INTERNATIONAL AMATEUR RADIO UNION
REGION 3
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HARMONISATION OF AMATEUR LICENCES IN R3

I reported at the 2000 Conference on the information I had collected, and the variety of systems under which amateur radio is licensed throughout the Region.

Information on grades of licence and privileges had been collated from 11 societies.

Grades of licence within a country varied from 1 to 4, power limits varied, examination methods varied, and Morse code standards varied. This all made it seemingly very difficult to suggest some degree of co-ordination between countries to achieve harmonisation. It seemed that comparisons of syllabuses would be necessary in order to establish some base line for equivalence.

Since then information has been received from several other countries, and I express my sincere thanks to all societies which have supplied material.

I have now compared the syllabuses of the top licence grade of several countries with that of Australia. Australia has a very detailed syllabus, with the topics clearly defined, providing a useful starting point.

This comparison is provided in Annex 1, where the topics from the Australian syllabus are provided in normal type and topics which do not appear on the Australian syllabus are in italic type.

It can be readily seen that there is a fair degree of consensus among those syllabuses studied.

There is, however, a better form of comparison. Over the years, the Australian regulatory body (Australian Communications Authority, formerly Department of Communications, formerly Spectrum Management Agency) has reached agreements with a number of countries which allow persons holding licences from other countries to be issued with Australian licences when visiting Australia. For this agreement to be reached, the regulatory body has had to inspect the standards and syllabuses of these other countries.

Australia now has a list of a number of countries with which a Reciprocal Agreement has been arranged, and also a list of countries where the qualifications have been investigated and agreed to be equivalent to Australian qualifications but no agreement has been concluded.

From these tables, it is possible to compile a list of Region 3 countries where comparisons have already been made.

Table 1. Countries with which a reciprocal agreement has been arranged (Region 3 only):-

CEPT

France (inc. New Caledonia)

India

Japan

Malaysia

New Zealand

Papua New Guinea

Solomon Islands

UK

USA

Table 2. Countries which have been deemed to have qualifications equivalent to Australian qualifications (Region 3 only):-

Hong Kong

Indonesia

Nauru

Philippines

Singapore

Sri Lanka

Vanuatu

From these tables, it can be seen that a majority of the countries in Region 3 have some degree of co-ordination in their qualifications, and so could be considered to have already been harmonised.

Information received from some countries also indicated that reciprocal agreements with further countries are already in place, as follows:

Japan has an agreement with Korea;

Hong Kong has an agreement with Britain and recognises qualifications from Australia, India, Malaysia, New Zealand, Sri Lanka, USA and Vanuatu;

Thailand has an agreement with the UK and USA.

In addition, Fiji and Bangladesh indicated that their examinations are based on or use the London City and Guilds examination system as used in the UK

Whilst syllabuses provide a certain amount of information, the chief determinant of standard of qualifications remains the actual examination questions used in testing candidates. Although requested, no country provided me with samples of examination papers. This is perhaps understandable, as many administrations consider their examination papers confidential (and frequently re-use them) and in some cases much effort would have been required to translate them.

Unfortunately, while my research encourages the belief that harmonisation is feasible, recent developments (including changes as a result of WRC 2003) have tended to upset the current arrangements. In Australia we are presently undergoing a review of the amateur service, with several proposals before the regulatory body. One suggestion is to lower the degree of difficulty of the present unrestricted licence, and add a new entry point below the level of the present Novice licence. This would necessitate the re-negotiation of a number of the reciprocal agreements, or even the loss of some.

As a conclusion, I would recommend that harmonisation be considered possible among those countries listed with regard to the higher level of examination if more than one level exists. Further work needs to be done on assessment of the lower level examinations. There is also need to consider the situation of countries intending to introduce a low level entry licence similar to that recently introduced in the UK.

Again, my sincere thanks to all who provided information for this project.

Annex 1

AMATEUR AOCP AND AOCLP SYLLABUS, THEORY EXAMINATION

Note: The purposes for which the following may be used, are specified in the Amateur Examination Policy Information Paper. This schedule must be read in conjunction with that Policy Information Paper.

THEORY EXAMINATION	HS	P29	G	9V	VT	ZL	H4
1. ELECTRICAL LAWS AND CIRCUITS							
Electrical fundamentals		P					
1.1 Atoms and electrons.						Z	
1.2 Conductors and insulators.			G		I	Z	S
1.3 Sources of electromotive force (EMF):				V			S
a. Cells;						Z	
i. primary cells - composition, construction;							
ii. secondary cells - capacity (ampere hours);							
iii.batteries - connection of cells, total voltage/capacity;							
iv. charging methods and rate of charging;							
v. internal resistance;						Z	
vi. typical volts per cell;							
b. Mechanical generators/alternators - basic principles of conversion of mechanical energy to electrical energy;					I		
c. Other sources (e.g. photo-voltaic or solar cells).							
Define basic terms	T			V			S
1.4 Direct Current (DC) circuits:				V			
Define units	T						S
a. Electrical units;			G	V	I	Z	
i. unit of quantity;				V			
ii. unit of current flow;			G	V		Z	
iii.unit of electrical pressure;			G	V		Z	
iv. unit of electrical resistance;			G	V		Z	S
v. unit of electrical power;			G	V		Z	S

Unit of frequency				V			
State Ohms law and use it to solve simple problems	T		G	V	I	Z	S
vi. relationship between units and calculations;	T		G	V		Z	S
b. Resistance;				V	I	Z	S
i. resistance in series;	T		G	V	I	Z	S
ii. resistance in parallel;	T		G	V	I	Z	S
iii.resistance in series and parallel;	T		G	V			S
Iv. calculation of total value;						Z	S
v. practical resistors, power rating, colour codes;	T			V			S
Current in series or parallel circuits	T						S
Vi. power dissipation, formulae, calculations.			G	V	I	Z	S
Power in a DC circuit	T		G	V			S
1.5 Electric and magnetic fields:	T			V			
a. Magnetism, permanent magnets;					I	Z	
b. Electromagnets, relays;					I	Z	
c. Electromagnetic induction.							
Magnetic and heating effects of currents, applications	T			V			
Energy and its units	T						
1.6 Alternating Current (AC):				V		Z	
Definition of a sine wave			G				
a. Generation of sine wave;			G	V			S
Define amplitude, frequency, period			G	V		Z	S
b. Sine wave amplitude values;			G	V		Z	S
i. root-mean-square (RMS);	T			V	I	Z	S
ii. average;				V	I		
iii.peak;			G	V	I	Z	S
iv. peak to peak;			G	V			S
c. Frequency and period relationship (calculations);	T		G	V		Z	S
d. Frequency and wavelength relationship (calculations);							
e. Harmonics and harmonic relationships (calculations).							
Explain terms -phase angle, phase difference, phase lag and lead				V	I		S
1.7 Radiofrequency (RF) ranges - LF, MF, HF, VHF, UHF and SHF.	T						
1.8 Capacitance:	T		G		I	Z	S

a. Unit of capacitance;			G	V			S
b. The capacitor - concept of energy stored in an electrostatic field;							
i. factors which determine capacitance;	T			V	I	Z	S
ii. dielectric losses;						Z	
iii.working voltages and characteristics of dielectrics;						Z	
iv. types of capacitors and typical applications;					I		
v. capacitors in series (calculations);	T		G	V	I		S
vi. capacitors in parallel (calculations);	T		G	V	I		S
c. Alternating voltage applied to a capacitor;				V			
i. phase relationships of voltage and current;					I		
ii. capacitive reactance - formula (calculations);	T		G	V	I		S
iii.effect of frequency and capacitance on reactance;				V		Z	S
d. Ohm's Law in capacitive circuits (calculations);	T			V	I		S
E Time constant of a CR network - formulae - calculations - applications.							
1.9 Inductance:	T		G	V		Z	S
a. Unit of inductance;			G	V			S
b. The inductor - concepts of induced EMF - self inductance - mutual inductance;					I		S
i. factors which determine inductance;						Z	S
ii. types of construction;							
iii.types of core, permeability;							
iv.types of practical inductors and typical applications;					I		
v. inductors in series (calculations);	T		G	V			S
vi.inductors in parallel (calculations);			G	V			S
c. Alternating voltage applied to an inductor;							S
i. phase relationships of voltage and current;							
ii.inductive reactance - formulae - calculations;	T		G	V	I		S
iii. effect of frequency and inductance on reactance;				V		Z	S
d. Time constant of an LR network - formulae - calculations - applications.							
Toroidal inductors						Z	
1.10 Alternating current circuits containing L,C and R:					I		
a. Impedance;			G	V		Z	S

i. Circuits containing reactance and resistance - formula - calculations;			G	V	I	Z	S
Reactance, impedance and power in an AC circuit			G	V			S
ii. Ohm's Law for combined LCR circuits;	T		G	V	I	Z	S
b. Tuned circuits;	T		G				S
i. resonance - concept - formula - calculations;			G	V			S
Resonant frequency calculation			G	V			S
ii. series tuned circuit - impedance at resonance;			G	V	I	Z	S
iii.parallel tuned circuit - impedance at resonance;			G	V	I	Z	S
iv. Quality factor (Q);			G	V		Z	S
v. L/C ratio;							
Coupled circuits					I		
Power factor					I		
Dynamic resistance			G				
vi. Resonance curves and selectivity.			G				S
Magnification of current or voltage at resonance			G				
Closed and opened circuits	T						
Current and voltage dividing circuits	T						
1.11 Transformers:	T		G		I	Z	
a. Principles of operations;			G	V			S
b. Construction, types and typical applications;			G	V	I		
c. Losses;	T				I		
i. Hysteresis;							
ii. eddy currents;							
iii. copper loss;							
d. Turns ratio - formula - calculation;	T					Z	
e. Voltage ratio - formula - calculation;	T			V		Z	S
f. Current ratio - formula - calculation;	T			V			S
g. Power ratio - formula - calculation;							
h. Efficiency - formula - calculation;							
i. Auto-transformers - applications;							
j. Characteristics of different types of core materials;							
k. Shielding - methods, purpose.							
Components used, applications, tolerances, preferred values				V			
1.12 The piezo-electric effect: characteristics of quartz crystal and typical applications	T						
2. CIRCUIT SYMBOLS							

Candidates are required to recognise the circuit symbols in common use for the devices encountered, in all sections of the syllabus.						Z	
3. MATHEMATICS							
3.1 Candidates will be expected to demonstrate their understanding of theory and prinoiples, by solving problems requiring the application of basio mathematios.							
Candidates must be able to derive answers from basio formulae and graphs consistent with the syllabus requirements. No formal Mathematioal questions will be set. Candidates may use non-programmable Calculators.							
The following subjects may be included in the mathematics section of the syllabus:							
a. Addition, subtraction, multiplication, division;							
b. Fractions;							
i. proper;							
ii. improper;							
iii.decimal;							
c. Powers of 10 (scientific notation);							
d. Units and sub-units (tera, giga, mega, kilo, UNIT, milli, micro, nano, pico) - conversion							
e. Squaring, square roots, cubes;							
f. Orders of magnitude;							
g. Approximation;							
h. Reciprocals;							
i. Graphs and interpretation (linear only);							
j. Basic transposition of formulae;							
k. Ratios - including the decibel as a voltage, current or power ratio and the reasons for its use			G			Z	S
Gain in dB of systems connected in cascade						Z	
l. Binary logic.							
4. SEMICONDUCTORS							
4.1 Semiconductor materials (a knowledge of atomic structure is not required)	T					Z	
Solid state fundamentals		P					
a.Germanium - effect of impurities - P type, N type;							
b. Silicon - effect of impurities - P type, N type;							
c. The PN junction;							

i. barrier region - effect of applied potential (forward and reverse bias):							
ii. junction capacitance/barrier region width;							
iii. forward voltage drop Ge;							
iv. forward voltage drop Si;							
d. Other common semiconductor materials (basic knowledge of properties).							
4.2 Diodes:	T			V	I	Z	S
a. Point contact diodes;							S
i. applications;	T			V		Z	S
ii. power limitations;	T						
iii. frequency limitations;							
b. Junction diodes (silicon);			G				
i. advantages for power handling;							
ii. ratings - peak inverse voltage (PIV);	T						
iii. ratings - maximum average current;	T						
iv. typical ratings and applications;							
Use as a rectifier, voltage regulator	T		G	V			S
Direction of current, names of electrodes	T						
c. Zener diodes;						Z	
i. applications;							
ii. principle of operation - zener control region;							
d. Voltage variable capacitor diodes (varicap/varactor);			G				
i. applications (including use as frequency multiplier and frequency tuning element			G				
ii. principle of operation - variation in capacitance with respect to reverse voltage							
iii. typical capacitance and frequency range;							
e. Hot carrier diode; typical applications and advantages only;							
f. SCR - Triac;							
i. applications;							
ii. comparison with silicon diode;							
iii. interference considerations;							
g. Light emitting diodes (LED);							
i. applications;							
ii. voltage drop and typical forward current.							
4.3 Transistors and integrated circuits:	T				I	Z	S
a. Bipolar transistors;	T			V			

i. principles of operation - transistor action - amplification - description as a current controlled device;			G	V	I		S
Direction of current	T						
ii. PNP/NPN - polarity of supply;			G	V			S
iii.characteristics as an amplifier - current amplification factor (beta) - gain bandwidth product (fT)	T		G	V			S
iv. ratings - collector current, collector voltage, collector dissipation;							
Biasing	T		G		I		S
v. circuit configuration;							S
Common emitter; bias provision and stabilisation (combined bias - calculations not required);input and output impedances; phase shift; typical applications;			G				
Common base; input and output impedance; phase shift; typical applications;			G				S
Common collector; input and output impedances phase shift; typical applications;			G				S
Transistor as a switch			G				S
b. Field effect transistors (FETs);			G				
i. principles of operation - amplification - description as a voltage controlled device -appreciation of FET types available and their uses(eg Junction FET, MOSFET, Dual-Gate MOSFET)				V			S
ii. biasing;					I		
iii.P channel, N channel;							
iv. typical input and output impedances;							
v. applications and advantages;							
vi. power ratings.							
Differences from npn and pnp transistors							
Diagrams of bi-polar transistors, FETs, valves recognition						Z	
4.4 Integrated circuits:			G				S
a. Recognition of common types and basic knowledge of applications;							S
b. General appreciation of types available.			G				
4.5 Using solid state devices:			G				
a. Precautions in handling;							
b. Protection methods.							
5. VACUUM TUBES	T						

5.1 Basic principles and applications.	T				I		
Vacuum tube principles		P					
5.2 Vacuum tube construction and characteristics:	T				I		
a. Diode;					I		
b. Triode;	T				I		
c. Tetrode;							
d. Pentode;							
e. Cathode Ray Tube (CRT).							
5.3 Vacuum tube amplifiers: application and function of common types, importance of bias.	T		G				
Thermionic emission,characteristic curves,multi-electrode valves					I		
Valves as rectifier, oscillator, amplifier, detector, frequency changer					I		
Power packs,stabilisation and smoothing					I		
6. POWER SUPPLIES		P		V			
6.1 Power mains considerations:							
a. Voltage and frequency;							
b. Wiring standards (AS 3000) - safety;							
c. Colour coding for mains flexible conductors;							
d. Safety precautions;							
i. fuses - ratings, types and replacement in mains operated equipment;							
ii. circuit breakers (detailed knowledge not required);							
iii. earth methods - importance of earthing power points;							
iv. mains switches - precautions, accessibility, pilot lamps.							
Power supply circuits				V			S
6.2 Ratings of power supplies in relation to transmitter output power.							
6.3 Rectifiers:			G	V		Z	S
a. Silicon diodes;						Z	
i. current ratings;							
ii. peak inverse voltage rating (PIV).							
6.4 Rectifier circuits:							S
a. Rectification;			G	V		Z	
i. halfwave-output waveform and ripple					I	Z	

frequency;							
ii. fullwave-output waveform and ripple frequency;					I	Z	
iii.bridge-output waveform and ripple frequency;					I		
iv. voltage doublers;							
b. Current and peak inverse voltage (PIV) ratings of rectifiers with respect to rectifier type, filter and load							
6.5 Filtering:			G	V	I		S
a. Requirement for filtering;							
b. Types of filters;							
i. capacitor input - characteristics;							
ii. choke input - characteristics;							
c. Typical filters and reasons for difference in component values and ratings for the following power supply types;						Z	
i. high voltage, high current;							
ii. high voltage, low current;							
iii.low voltage, high current;			G				
iv. low voltage, low current.			G				
6.6 Protection:							
a. Bleeder resistors - reasons for use and typical values;							
b. Fuses and circuit breakers;						Z	
c. Pilot lamps;							
d. Metering;							
e. Methods of overload protection for power supplies.							
6.7 Voltage regulation:				V	I	Z	S
a. Need for voltage regulation;			G		I	Z	
i. effects of variations in load;							
ii. effects of mains or supply voltage variations;							
b. Zener diode regulators;							
i. applications;							
ii. appreciation of degree of regulation;							
iii.zener voltage;							
iv. power rating;							
v. calculation of series resistor value;							
c. Knowledge of waveforms at various points in a				V			

power supply;							
d. Solid state regulator circuits, including integrated circuits (typical applications,features and advantages only).							S
6.8 Solid state power supplies;							
a. Principles of operation;							
i. typical systems;							
ii. operation of control elements, purpose, ratings - including electronic current limiting							
iii.typical efficiency in relation to load;							
iv. effect of shorted load;							
b. Regulation.			G				S
7. OSCILLATOR AND AMPLIFIER PRINCIPLES							
7.1 Basic concept of sinusoidal oscillation:							S
a. Power source;							
b. Gain;							
c. Positive feedback.							
7.2 Crystal oscillators:				V	I		S
a. Quartz crystal - basic knowledge of types/cut, limitations, frequency range and adjustment	T						
b. Principles of operation and circuit configuration of crystal oscillators;				V	I		S
i. Pierce;							
ii. Colpitts;							
iii.Overtone;							
iv. Series mode, parallel mode.							
7.3 Variable Frequency Oscillators (VFOs):			G	V			S
a. Frequency determining components;							S
b. Principles of operation and circuit configuration of VFOs;				V			
i. Armstrong;							
ii. Colpitts;							
iii.Hartley;							
iv. Clapp;							
c. Varicap tuning;							
d. Phase Locked Loop (PLL) VFOs;							
i. broad understanding of PLL concept;							
ii. basic understanding of control elements and overall function of the PLL (block diagram only)							

7.4 Factors affecting oscillator stability:			G	V	I		S
a. Supply voltage - need for regulation;							
b. Temperature;							
c. Mechanical stability;							
d. L/C ratio;							
e. Isolation from loading effects;							
f. Reason for crystal control.							
7.5 Basic principles of amplification:			G	V		Z	S
a. Characteristics, method of biasing and operating efficiencies for:							
i. Class A operation;							
ii. Class B operation;							
iii.Class C operation;							
iv. Class AB operation;							
b. Parallel and push-pull connection; advantages of each.							
Radio frequency oscillators and synthesizers		P					
8. TRANSMITTERS							
8.1 Transmitter principles:		P				Z	
Classes of emission	T			V			
Meaning of CW, SSB, FM properties of signals						Z	
a. Bandwidth of emission; comparison of modes;							
Signal information	T					Z	
b. Transmitter stages;				V		Z	S
i. oscillator, need for stability;			G	V			S
ii. buffer, purpose, typical gain;							
iii.driver;							
Mixer			G				
iv. power amplifier;			G	V			S
v. frequency doubler and tripler;	T			V			S
vi. modulator;	T		G	V			S
vii.coupling methods;							
c. Keying methods;	T			V			S
i. clicks and chirps - causes, effects and remedies;							
ii. typical keying waveforms - recognition of appropriate oscilloscope displays;							
d. Frequency translation (heterodyning);				V			S
i. reasons for heterodyning;							

Synthesisers, advantages and disadvantages			G				
ii. methods used - simple mixers - recognition of stages in block diagram of typical transmitters			G			Z	S
e. Transmitter tuning, neutralising; criteria for minimising potential for spurious radiation and generation of parasitics.			G				S
Principles and operation of low power transmitter					I		
8.2 Amplitude modulated telephony:	T			V			
Modulation and demodulation		P					
a. Concept of amplitude modulation;							S
b. Bandwidth of emission - typical spectrum - range of audio frequencies used - reasons for restricting;							
c. Microphones - principles of operation and construction, impedance and method of connection to speech amplifier stage;	T						
i. dynamic (moving coil);							
ii. crystal;							
iii.capacitor (condenser);							
iv. electret;							
v. ceramic;							
d. Modulation;	T		G	V			S
i. concept of high and low level modulation and the need for linear amplification after low level modulation;			G	V			
Adjustment of modulation level							S
ii. principles of:							
anode and screen modulation;							
grid modulation;							
collector modulation;							
Emitter modulation;							
Other methods;							
iii.depth of modulation:							
causes and consequences of over modulation;			G				
effect of under modulation;							
iv. relationship of carrier and sideband power;							
v. efficiency of power amplifier stage;							
RF power amplifiers	T	P					
vi. speech processing system principles - advantages and limitations.							

Voice, digital, image communications		P					
Special modulation techniques		P					
8.3 Single Sideband (SSB) suppressed carrier amplitude modulated telephony				V	I	Z	S
Advantages of ssb and fm			G	V			S
Advantages of Morse and telephony			G	V			S
a. Bandwidth of emission - typical spectrum - range of audio frequencies used - reason for restricting	T						
b. Advantages compared to double sideband amplitude modulation;				V			S
c. Filter method of SSB generation;							
i. circuit diagram analysis of balanced modulator;							
ii. types of filters;			G				
low frequency crystal;							
high frequency crystal;							
low frequency mechanical;							
iii.required filter characteristics;			G				
iv. placement of carrier frequency;							
d. Sideband switching USB/LSB;							
e. Spurious mixing products;			G				
f. Frequency translation for multiband operation;				V			
Automatic level control			G				
g. Need for linear amplification;	T		G	V			
h. Criteria for linear amplifiers;				V			Z
i. class of operation;							
ii. power supply requirements;							
iii.Operation within dynamic range;							
i. Effects of non-linearity on signal quality and bandwidth - 'flat-topping'						Z	
j. Matching of power amplifier stage to load;							
i. pi tank circuit;							
ii. broadband circuits;							
k. Typical circuits for individual stages;							
l.Block diagram knowledge of complete transmitter, including frequencies at each stage	T			V		Z	
Power distribution in transmitters						Z	
8.4 Frequency modulation/phase modulation:			G	V	I	Z	S
a. Concept;							
b. Bandwidth of emission;	T						

i. narrow band frequency modulation (NBFM);							
ii. wide band frequency modulation (WBFM);							
iii.existence of sidebands - deviation - modulation index;	T						
c. Generation of FM/PM;							
i. reactance modulator (variable L or C);	T		G	V			S
ii. other modulation methods - varactor, PLL;							
iii.effect of frequency multiplication on deviation;	T			V			
iv. audio preamplifier characteristics - pre-emphasis - clipping;							
v. class of operation of typical power amplifier stages;							
d. Block diagram - knowledge of complete transmitter, including frequencies at each stage	T		G	V		Z	S
Transceiver, linear amplifier, low pass filter						Z	
SWR bridge,antenna switch, antenna tuner, dummy load, antenna function of each block						Z	
Modulation for PM,RTTY	T						
Codes for Baudot, AMTOR and ASCII	T						
Block diagrams of SSB, CW, FM transmitters, purpose of each block, signals produced	T					Z	
Transmission and reception of Facsimile and TV signals					I		
8.5 VHF/UHF techniques:							
a. Transverters - block diagram;							
b. Varactor multipliers;							
c. Tank circuit design, cavity resonators, strip lines (efficiency considerations;							
d. General design considerations of these frequencies.						Z	
9. RECEIVERS							
9.1 Receiver principles:	T	P		V	I		S
a. Interference considerations (e.g. image, crossmodulation, intermodulation fundamental overload);							
i. recognition of symptoms;							
ii. potential remedies;							
Tuned radio frequency receiver	T				I		
9.2 The superheterodyne receiver:	T		G	V	I	Z	S
a. Principles of operation - advantages - typical	T		G	V		Z	S

block diagram - circuit diagram and component function of:							
i. RF amplifier stage;	T		G	V		Z	
ii. local oscillator stage - fixed tuned - variable;	T						S
iii.intermediate frequency (IF) amplifier stage;	T		G	V		Z	S
Mixer						Z	
Frequency changing			G			Z	S
iv. crystal calibrator;							
v. detectors (AM-SSB-CW);	T		G	V	I	Z	S
vi. beat frequency oscillator (BFO) stage - application;	T		G	V		Z	S
Carrier insertion oscillator			G	V			S
vii.audio amplifier stage;	T		G			Z	S
viii.automatic gain control (AGC) - simple, delayed;			G		I	Z	S
ix. S meter;							
x. noise limiters/blankers;					I		
CW reception					I		
Principle of SSB reception							S
b. Double conversion and direct conversion receivers - reasons for use, advantages/disadvantages;						Z	
c. receiver specifications;							
i. selectivity;					I	Z	
ii. sensitivity;					I	Z	
iii.stability;							
iv. image rejection;			G	V	I	Z	S
v. dynamic range;							
vi. crossmodulation;							
vii.signal-to-noise ratio;					I	Z	
Fidelity					I		
Adjacent channel interference			G	V	I		S
Image frequency interference,minimising					I		S
d. Frequency modulation receivers - typical block diagram, functional description;	T		G	V			S
i. detectors - ratio detector - discriminator;	T		G	V			S
ii. limiters;							
iii.capture effect;							
iv. quieting and signal/noise ratio considerations;							
v. de-emphasis;							

e. Frequency readout;							
i. analogue;							
ii. digital - basic knowledge as a system;							
f. Phase locked loop (PLL);							
i. Concept of basic loop - explanation of operation in block diagram format;							
ii. applications, detector - oscillator;							
Squelch circuits					I		
g. Transceivers;		P	G				
i. basic concept of transceiver;							
ii. common stages in transceivers;							
iii.transmit/receive switching methods;							
iv. appreciation of function of the various controls on a modern transceiver							
Block diagram of SSB, CW, FM receivers, purpose of each block,						Z	
Block diagram and adjustment			G				
Simplex, duplex and semi-duplex operation	T						
10. PROPAGATION	T						
10.1 Characteristics of radio waves:	T		G	V	I		S
Define basic terms			G	V	I		S
a. Electromagnetic radiation;							S
Relation between electric and magnetic components			G	V			S
i. propagation;	T						
Characteristics of radio frequency wave propagation bands	T						
ii. free-space velocity - formulae, calculations;			G	V			S
Frequency/wavelength				V			S
iii.reflection, refraction and diffraction;			G	V		Z	S
b. Polarisation;			G	V			S
i. electric and magnetic fields;			G	V			S
ii. vertical polarisation;							S
iii.horizontal polarisation;							S
c. Types of propagation;							
Sky waves					I	Z	
i. ionospheric waves;			G	V	I	Z	S
ii. tropospheric waves;			G	V	I	Z	S
iii.ground waves;			G	V	I	Z	S
iv. VHF/UHF/SHF considerations;	T					Z	
Basic phenomena in HF, VHF, UHF propagation						Z	

d. Ionospheric propagation;			G		I		S
i. properties of the ionosphere; ionisation; refraction; absorption;			G	V	I	Z	S
ii. definitions; skip distance; skip zone; virtual height; ALF; MUF; optimum working frequency (OWF)			G		I	Z	S
Critical frequency			G				S
iii.variations in ionisation densities at different heights (D, E and F regions); typical height; thickness; diurnal and seasonal variations; effect of frequency;	T		G	V	I	Z	S
iv. multiple hop propagation;						Z	
v. reflection losses;							
vi. long and short path;							
Great circle paths						Z	
vii.radiation angle;						Z	
Sporadic E						Z	
viii.the sun; solar radiations that influence the ionosphere (short and long term); solar cycle; sunspots (effect on propagation);solar rotation(27 days);	T		G	V		Z	S
Effect of ionisation on propagation			G	V			S
e. Tropospheric propagation;			G	V	I		S
i. causes of tropospheric bending and ducting;	T						S
ii. effect on VHF/UHF;					I		
f. Ground wave propagation;			G	V			S
i. characteristics;							
ii. distance versus frequency;							
g. Fading - types and causes (all frequencies).			G	V	I	Z	S
Doppler caused by satellite motion						Z	
Radio frequencies and propagation		P					
Space communications		P					
11. ANTENNAS AND TRANSMISSION LINES							
11.1 Fundamentals of antennas:	T	P	G	V	I		S
a. Antenna resonance and standing waves;							
b. Polarisation;	T					Z	
c. Field strength;							S
E and H fields around antennas						Z	
Polar diagrams			G				
Basic antenna	T			V			S
d. The dipole;			G			Z	

i. length - formulae and calculations;						Z	
ii. current and voltage distribution							
iii.impedance;						Z	
iv. radiation characteristics;							
v. methods of feeding;						Z	
vi. reference - isotropic radiator;						Z	
Matching						Z	
e. Long-wire antennas (e.g. Rhombic, V-beam);							
i. long-wire characteristics;							
ii. current and voltage distribution;							
iii.physical lengths;							
iv. impedance;							
v. gain-directional characteristics;							
vi. methods of feeding;							
Tuning antennas with inductance						Z	
End fed							
Common types of transmitting and receiving antennas					I		
f. Multiband antennas;			G	V			S
i. common feed dipoles, impedance considerations;							
ii. tuned trap antennas;							
iii.angle of radiation - radiation patterns, polarisation;						Z	
g. Vertical antennas;						Z	
i. the ground plane, 1/4 and 5/8 wavelength;			G			Z	
ii. voltage-fed half wave;							
h. Directive array with parasitic elements;			G	V			S
i. the yagi - element names, length and spacing - gain-effect of additional elements on feed impedance - methods of matching;			G			Z	
ii. cubical quad - element names, length, structure and spacing - gain;			G				
iii.other directional antenna types (including those suitable for UHF/SHF)- practical applications;				V			
Antennas for microwave					I		
i. Artificial antenna (dummy load);			G	V		Z	S
i. circuit configuration including current and voltage measurement;							
ii. method of calculating output power in the load;							S

iii. ratings and cooling;							
iv. need to inhibit radiation, shielding;							
j. Mobile antennas - method of construction, efficiency, bandwidth, impedance and methods of feeding;							
i. base loaded whips;							
ii. centre loaded whips;							
iii. distributed loading whips (helical);							
iv. 1/4 and 5/8 wavelength (VHF/UHF);							
k. Impedance matching methods;			G	V		Z	S
i. baluns and stubs;	T					Z	
ii. transformer matching;							
iii. folded dipoles;							
iv. gamma matching;							
v. antenna tuning units (ATU), configurations, advantages and uses.			G				
Matching based on tuned circuits,			G				
Networks			G				
11.2 Transmission lines:		P		V		Z	
a. Reasons for use;							S
b. Coaxial and balanced transmission lines;	T		G	V		Z	S
Coaxial, balanced, twin lead						Z	
i. characteristic impedance (Zo);				V		Z	
ii. dielectrics;							
iii. losses, attenuation;						Z	
iv. velocity factor;			G	V			S
c. Standing waves on a transmission line for the following conditions of termination (amplitude of current and voltage variations along a line);	T		G	V		Z	S
i. open circuit;							
ii. resistance greater than Zo;							
iii. resistance less than Zo;							
iv. correctly terminated;							
v. short circuit;							
d. Voltage standing wave ratio (VSWR);	T		G			Z	S
i. reflected power;							
ii. tolerable VSWR;				V			
iii. effect of high VSWR;							
iv. relationship between VSWR/load/Zo;							
v. measurement							

12. TEST EQUIPMENT AND MEASUREMENTS	T	P					
Ac,dc and rf voltages and currents,common instruments, analogue and digital,multimeter			G				
Various measuring devices	T			V		Z	S
Usage and accuracy				V			
Analogue type meter	T						
12.1 Permanent magnet moving coil (PMMC) meter:					I		
a. Principle of operation;					I	Z	
b. Applications and methods of use as:							
i. DC voltmeter;			G	V		Z	S
ii. DC ammeter;			G	V		Z	S
iii.Ohm meter				V			
iv. AC meter;			G	V			S
c. Sensitivity, accuracy and loading effects when used as a voltmeter.			G			Z	S
Moving iron meter					I		
Impedances, connections, peak and RMS values						Z	
Power input and output				V		Z	S
Metering in equipment				V			
Current at radio frequencies				V			S
12.2 Electronic voltmeter (digital and analogue) - advantages, applications and comparison of uses;			G				
Frequency measurement					I		
12.3 Cathode ray oscilloscope (CRO):			G	V			
a. Applications and limitations (including SSB power measurement);			G				S
b. Interpretation of basic display;			G	V			S
i. X axis - time;							
ii. Y axis - amplitude;							
c. Interpretation of wave shapes;			G	V			
i. DC;							
ii. Sine wave AC;							
iii.Lissajous patterns;							
iv. Envelope and trapezoidal display of AM modulation percentage;			G	V			S
v. SSB speech patterns;							S
vi. keying waveforms.							
12.4 Basic test instruments:							
a. A knowledge of the principles of operation, applications and limitations of the following instruments;							

i. RF probe (RF voltmeter);				V			
ii. absorption wavemeter (tuneable and untuned types);			G	V			S
iii.field strength meter;							
iv. dip oscillator;							S
v. reflectometer (SWR meter);			G	V			S
vi. RF wattmeter;				V		Z	S
vii.2 tone audio test oscillator (SSB power measurements).	T		G				
Crystal calibrator							S
Frequency counter				V			S
12.5 Advanced test instruments:							
a. Appreciation of the use and limitations of the following instruments:			G				
i. digital frequency meter (DFM);			G	V	I		S
ii. RF signal generator;							
iii.antenna noise bridge.							
Relative accuracy and usage			G				S
13. INTERFERENCE	T						
13.1 Transmitter defects:						Z	
a. Definitions, causes, effects, location and suppression of interference caused by:	T			V			
Causes and cures of interference		P					
Mains born interference						Z	S
Poor frequency stability			G	V			S
Out of band radiation			G	V			
Frequency checking			G	V			
Cross modulation						Z	
i. parasitic oscillations;			G	V		Z	S
ii. harmonic radiation;			G			Z	S
iii.self oscillation (instability);				V			S
iv. spurious outputs and overdriving (splatter);			G	V			S
v. intermodulation products;							
vi. key clicks.				V		Z	S
Overmodulation			G	V			S
Excessive deviation			G				S
Frequency synthesisers			G				
13.2 Interference to broadcast and TV reception (BCI and TVI) and other domestic equipment:	T					Z	

EMC concepts						Z	
Design, construction and operation to limit interference			G	V			S
a. Causes:							
i. front end overload (including blocking);							
ii. fundamental overload (AF/RF);							
iii.cross modulation;						Z	
Distortion						Z	
b. Remedies:			G			Z	
i. stubs;							
ii. filters (including toroids);	T		G			Z	
iii.ferrite beads, chokes and by-pass capacitors;			G				
c. Recognition of symptoms and precautions to avoid the various interference problems, including those which can be generated by ancillary devices (eg SCR or triacs)							S
d. Interference due to re-radiation - external cross-modulation - causes - effects - cures.							S
EMC problems of operating close to other equipment			G				
Broad band and narrow band interference			G				
Interference sources			G				
Signal paths, rf, if and mains born			G	V			
Methods of improving immunity			G	V			
Methods of improving station design to reduce emc problems			G				
Rf grounding, mains filtering, screening, monitoring, minimum power, location, type and size of antennas, screened cables, balanced lines and baluns			G	V			
Gain, impedance, basic properties of opeerational amplifiers. Op amps in active filters						Z	
Steps in investigating emc problems			G				
Audio-bandwidth limitations				V			S
Emc considerations in mobile operations			G				
Location of tx and connection to 12 volt supply, routing of power and antenna cables, location and grounding of antenna, possible effects of rf on vehicle electronics			G				
13.3 Filters and their applications:			G			Z	
a. High-pass;	T		G			Z	
b. Low-pass;	T		G			Z	
c. Band-pass;	T		G			Z	
Band stop			G			Z	

Notch						Z	
AC line filter	T						
d. Coaxial (all types including cavity resonator);							
e. Strip line.							
Bandwidth, insertion loss, impedance			G				
Screening, lead lengths, ferrite rings, beads, bypass capacitors			G				
Gain, impedance, basic properties of operational amplifiers						Z	
Op-amps in active filters						Z	
14. ADVANCED MODES OF TRANSMISSION AND RECEPTION							
14.1 A basic appreciation of the use and applications and interference potential of the following modes of transmission and the bandwidths involved							
a. High definition television (ATV);							
b. Slow scan television (SSTV);							
c. Radio teletype (RTTY);							
d. Repeaters (FM and ATV);							
e. Satellite translators and transponders;							
f. Beacons;							
g. Transmission techniques involving bandwidth compression (e.g. narrow band voice modulation - NBVM							
Elementary principles of communication via satellite					I		
h. Computer controlled communication systems (AMTOR, packet radio etc).							
Basic digital communication principles, names of common digital modes,principles of BBS systems,modems, TNCs						Z	
15. SAFETY	T						
15.1 The human body:						Z	
a. Variations in body resistance;							
Removing person from live circuits						Z	
b. Consequences of electric shock.						Z	
15.2 Safety with high voltages:							
a. Safety hazards;							
i. bare wires							
ii. loss of earth connection (including RF earth)						Z	
Purpose of ground lead, connection						Z	
iii.charged capacitors.							

15.3 Mains wiring (to AS 3000):							
a. Australian mains power point configuration;							
b. Colour code for active, neutral and earth;						Z	
c. Difference between active, neutral and earth;							
d. Basic principle of earth connection;						Z	
e. Fuses and circuit breakers;						Z	
Action of RCD, fuse, isolating transformer, grounding						Z	
i. principle of operation;							
ii. importance of use of appropriate rating.							
15.4 Lightning							
a. Danger of lightning strikes;							
b. Paths of entry;							
c. Lightning arrestors and other precautions.							
15.5 Safety in use of high RF energy levels (including precautions at microwave frequencies).							
15.6 Safety in use of hazardous materials or equipment (e.g. high voltage power supplies; batteries - electrolyte, ventilation, charge/discharge rate. Beryllium encapsulated solid state devices).							
15.7 Safety in mobile station operation - awareness of hazards (e.g. blasting areas, mains power lines and explosive atmospheres).							
HF station arrangement						Z	
Digital systems						Z	
Practical procedures for safety purposes; HF antenna, high power transmitters	T						
Two tone test for linearity	T						