary turns to primary and secondary impedances.

	4.30	Understand the cause and effects of eddy currents and the need for laminations (or ferrites) in transformers. Understand the meaning of the terms copper, hysteresis and external induction loss.
Filters	4.31	Identify the circuits and related response curves of low pass, high pass, band pass and band stop (notch) filters. Understand the concepts of cut-off frequency and insertion loss. Recall that crystals, ceramics, and resonant cavities can be used in filter circuits.
Screening	4.32	Recall that screening with thin metal sheet is effective in reducing unwanted radiation from equipment and between stages within equipment.
Temperature effects	4.33	Recall that temperature has an effect on the value of components. Components with a negative coefficient will reduce in value as temperature rises whereas those with positive coefficient will increase in value. Understand how a component's temperature coefficient impacts on the design of a tuned circuit.
Solid state devices	4.34	Understand that doping (adding impurities) semiconductor material (silicon and germanium) produces P-type (electron deficient) and N-type (electron rich) semiconductors. Understand current flow in terms of electron and hole movement. Understand how the P-N junction forms a semiconductor diode. Understand the formation and effect of the depletion layer. Understand the meaning of barrier potential, and forward voltage drop. Understand that an applied potential difference, depending on the polarity, can cause electrons to flow across the P-N junction (forward bias) or prevent electron flow (reverse bias).
	4.35	Recall that a Zener diode will conduct when the reverse bias potential is above its designed value. Identify the E/I characteristic curve of a Zener diode.
	4.36	Understand that the depletion layer in a reverse biased diode forms the dielectric of a capacitor and that the magnitude of the reverse bias affects the width of the layer and the capacitance. Understand the varactor (varicap) diode behaves as a voltage variable capacitor.

	4.37	Understand that a forward biased P-N junction emits electro-magnetic radiation and that light emitting diodes may emit infra-red or visible light.
	4.38	Understand the 3 layer model of the transistor (NPN and PNP) and the channel model of the field effect transistor (FET). Understand the meaning of the term beta, or current gain of a transistor.
	4.39	Understand the basic methods of biasing bipolar transistors, junction FETs and MOSFETs (metal oxide semiconductor field effect transistors).
Integrated Circuits (IC)	4.40	Recall that individual components such as transistors, resistors, capacitors and diodes may be combined in packages known as integrated circuits (IC). Recall that ICs come in many forms including amplifiers, mixers and oscillators. Recall that ICs often generate heat that may need to be dissipated.
Decibels	4.41	Recall the formulae for decibel voltage and power ratios. Calculate the gain or loss in decibels of any two voltage or power levels.
Mains power supplies	4.42	Identify the circuit diagrams and characteristics of half wave, full wave and bridge rectifier circuits and associated smoothing circuits.
	4.43	Understand the need for rectifier diodes to have a sufficient peak inverse voltage (PIV) rating and be able to calculate the PIV in diode / capacitor circuits.
	4.44	Understand the function of stabilising circuits and identify Zener diode / pass transistor and switching / switched mode stabilizing circuits. Identify typical circuit configurations for linear and switching power supplies and DC to AC converters or inverters.
Circuit symbols	4.45	Identify the circuit symbols commonly used for the devices encountered in all sections of this syllabus.

5. Transmitters and Receivers

Transmitter architecture	5.1	Understand the block diagram of an amplitude modulation single sideband (SSB) transmitter employing the following stages: microphone amplifier, carrier oscillator, buffers, balanced modulator, crystal filter, mixers, intermediate frequency (IF) amplifier, crystal oscillator, variable frequency oscillator, driver amplifier, power amplifier and automatic level control (ALC) loop.
		Understand the block diagram of a frequency modulation (FM) transmitter employing the following stages: microphone amplifier, pre-emphasis, carrier oscillator, reactance modulator, mixers, multipliers, IF amplifiers, filters, variable frequency oscillator, driver amplifier and power amplifier.
Amplifiers	5.2	Identify different types of transistor configurations (e.g. common emitter (source), emitter follower, common base and common source) and explain their operation in terms of input and output impedances, current gain, voltage gain and phase change.
	5.3	Recall the characteristics of A, B, A/B and C class amplifiers.
		Recall the meaning of the term 'complimentary symmetry amplifier'.
	5.4	Understand the term 'efficiency of an amplifier stage'. Given an amplifier stage's efficiency, estimate expected RF output power for a given DC input power.
Oscillators	5.5	Understand the function of the components in typical variable frequency oscillators (VFO) and crystal oscillators.
		Identify typical oscillator and VFO circuits.
Frequency synthesis	5.6	Identify the block diagram of a phase locked loop (PLL) frequency synthesiser and the functions of its stages (i.e. oscillator, fixed divider, phase detector, low pass filter, voltage controlled oscillator and programmable divider).
		Recall the block diagram of a simple direct digital synthesis (DDS) frequency synthesiser.
		Recall that increasing the number of 'bits' in a synthesiser will increase the purity of the signal.
		Understand why frequency synthesisers may not produce the wanted frequency.
Frequency multipliers	5.7	Understand that frequency multipliers use harmonics to generate frequencies above an oscillator's fundamental frequency.

Mixers	5.8	Understand that the desired frequency is often produced by mixing together the output from two or more frequency sources.
		Understand how unwanted frequencies may also be produced and how they may be eliminated.
Modulation	5.9	Recall the meaning of the term 'peak deviation'.
		Recall the meaning of the term 'modulation index'.
		Recall the relationship among modulation index, deviation and modulating audio.
		Recall, for frequency modulation, the meanings of 'narrow band' and 'wide band' modulation.
		Recall, for amplitude modulation (AM), the meaning of 'depth of modulation'.
		Recall the typical bandwidth requirements of the digital modes PSK31 (phase shift keying, 31 baud), RTTY (Radioteletype), Packet Radio and FSK (frequency shift keying).
		Recall that the occupied bandwidth for digital modes changes with the data rate (bit rate).
	5.10	Understand the operation of AM single sideband (SSB), AM double sideband (DSB) and FM modulators. Recall what determines the bandwidth of such transmissions.
Power amplifiers	5.11	Understand the need for linear amplification. Recall which forms of modulation require a linear amplifier.
	5.12	Identify the schematic diagram of a power amplifier. Recall the function of the main components (output circuit, bias, input circuit, output filter and matching circuit). .
	5.13	Recall, in a valve power amplifier (PA), the function for the heater, cathode, control grid and anode. Recall the advantages and disadvantages of valve PA circuits.
	5.14	Understand the effects of different types of modulation and speech processing on the 'rating' of power amplifiers.
		Recall that transmission modes that have a high duty cycle may require a reduction in transmitter power to prevent overheating.
	5.15	Recall the function of ALC in power amplifiers.
Transmitter interference	5.16	Recall the effects of transmitter frequency drift and suitable remedies.
	5.17	Recall the cause and effect of 'chirp' and suitable remedies.

		Recall the cause and effect of 'key clicks' and the shaping of Morse keying waveforms.
	5.18	Understand methods for avoiding the generation of harmonic signals (e.g. use of push-pull amplifiers). Recall that transmitters may radiate unwanted signals. Understand the use of low pass and band pass filters in minimising the radiation of unwanted signals such as harmonics and mixer products. Understand intermodulation interference and typical remedies.
	5.19	Recall that unwanted emissions may be caused by parasitic oscillation and / or self oscillation. Understand the use of suitable remedies. Understand the meaning of the term 'neutralisation' as applied to RF amplifiers.
	5.20	Understand that over modulation or overdriving a transmitter (or amplifier) results in the production of harmonics and/or intermodulation products.
	5.21	Understand how frequency synthesisers may not produce the intended frequency. Identify remedial measures (out of lock inhibit).
External power amplifiers	5.22	Understand the need to drive external power amplifiers with the minimum power required for full output. Understand how overdriving may cause harmonics and/or intermodulation products.
Receiver parameters and terminology	5.23	Understand the meaning of receiver sensitivity.
	5.24	Understand the term selectivity. Identify filter response curve characteristics.
	5.25	Recall that the dynamic range of a receiver is the difference between the minimum discernible signal and the maximum signal without overload. Recall that dynamic range is expressed in decibels.
	5.26	Recall, in simple terms, the meaning of 'signal to noise ratio' as applied to a receiver specification. Recall that the noise generated in the receiver will influence the minimum discernible signal.
Receiver architecture	5.27	Understand the block diagram of a superheterodyne receiver used for amplitude modulation single sideband (SSB) reception including the stages: radiofrequency (RF) amplifier, mixer, variable frequency oscillator, filter, crystal oscillator, IF amplifier, beat frequency oscillator, product detector, audio amplifier and AGC loop. Understand the block diagram of a superheterodyne receiver used for frequency modulation (FM) reception including the stages: RF amplifier, mixer, variable frequency oscillator, filters, crystal oscillatory, IF amplifier, discriminator, limiter, de-emphasis and audio amplifier.

RF amplifier and preamplifier	5.28	Recall the function of the first RF amplifier in a superheterodyne receiver. Understand the effects of using RF preamplifiers on receiver performance. Understand that overloading will cause receiver intermodulation and other spurious signals.
Mixer and Local Oscillator	5.29	Understand the function of a mixer in the generation of the intermediate frequency (IF). Recall that for given RF and IF, there is a choice of two possible local oscillator (LO) frequencies. Understand the reasons for the choice of local oscillator frequency. Calculate the local oscillator frequency for a given RF and IF. Understand the meaning of conversion loss.
	5.30	Understand the meaning of image frequency and calculate the frequency from given parameters.
Intermediate frequency (IF) amplifier	5.31	Understand the advantages and disadvantages of high and low IF and the rationale for the double superheterodyne receiver.
	5.32	Understand the operation of an IF amplifier. Understand the use of IF transformer coupling. Identify critical and over-coupled response curves. Understand how crystal and ceramic filters can be used to improve receiver IF selectivity. Understand how the gain of an IF amplifier can be varied, how this may cause distortion and how the effects of the distortion are avoided.
Demodulation	5.33	Understand the operation of continuous wave (CW), AM DSB and SSB and FM demodulators.
Automatic Gain Control (AGC)	5.34	Understand the derivation and use of an automatic gain control (AGC) voltage. Recall that automatic gain control circuits can also be used to drive signal strength meters.
Converters and transverters	5.35	Understand the use of external converters and transverters when using high frequency equipment for operation at very high frequencies (VHF) or above.
Transceivers	5.36	Understand that transceivers normally use common oscillators in transmitter and receiver circuits. Understand that transceivers may use common IF filters to limit both the transmitter and receiver bandwidths. Recall the function and use of the receiver incremental tune (RIT) control.
Digital emissions	5.37	Understand, at a block diagram level, the terminal node controller (TNC) of a packet radio station. Recall the meaning of Forward Error Correction (FEC) and Automatic Repeat Request (ARQ).
6. Transmission lines and Antennas		

Transmission line basics	6.1	Understand that the velocity factor of a transmission line is the ratio of the velocity of radio waves in the transmission line to that in free space and that the velocity factor is always less than unity (1).
		Calculate physical transmission line lengths given the transmission frequency and velocity factor.
		Recall the velocity factor for typical coaxial and parallel pair transmission lines.
		Recall that transmission line loss increases with increasing frequency. Understand how the operating frequency may determine the choice of transmission line.
	6.2	Understand that a quarter-wave length of transmission line can be used as an impedance transformer.
		Calculate the characteristic impedance (Z_o) of a quarter wave transmission line transformer. $Z_o = \sqrt{Z_{in} \times Z_{out}}$.
	6.3	Recall the basic construction and use of waveguides.
Baluns	6.4	Recall the construction and use of typical baluns.
		Understand the operation of 1:1 baluns and Guanella 4:1 baluns.
	6.5	Understand that, when feeding balanced antenna with unbalanced transmission line (coaxial cable), it is preferred practice to use a balun to prevent feedline radiation.
Antennas	6.6	Recall the formula for calculating half-wavelengths and be able to apply 'end factor correction' in calculating the approximate physical lengths of dipole elements.
	6.7	Recall that the angle at which the propagated radio wave leaves the antenna is known as the (vertical) angle of radiation. Recall that longer communication distances require a lower angle of radiation.
		Recall the effect of an antenna's height above ground on the angle of radiation.
	6.8	Identify folded dipole, trap dipole, quad, quarter wave ground plane, 5/8 wave vertical, loop, end fed and Yagi antennas.
	6.9	Recall the current and voltage distribution on the dipole and $\lambda/4$ ground plane antennas.
		Recall the feedpoint impedances of half wave dipoles, quarter wave ground plane and loaded 5/8 wave verticals, folded dipoles, full-wave loops and end fed quarter wave and half wave antennas.
		Recall the effect of parasitic and other antenna elements on feed point impedance and the use of folded dipoles in Yagi antennas.
	6.10	Understand that standing waves are caused by the interaction of forward and reflected waves on a transmission line.

	6.11	Recall that an antenna trap is a parallel tuned circuit and understand how it enables a single antenna to be resonant and have an acceptable feed-point impedance on more than one frequency. Recall that this technique may be extended to multi-element antennas such as Yagis.
Return loss and standing wave ratio (SWR)	6.12	Understand that the standing wave ratio (SWR) is a measure of the ratio of forward and reflected power on a transmission line. Understand that SWR can be determined by forward and reflected voltage or current.
	6.13	Recall that return loss is the ratio of the forward signal power to the return signal power. Recall that this ratio is normally expressed in dB. Understand that a low SWR equates to a high return loss and a high SWR equates to a low return loss.
	6.14	Understand that the loss in the transmission line will reduce the SWR and increase the return loss as measured at the transmitter. Understand transmission line loss has no effect on the SWR at the antenna. Recall that Return Loss at transmitter = Return Loss at antenna + 2×(transmission line loss). Understand that standing waves increase transmission line loss. Recall that an SWR of 1.5:1 or less is acceptable.
Antenna Matching Units (ATU)	6.15	Understand that an AMU (also know as Antenna Tuning Unit (ATUs) or Transmatch), can "tune-out" reactive components of the antenna system feed-point impedance (before or after the transmission line) and can transform impedances to an acceptable resistive value. Understand that if the AMU is located at the transmitter, it will have no effect on the actual SWR on the transmission line between the AMU and antenna. Identify T, Pi and L AMU circuits.
7. Propagation		
Electromagnetic radiation	7.1	Recall that an electro-magnetic wave comprises E and H fields in phase, at right angles and at right angles to the direction of travel. Recall that in circular polarisation, the polarisation of the wave rotates as it propagates. Recall that circular polarisation is often used for satellite communication where the orientation of the satellite is indeterminate. Recall that, above 30 MHz, transmit and receive antennas should have the same polarisation.
	7.2	Recall that under free space conditions electro-magnetic waves travel in straight lines and spread out according to an inverse square law of power flux density. Recall that

		the field strength, measured in volts / metre, decreases linearly with distance.
Ionosphere	7.3	Understand that the ionosphere comprises layers of ionised gasses and that the ionisation is caused by solar emissions including ultra-violet radiation and charged solar particles. Recall the various ionospheric layers (D, E, F1 and F2) and their approximate heights above the earth.
	7.4	Recall that the E layer can refract radio waves. Recall that sporadic-E is caused by areas of highly ionised gas that can refract waves in the VHF band. Recall that the E layer refraction supports single hops up to about 2000km.
	7.5	Recall that the F2 layer refraction supports single hops for HF signals up to about 4000km. Recall that the F layers combine at night. Recall that multiple hops permit world-wide propagation.
	7.6	Understand the types of fading that occur and their effect on the received signal.
	7.7	Recall that the highest frequency, transmitted vertically, that will be refracted back to the transmitter is known as the Critical Frequency. Recall that the highest frequency that will be refracted over a given path is known as the 'maximum usable frequency' (MUF) and that this will be higher than the critical frequency. Recall, in general terms, how the MUF varies over the 24 hour daily cycle and between summer and winter. Recall that the optimum working frequency (OWF) is 15% lower than the MUF.
	7.8	Recall that the D layer absorbs the lower radio frequencies during daylight hours and that it disappears at night.
	7.9	Recall which Amateur bands will be 'open' to support ionospheric propagation at different times of the day and year.
Tropospheric Ducting	7.10	Understand that unusual atmospheric conditions such as temperature inversions may enable long distance communications on frequencies above 30 MHz.

Scatter	7.11	Recall that radio waves can be scattered by tropospheric events and objects such as aircraft at frequencies above 30 MHz.
Ground wave	7.12	Recall that the ground wave has a limited range due to absorption of energy in the ground and that the loss increases with increasing frequency.

8. Interference and Electromagnetic Compatibility (EMC)

Interference - points of entry into television and radio	8.1	Understand that television receivers and most broadcast radio receivers employ superheterodyne circuits and recall some typical frequencies used in radio and television receivers; i.e. 470-. 854MHz TV RF, 33-40MHz TV IF, video baseband 0-5MHz Radio IFs typically 455kHz and 10.7MHz. Understand that any P-N junction within an electronic device can demodulate unwanted RF. Understand the non-linearity of an overloaded amplifier can demodulate unwanted RF signals.
	8.2	Understand that amateur transmissions can be picked up by the IF stages of TV and radio receivers. Understand the potential for image frequency interference.
	8.3	Recall that amateur transmissions can enter the RF stages and cause cross modulation and / or blocking. Recall that cross modulation occurs when strong transmissions such as Amateur SSB signals modulate the wanted signal. Recall that blocking (also known as desensitisation) occurs when strong transmissions such as Amateur FM signals cause the radio or television to be overloaded.
	8.4	Understand that television mast-head amplifiers are commonly wide band devices and can suffer from cross-modulation and overload.
	8.5	Recall that amateur transmissions can enter audio stages via long speaker leads or other interconnections.
	8.6	Recall that RF signals capable of causing interference can be generated and re-radiated by corroded contacts in any metalwork, including transmitting and receiving antennas, supports and guttering.
	8.7	Understand that television picture 'ghosting' is commonly caused by multi-path reception and does not normally indicate a fault in the TV receiver. Understand that ghosting can be caused by faulty television antenna systems.

Other electronic devices	8.8	Recall that RF signals may enter any electronic device via the mains lead.
Filters	8.9	Understand the construction and use of a typical mains filter.
	8.10	Identify a typical circuit of a braid-breaking filter and a combined high-pass / braid-breaking filter. Understand the use of these filters. Understand the use of ferrite rings in attenuating unwanted signals.
	8.11	Understand the use of ferrite beads or toroids in internal and external filtering.
	8.12	Understand the use of high pass, low pass and band pass filters in improving the immunity of devices affected by unwanted RF signals. Understand the use and construction of coaxial stubs.
Field strength	8.13	Recall that reducing field strength to the minimum required for effective communication is good radio practice. Recall and apply the formula for field strength given the effective radiated power (ERP) and distance from the antenna.
Transmission lines and antennas	8.14	Recall that, particularly at HF, balanced antenna systems tend to cause fewer electro magnetic compatibility (EMC) problems than unbalanced antennas. Recall that the transmission line (balanced or unbalanced) should leave the antenna at right-angles to minimise unwanted coupling. Recall that the ability of an unbalanced line (coaxial cable) to not radiate EMR or be affected by EMR is determined by the shielding ability of the screen.
Mobile installations	8.15	Understand that EMC problems in motor vehicles interfere with the operation of computerised engine management and other electronic systems. Recall suitable precautions to minimise EMC problems in vehicles.
Social issues	8.16	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 ACMA.
9. Operating Practices and Procedures.		
Equipment practices	9.1	Demonstrate connecting a transmitter/receiver safely to a power supply, microphone, transmission line and antenna.
Knowledge of the frequencies and emissions that may be used under an Amateur licence	9.2	Recall, using the relevant LCD's and band plan, frequencies and emissions that may be used under an Amateur Licence. Recall that Amateur band plans, by agreement, play an important part in managing interference between Amateur stations.
Requirement not to transmit on frequencies in use	9.3	Recall and demonstrate the requirement to listen on a frequency before transmitting to ensure that interference will not be caused to other stations using the frequency.
Operating practices	9.4	Demonstrate, by making on-air contacts using appropriate calling procedures, the correct operation of HF and VHF

		or UHF transmitter/receivers in modes consistent with the conditions of an Amateur Licence.
		Demonstrate the use of a signal strength meter to make meaningful signal reports.
Operating through a repeater	9.5	Recall and demonstrate, using supplied reference material, the correct use of voice repeaters including the use of Continuous Tone Coded Squelch System (CTCSS) and Dual Tone Multiple Frequency (DTMF) access control systems.
	9.6	Recall and demonstrate the need for leaving adequate breaks between transmissions when using voice repeaters.
Making a "CQ" call and changing to a working frequency	9.7	Demonstrate an all-stations (CQ) call on HF and VHF or UHF, making a contact and initiating a change of frequency (QSY) from the calling channel to a working channel.
Transmitter measurements	9.8	Recall and demonstrate the measurement, or estimation, of the output power of a transmitter. Measure the SWR using a suitable measuring device.
Correcting simple equipment maladjustments	9.9	Recall and demonstrate the correction of simple problems such as high SWR, excessive modulation, and excessive RF output power.
10. Safety		
Dangerous voltages	10.1	Recall that high voltages and high currents are dangerous.
		Recall that high voltages should not be accessible to non qualified persons.
		Recall the desirability of using safety interlocks on high voltage equipment.
		Recall that it is a good practice to not work alone when measuring high voltages or high currents.
		Recall that tools and other equipment used for measuring high voltages or high currents should be checked regularly. Recall that, under some legislation, the equipment may need to be checked by a qualified person.
Electrical safety - equipment to be approved	10.2	Recall that any mains operated equipment sold, hired or supplied must be approved by an Electricity Authority or other relevant authority. Recall that approved equipment will have an approval label.
Awareness of State Electricity Authority requirements	10.3	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.

Electrical earthing	10.4	Recall why most mains powered equipment should have a safety earth connection.
		Recall that it is good practice to have an approved earth leakage detector fitted to the mains by an authorised person. Recall that portable earth leakage detectors can be used with individual mains appliances.
Fuses	10.5	Recall that fuses prevent excessive currents that may cause heat damage or fires.
Correct fuse to be used	10.6	Recall that a correct fuse must be fitted to all electrical equipment.
Replacing fuses	10.7	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.
Station layout for safety	10.8	Recall that the layout of an Amateur station should take account of physical safety issues. Recall that trailing cables are trip hazards and dangerous.
Power lead safety	10.9	Recall that frayed or damaged power leads are dangerous and should be replaced or repaired by an authorised person.
Know location and desirability of a Mains OFF switch	10.10	Recall the desirability for a clearly marked switch to turn off all station equipment in case of emergency.
Actions to be taken in the event of an accident involving electricity	10.11	Recall that, in the event of an accident involving electricity, the first action is to safely switch off the power.
Electric shocks	10.12	Recall that a casualty of electric shock must not be touched unless the power has been switched off.
Call for help – use of resuscitation techniques	10.13	Recall that emergency services need to be called immediately and that Cardio Pulmonary Resuscitation (CPR) may need to be administrated.
Battery safety	10.14	Recall that batteries contain chemicals and emit fumes and may explode if punctured or exposed to flames or sparks.
		Recall that overcharging batteries may lead to excessive heat, explosion or fire.
Antennas and safety	10.15	Recall that it is important for all persons (and animals) to be kept at a safe distance from antennas.
		Recall that when high power is used it may be necessary to physically restrict access to towers and antennas with fences, cages or guards.

Radio waves can be dangerous	10.16	Recall that electromagnetic radiation (EMR) can be dangerous. Recall that the level of danger varies with frequency, power and proximity.
		Recall that RF energy may cause damage to the eye and other body tissues through heating.
		Recall that the removal of equipment shielding may lead to excessive localised RF radiation levels.
		Understand the requirements for demonstrating compliance with licence conditions applicable to EMR.
Safe distance	10.17	Recall that the distance from an antenna that is safe depends on the ERP, operating frequency, antenna type and orientation.
Antenna erection	10.18	Recall that antenna erection is potentially dangerous and should be carried out by suitably experienced persons. Recall that Occupational Health and Safety legislation and State and local government legislation may apply to persons climbing or working on tall structures.
Securing and siting antennas	10.19	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.
Lightning protection	10.20	Recall that it is good practice to install lightning protection on antennas and to disconnect antennas from any radio equipment prior to a thunderstorm.
Safe use of headphones.	10.21	Recall that excessive volume when wearing headphones can cause damage to human hearing.
Station security	10.22	Recall that an operable Amateur station must not be accessible to unauthorised persons.

11. Measurements		
Meters	11.1	Understand the use of multiplier resistors in analogue voltmeters, shunts in ammeters and the effect of the test meter on the circuit under test.
		Understand that the characteristics of the meter will determine measurement accuracy.
Frequency measurement	11.2	Recall the uses and limitations of crystal calibrators, digital frequency counters and standard frequency transmissions.
Oscilloscopes	11.4	Understand the purpose and basic operation of an oscilloscope. Calculate the frequency and voltage of a waveform from given data.
Spectrum Analyser	11.5	Understand the purpose and basic operation of a spectrum analyser.
		Identify AM (SSB) and FM waveforms.
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		Identify AM (SSB) and FM waveforms.
RF power measurement	11.6	Understand that steady RF power may be determined by measuring the RF potential difference across a non radiating antenna (dummy load).
		Understand the meaning of PEP (peak envelope power) of an SSB transmission. Understand that PEP may be determined using a peak reading power meter or an oscilloscope and dummy load.
		Recall how to determine the mean power of a FM transmitter.
SWR measurements	11.7	Identify the circuit of an SWR meter and understand its operation.
Antennas	11.8	Recall how the resonant frequency of an antenna may be determined.
		Recall how the feedpoint impedance of an antenna may be determined using an impedance measuring device.

Notes to the Amateur Operator's Certificate of Proficiency (Advanced) Syllabus and Examination.

1. The examination comprises:
- Part a) one multi-choice question paper (50 questions) covering theory.
     - questions may be drawn from all Parts of the syllabus other than Parts 1, 2 and 9; and
- Part b) one multi-choice question paper (30 questions) covering regulations.
     - questions may be drawn from Parts 1 and 2 of the syllabus; and
- Part c) a practical assessment of operating knowledge and skills.
     - assessment will be based primarily on Part 9 of the syllabus, however the assessment may address matters included in Parts 2 and 10 of the syllabus.
     - where possible, the practical assessment will be carried out under actual operating conditions.

2. See the Amateur Examiniation Policy Information Paper for information about exemptions.

3. A pass in the Theory or Regulations, or demonstrated competence in the practical component of the examination, will remain valid until a pass in all Parts of the examination is obtained.

4. The examination may be undertaken in one session or as part of a course of training.

5. Ninety (90) minutes is allowed for the theory paper where the examination is undertaken at one session.

   Thirty (30) minutes is allowed for the regulations paper where the examination is undertaken at one session.

6. Subject to exemptions, a certificate of proficiency will be issued to persons who correctly answer 70% of the questions in both Theory and Regulations papers and demonstrate competence in all elements of the practical component of the examination.

7. Candidates will be supplied with reference materials in order to facilitate some of the assessment requirements. The materials may include look up tables, formula sheets, diagrams, photographs, relevant Radiocommunications Licence Conditions Determinations, band plans and physical examples.

8. Under the heading 'Assessment Objective', the syllabus uses the words 'recall', 'understand', 'demonstrate' and 'identify' to denote the differing levels of answer required:

   Recall - indicates the requirement to recall a fact and apply it directly to the assessment question or situation. Reference material may be supplied;

   Understand - indicates the need for a more detailed knowledge of the subject;

   Demonstrate - indicates that the candidate is required to display an ability to carry out a physical task; and

   Identify - indicates that the candidate is required to identify particular objects, diagrams or other matters from a supplied set of alternatives.

9. Reference to an 'Inspector' means an Inspector appointed under the *Radiocommunications Act 1992*.

10. Reference to a 'transceiver' means a combined transmitter and receiver.

Formula Sheet

This formula sheet will be provided to candidates in the examination and may be used to answer any question.

$R_T = R1 + R2 + R3$

$I = \dfrac{E}{R}$

$fr = \dfrac{1}{2\pi\sqrt{LC}}$

$Z = \sqrt{R^2 + X^2}$

$\dfrac{1}{R_T} = \dfrac{1}{R1} + \dfrac{1}{R2} + \dfrac{1}{R3}$

$\lambda = \dfrac{c}{f}$

$Period = \dfrac{1}{frequency}$

$Q = 2\pi fCR_D$

$C_T = C1 + C2 + C3$

$P = EI = \dfrac{V^2}{R} = I^2 R$

ERP = power x gain (linear)

$V_{RMS} = \dfrac{V_{Peak}}{\sqrt{2}}$

$\dfrac{1}{C_T} = \dfrac{1}{C1} + \dfrac{1}{C2} + \dfrac{1}{C3}$

$X_C = \dfrac{1}{2\pi fC}$

$c = 3x10^8\,{}^{m}\!/\!{}_{s}$

Modulation Index $(\mu) = \dfrac{\Delta f}{f_s}$

$L_T = L1 + L2 + L3$

$X_L = 2\pi fL$

$Zo^2 = Z_{IN} x Z_{OUT}$

$t = CR = \dfrac{L}{R}$

$\dfrac{1}{L_T} = \dfrac{1}{L1} + \dfrac{1}{L2} + \dfrac{1}{L3}$

$Q = \dfrac{2\pi fL}{R} \ or \ \dfrac{1}{2\pi fCR}$

$I_P = I_S \dfrac{N_S}{N_P}$

Voltage gain or loss $= 20 Log_{10} \dfrac{E1}{E2} dB$

$SWR = \dfrac{\sqrt{P_f} + \sqrt{P_r}}{\sqrt{P_f} - \sqrt{P_r}}$

$bw = 2(AF_{max} - \Delta f)$

$Z_P = Z_S \left(\dfrac{N_P}{N_S}\right)^2$

Power gain or loss $= 10 Log_{10} \dfrac{P1}{P2} dB$