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IRISH RADIO TRANSMITTERS SOCIETY
Since 1932

Amateur Radio in Ireland
www.irts.ie

Studying for the Harmonised Amateur Radio Examination Certificate

Introduction

Since 2005, the Irish Radio Transmitters Society (IRTS) has been responsible for setting, organising and correcting the Harmonised Amateur Radio Examination Certificate (HAREC) examination in Ireland. Holders of the HAREC qualification are entitled to apply for an Amateur Station Licence.

Examination papers are approved by the Commission for Communications Regulation (ComReg) and the results are forwarded by IRTS to ComReg for transmission to the candidates.

Why an examination is needed

An amateur station licence entitles the holder to construct and operate radio transmitters which, depending on propagation, can send signals to the furthest points on Earth and indeed into space. Radio amateurs potentially have access to more than 20 frequency bands spanning the entire radio spectrum. When you think of the other services that use radio signals – broadcast stations, marine and air navigation / safety, satellites, GPS and mobile phones, to name but a few – you can see why radio amateurs, like all others licensed to transmit radio signals, must abide by certain rules.

Radio amateurs have greater privileges than most radio spectrum users – for example they are allowed to transmit using home-constructed equipment, they also have greater freedom to choose operating frequencies and modes than the commercial stations. However, to earn these privileges prospective radio amateurs must show that they –

- have a clear grasp of the relevant national and international regulations,
- know the accepted operational procedures used in radio transmissions, and
- have an understanding of the technical side of radio.

Examination syllabus

The Irish HAREC examination is based on a Europe-wide syllabus for the CEPT Harmonised Amateur Radio Examination Certificate (HAREC). The syllabus is designed to ensure that candidates can demonstrate proficiency in the regulations governing the amateur radio service in Ireland as well as the technical and operational aspects of amateur radio. A copy of the syllabus, along with notes for candidates, is attached.

Examination format

The examination comprises a multiple choice question paper with 60 questions and the time allowed is 2 hours. Four possible answers are shown for each question, only one of which is correct. Candidates must decide which of the options is correct and place a tick in the appropriate box on the answer sheet. There may be other possible answers to some questions; however, the choice of the correct answer from the options given is required.

The pass mark is 60% and a pass is required in each of the two main sections of the paper, Section A and Section B.

The topics covered in the paper are:

Section A - Amateur Radio Regulations and Related Topics (30 Questions)

- Licensing Conditions
- Operating Rules and Procedures
- Electromagnetic Compatibility and Transmitter Interference
- Safety

Section B – Amateur Radio Theory and Related Topics (30 Questions)

- Electrical & Electronic Principles including Components and Circuits
- Transmitters and Receivers
- Feeders and Antennas
- Propagation
- Measurements

Study material

For a start, candidates and tutors should look at the documents overleaf, which are:

1. **The exam syllabus** – essential reading! As well as outlining the topics to be covered in the exam, the syllabus includes –
   - **Notes for candidates** – designed to assist candidates and their teachers with their work in preparing for the exam by suggesting certain areas worth focusing on
   - **Four pages of Annexes** – containing key information very relevant to the exam questions
2. **Sample paper** – a useful guide to how the questions are presented in the exam
3. **Examination Reports** – these reports, published by the Examinations Board, include observations and advice that should be of assistance to anyone studying for the Licence Examination

An online **Course Guide** is available at www.irts.ie/course A zip file of this guide is available on the Downloads page at www.irts.ie/downloads for offline viewing.

We also suggest that candidates look at some of the material in the links on the IRTS **Radio Theory Links** page at www.irts.ie/theory

For those who prefer printed material, there are a number of online bookstores specialising in amateur radio material, including those run by PW Publishing and the Radio Society of Great Britain. Note, however, that as the UK amateur radio licensing system is based around three separate examinations [Foundation, Intermediate, Advanced], material on all three examinations would need to be covered by candidates studying for a full HAREC-level examination.

Practical Experience

Experience at setting up and operating radio equipment alongside existing licensed radio amateurs – either in a club or home environment – can make the task of preparing for the licence examination a lot easier and indeed more enjoyable. Learning about topics such as band plans, permitted frequencies or modes and SWR measurements solely in a classroom environment can be difficult, it is far better to pick up this knowledge from operating under the supervision of experienced radio amateurs, using the classroom to complement the know-how picked up during these sessions. To find out the nearest club, have a look at the list of IRTS affiliated clubs and societies at www.irts.ie/clubs

Examination Syllabus for a Harmonised Amateur Radio Examination Certificate (HAREC)

This syllabus complies with the conditions of CEPT Recommendation T/R 61-02 and has been approved by the Commission for Communications Regulation (ComReg)

This syllabus will be used for examinations held from 1 January 2013 onwards.

Important Notice: The "Notes for Candidates" in this document are designed simply to assist candidates and their teachers with their work in preparing for an examination by suggesting certain areas worth focusing on. The Notes are not intended to be comprehensive, nor do they in any way limit the scope of questions that may be asked.

Examination questions will be drawn from the topics listed in the Syllabus. Questions in the respective sections may require knowledge from other sections of the syllabus, but the main emphasis of each question will relate to the section it is drawn from.

Version 1.0: 9 June 2010

Version 1.1: 17 December 2011 No significant change to the content of the Syllabus and Notes for Candidates. The layout of the document has been adjusted to conform to the revised arrangement of examination sections

Version 1.2: 6 February 2013 Changes to the "Licensing Conditions" section of the syllabus consequent on the publication of revised Amateur Station Licence Guidelines by ComReg

Version 1.21: 17 September 2016 Minor drafting changes

Version 1.22: 28 December 2016 Minor drafting changes

Version 1.23: 30 April 2018 Minor drafting changes

A.1 Licensing Conditions (9 questions)

<table>
<tr><th>Syllabus</th><th>Notes for Candidates</th></tr>
<tr><td>

- ITU Radio Regulations relating to:
  - purpose of the amateur service
  - emission designations
  - permitted communications
  - use of call signs
  - secondary allocations
- National Regulations, in particular "Wireless Telegraphy (Amateur Station Licence) Regulations, 2009 (S.I. No 192 of 2009)".
- Guidelines published by ComReg, in particular "Amateur Station Licence Guidelines" (ComReg 09/45R4).
- In relation to the Amateur Station Operational Bands/Powers/Modes Permitted in ComReg 09/45R4, the syllabus requirements include –
  - permitted frequencies,
  - permitted modes,
  - maximum power levels (including power levels for land mobile and maritime mobile, but not including power levels for contest operation),
  - status of allocation (primary / secondary), and
  - entitlement to operate maritime mobile

for the following bands:

kHz	kHz	MHz
1810-2000	18068-18168	50.0-52.0
3500-3800	21000-21450	69.9-70.5
7000-7200	24890-24990	144.0-146.0
10100-10150	28000-29700	430.0-440.0
14000-14350		

- "CEPT Amateur Radio Licence" regulations regarding operation during visits to other countries participating in these arrangements

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See the document "Amateur radio licence examination and the ITU Radio Regulations" in Annex 2 of this document.

As well as permitted frequencies etc., note the other requirements set out in ComReg and other documents referred to in the syllabus: for example –

- SWR and frequency measuring devices
- Log book entries
- Limitations / requirements for land mobile and maritime mobile operation
- Limits on non-ionising radiation and spurious emissions: it is not necessary to memorise the quantitative limits, however the aims of the limits should be understood

The document "Amateur Station Licence Guidelines" (ComReg 09/45R4) is available at www.comreg.ie *

The document "Wireless Telegraphy (Amateur Station Licence) Regulations, 2009 (S.I. No 192 of 2009)" is available at www.comreg.ie * or at www.irishstatutebook.ie

For the CEPT amateur radio licence regulations, see "CEPT Recommendation T/R 61-01 (CEPT licences)" which is available at www.irts.ie/downloads Note what these regulations do and don't permit and the conditions of use.

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*** Copies of regulations and guidelines for Radio Amateurs are available from this page:**

https://www.comreg.ie/industry/radio-spectrum/licensing/search-licence-type/radio-amateurs-2/

A.2 Operating Rules and Procedures (10 questions)

Syllabus	Notes for Candidates
▪ ITU Radio Regulations relating to the composition of call signs ▪ ITU radio regions ▪ National call sign prefixes [Europe and North America] – see Annex 1 ▪ IARU band plans for frequencies up to 440 MHz ▪ Distress signals, emergency traffic and natural disaster communication ▪ Format of CQ calls to specific stations ▪ Q-codes – see Annex 1 ▪ Operational abbreviations – see Annex 1 ▪ Phonetic alphabet – see Annex 1 ▪ RST code – see Annex 1	See the document "Amateur radio licence examination and the ITU Radio Regulations" in Annex 2. Copies of the IARU band plans are at www.irts.ie/downloads In reviewing the band plans, note in particular the band segments for: • CW only • contest preferred • priority for intercontinental • beacons only • global emergency centre of activity Also note the accepted usage in the bands for USB and LSB.

A.3 Electromagnetic Compatibility and Transmitter Interference (7 questions)

Syllabus	Notes for Candidates
Interference in electronic equipment ▪ Aims of Electromagnetic Compatibility (EMC)	Electromagnetic Compatibility is the avoidance of interference between two pieces of electronic equipment.
Cause of interference in electronic equipment ▪ Field strength of the transmitter ▪ Spurious radiation from the transmitter ▪ Undesired influence on the equipment: • via the antenna input • via other connected lines • by direct radiation ▪ Cross modulation and intermodulation ▪ Over modulation, splatter, key clicks ▪ Overdriving linear amplifiers	Spurious radiation from a transmitter could include parasitic radiation, harmonics, unwanted mixer products, splatter, key clicks and spurious emissions. Note that the reasons for receiver interference may include – • lack of selectivity • interference received through the mains power supply • feeder problems Understand bandwidth in relation to interference.
Measures against interference ▪ Measures to prevent and eliminate interference effects: • Filtering • Decoupling • Shielding • Location of antennas ▪ Balanced antenna systems and antenna tuning units ▪ Drive levels in linear amplifiers ▪ Operating frequency – ensuring that no part of a transmitted signal is outside band limits [respective implications for USB and LSB transmissions]	Candidates should be familiar with typical filter circuits – low pass, high pass, band pass and band reject – as well as their uses. Measure against interference would include the use of coaxial stubs and toroids. In relation to linear amplifiers, note the importance of correct drive levels and understand the consequences of incorrect drive levels.

A.4 Safety (4 questions)

Syllabus	Notes for Candidates
▪ The human body – • electric shock risks and dealing with the consequences of an electric shock • dangers of exposure to electromagnetic radiation, including hazards from antennas and waveguides • safe working conditions ▪ Minimising risks from the mains power supply, including: • the correct wiring of mains plugs • fuses and appropriate fuse ratings • isolating transformers • correct earthing procedure • use of trip switches such as Residual Current Devices (RCDs) or Earth Leakage Circuit Breakers (ELCBs) ▪ Additional precautions needed where high voltages are present ▪ Lightning protection ▪ Location of antennas ▪ Non-ionising radiation: • Sources • Health Risks • Methods of minimising adverse effects ▪ Battery safety	Note that there is a regulatory requirement for radio amateurs to ensure that "…the safety of persons or property is not endangered …" Safe working conditions would include – • when soldering, the requirement for good ventilation and suitable eye protection • use of secure positioning when drilling, sawing or filing In relation to high voltages, note – • the use of bleeder resistors and the discharge of smoothing capacitors • valves used in transmitters / amplifiers may have voltages in excess of 1kV • access needs to be strictly controlled • tools used to measure high voltages should be checked regularly In relation to the location of antennas and feeders, the issues would include – • keeping non-ionising radiation within permitted limits • protecting against damage to persons or property • guarding against RF burns • position of overhead power lines

B.1 Electrical and Electronic Principles including Components and Circuits (8 questions)

Syllabus	Notes for Candidates
DC, Resistors and Ohm's Law ▪ Meaning of the terms voltage, current, resistance and power, the units used to measure them and the relationship between them ▪ Ohm's Law and its various formulations ▪ Symbols used for the units (V, I, R, W, Ω, kΩ, MΩ etc.) ▪ Resistors in series and in parallel, including a combination of series and parallel resistors – current, voltage and power in these circuits ▪ Resistor accuracy and its impact on voltage, current and power ▪ Power dissipation ▪ Conductors, semi-conductors and insulators	A knowledge of Ohm's Law is essential, however it is equally important to have an intuitive understanding of what happens when resistors are put in series and in parallel. While simple maths may be needed to answer some questions, the "intuitive understanding" referred to above is just as important as mathematical ability. Note that resistors determine both the current flow and the voltage drop.
Inductors ▪ Units (µH, mH etc.) and symbols ▪ Calculations involving series and parallel inductors ▪ The effect of number of turns, diameter, length and core material on inductance (qualitative treatment only) ▪ Inductance and inductive reactance ▪ Impedance	As in the case of Ohm's Law, the intuitive understanding of how inductors perform in practical circuits is as important as their behaviour in a mathematical sense. Only a general understanding of the effect on inductance of different physical characteristics (number of turns etc.) of inductors is expected. An understanding of the concept of reactance is more important than an ability to calculate the reactance of a component at a given frequency.
Capacitors ▪ Units (µF, pF etc.) and symbols ▪ Calculations involving series and parallel capacitors ▪ The relationship between dimensions, capacitance and dielectric (qualitative treatment only) ▪ Capacitance and capacitive reactance	A clear understanding of capacitors / capacitance and their function in electronic circuits is essential. Note that, as in the case of inductors, only a qualitative treatment of the effect of different physical characteristics is expected. Also, see the comment on inductors in relation to reactance.
Impedance, Resonance and Reactance ▪ Meaning of impedance, resonance and reactance ▪ Calculation of impedance of an inductor from resistance and reactance ▪ How reactance of an inductor and a capacitor varies with frequency ▪ Parallel and series resonant circuits ▪ Q-factor	These topics are in effect an extension of the sections on inductors and capacitors. While candidates will not be expected to calculate the resonant frequency of a circuit, they do need to understand how the current flow in parallel and series resonant circuits will vary as the frequency varies. An understanding of the consequences for a circuit of a high or low Q-factor is expected.

B.1 Electrical and Electronic Principles including Components and Circuits (cont'd)

Syllabus	Notes for Candidates
Other Components ▪ Diodes: silicon, zener, LED and varicap ▪ Transistors: NPN, PNP, FET ▪ Transformers: isolation, step-up, step-down; turns ratio, current ratio and voltage ratio ▪ Quartz crystals ▪ Batteries ▪ Component symbols	An understanding of the purpose and the behaviour (e.g. rectification, Peak Inverse Voltage (PIV), voltage drop, amplification) of these components is required. An understanding of the effect of both series and parallel connection of batteries would be expected
Circuits ▪ Circuits and output waveforms of full-wave, half-wave and bridge rectifier power supplies, including smoothing and voltage regulation ▪ Recognise common-emitter, common-collector/emitter-follower, common-base circuits ▪ Class A, B, A/B and C biasing	Candidates need to be generally familiar with what these simple circuits look like and their principal characteristics. In relation to biasing circuits, the key differences between the various types are in efficiency and harmonic output.
Alternating Current ▪ The unit (hertz), frequency, period, duration of period and amplitude ▪ Sine waves and square waves ▪ Ohm's Law in inductors and capacitors ▪ Relationship between peak, peak-to-peak, average and RMS value of sine waves ▪ Harmonics ▪ Phase, phase difference, phase lag and lead	A good general understanding of what is involved in alternating current (AC) is needed. Candidates should understand what a graphic representation of AC in time would look like. An understanding of how reactance is dealt with is required. A basic understanding of phasing concepts is all that is required.
Miscellaneous ▪ Amplifier gains, expressed in dB, for the following values: 0dB, 3dB, 6dB, 10dB and 20dB [both positive and negative] ▪ Digital Signal Processing (DSP): • purpose / benefits • basic block diagram • importance of sampling rate ▪ LC (i.e. coil/capacitor) oscillators and crystal oscillators	Candidates should be aware that DSP is used to filter noise and audio in receivers and to synthesize signals in transmitters. Candidates should be able to recognise LC and crystal oscillator circuits and be aware of the typical usage, advantages and disadvantages of each type.

B.2 Transmitters and Receivers (6 questions)

Syllabus	Notes for Candidates
Transmitters (modes: CW, SSB, AM, FM) ▪ Generic HF station and transmitters for each mode: block diagrams and principal function of each stage ▪ Content of transmitted signals for each mode and implications for power amplifier duty cycle and rating ▪ Effect of audio modulation, where applicable ▪ Typical RF bandwidth of signals in each mode ▪ Methods of achieving frequency stability ▪ FM: modulation index, deviation, calculating total bandwidth ▪ Amplifiers including linear amplifiers and their uses ▪ Calculation of ERP (dBW) from output power (Watts), antenna gain (dB), feeder loss (dB) ▪ Purpose of ALC ▪ Output impedance	It is important to understand both the function and position (within the block diagram) of stages such as the variable frequency oscillator (VFO), buffer, driver, amplifier, balanced modulator, crystal filter, mixer, frequency multiplier, SWR meter, low pass filter, dummy load. Note that the desired transmitting frequency is often produced by mixing together the output from two or more frequency sources, and how unwanted frequencies may be produced. A broad understanding is needed of the nature of the output signal from CW, SSB, AM and FM transmissions. Note also that the modulating signal may be analogue or digital; in the case of digital signals which are continuous, note the particular need to be conscious of drive levels and transmitter ratings. A broad understanding is needed of the function and operation of linear amplifiers (including valve amplifiers). Candidates need to understand that some transmitters and most amplifiers use valves, which may have voltages in excess of 1kV applied (note the "high voltages" reference in Syllabus Section A.4 Safety)
Receivers (modes: CW, SSB, AM, FM) ▪ The superheterodyne receiver: block diagram and principal function of each stage ▪ Achieving selectivity and sensitivity ▪ Uses of the IF, BFO, AGC, CIO ▪ Image frequency / image response / high and low intermediate frequencies ▪ Typical filter bandwidths for each mode ▪ Crystal filter shape factor [ratio between the 6dB and 60db bandwidth and its effect on selectivity] ▪ Minimum discernable signal and dynamic range [basic understanding of concepts] ▪ Signal to noise ratio [basic understanding of concepts] ▪ Transverters	Candidates should understand the principles behind the design of superheterodyne receivers, along with an awareness of the function and position within the block diagram of the main (block) stages. The receiver components of interest would include the RF pre-amplifier, mixer, local oscillator, intermediate frequency (IF) amplifier, detector, beat frequency oscillator (BFO), automatic gain control (AGC), carrier insertion oscillator (CIO). Understand the concepts of selectivity, sensitivity and stability. Candidates should be familiar with the concept of image frequency – the circumstances in which it can appear and methods of minimising the consequences. They should also understand the use of high and low IF frequencies in relation to image response. In relation to transverters, a basic understanding of operation and use is all that is required.

B.3 Feeders and Antennas (7 questions)

Syllabus	Notes for Candidates
Feeders ▪ Feeder types: open-wire (narrow-spaced, wide-spaced), coaxial cable, waveguide ▪ Factors determining characteristic impedance ▪ Velocity factor ▪ Standing waves: causes and consequences ▪ Open and closed stubs ▪ Antenna matching units ▪ Uses and circuit diagrams of baluns	Be aware of the implications of the feeder being matched or mis-matched to the transmitter output. The significance and typical values of feeder velocity factors should be covered. Characteristic impedance and construction of common coaxial and balanced feeders. Stubs (short pieces of feeder wire) can be used for matching antennas but note that the use of stubs also features in the section on Electromagnetic Compatibility and Transmitter Interference.
Antennas ▪ Antenna types: half-wave, quarter-wave vertical (ground plane), folded dipole, trap dipole, Yagi ▪ Physical construction (dimensions, components) ▪ Balanced and unbalanced antennas ▪ Distribution of current and voltage ▪ Impedance at the feed point ▪ Capacitive or inductive reactance of a non-resonant antenna ▪ Polarisation, directivity, efficiency and gain ▪ Effective radiated power (ERP) ▪ Front to back ratio ▪ Horizontal and vertical radiation pattern ▪ Relationship between frequency and wavelength	In order to answer questions on antennas, for each antenna type, candidates should be familiar with (where relevant) – • what the antenna looks like • typical dimensions relative to operating frequency • characteristic impedance • effect of shortening or lengthening the antenna • name and positioning of the parasitic elements • how traps are constructed and their effect • voltage and current patterns • radiation patterns Also understand the concepts of ‘balanced’ and ‘unbalanced’ in relation to antennas and be aware of examples of each type.

B.4 Propagation (6 questions)

Syllabus	Notes for Candidates
▪ Electromagnetic waves – polarisation ▪ Atmospheric regions: troposphere, ionosphere ▪ For the troposphere and individual ionospheric layers: location, influence of the sun, effect on propagation at different frequencies ▪ Solar flares / sunspot cycles ▪ Critical frequency & maximum usable frequency (MUF) ▪ Modes of propagation: ground wave, sky wave (ionospheric wave), tropospheric wave, ducting, refraction, diffraction ▪ Angle of radiation and skip distance ▪ The influence of the height of antennas on the distance that can be covered ▪ Meteor scatter, reflections from the moon ▪ Sporadic E propagation ▪ Impact of distance on field strength for line of sight propagation ▪ Fading	When studying atmospheric regions, consider their effects on LF / HF / VHF propagation, respectively (where and at what times of the day / year are they typically situated, do they absorb or reflect? etc.). Be aware also of typical ranges for single-hop transmissions using the different layers. As regards field strength for line of sight propagation, note that there are two methods of expressing RF field strengths: • Watts per square metre (W/m^2), i.e. "power density". The power density is proportional to the inverse of the square of the distance from the source (e.g. at twice the distance you get a quarter of the power in W/m^2) • Volts per metre (V/m). Using this measurement, the power is proportional simply to the inverse of the distance from the source (e.g. at twice the distance you get half the power in V/m) In relation to fading, a basic understanding of how it occurs is all that is required.

B.5 Measurements (3 questions)

Syllabus	Notes for Candidates
Making Measurements ▪ Measurement of DC and AC (including RF) voltage, current, resistance and power ▪ Ammeter and voltmeter: usage, internal resistance and how to extend their ranges ▪ Transmitter measurements: RF voltage, current and power, PEP (two-tone test), signal quality, spurious signals ▪ DC input power / RF output power / efficiency ▪ Usage and placement of an SWR meter ▪ Resonant frequency of a tuned circuit ▪ Impact of antenna gain and feeder loss on ERP	Because radio amateurs can build and set up their own equipment, they are obliged to be in a position to ensure that their equipment is operated within the permitted frequency bands, at permitted power levels and with appropriate signal quality etc. The ability to use suitable measuring equipment arises from this obligation. Know the efficiency of different classes of amplifiers.
Measuring Instruments ▪ Analogue and digital meters ▪ RF power meter, RMS voltmeter ▪ SWR meter ▪ Frequency measurement instruments ▪ Oscilloscope ▪ Dummy load: usage and construction	Candidates need to know where different measuring instruments should be placed in circuits – whether in series or in parallel with the current flow, at the circuit input or output etc. In relation to an oscilloscope, note in particular what is shown on the X and Y axis, respectively.

This Annex forms part of the Syllabus

Principal national call sign prefixes – Europe and North America

European countries / entities	
OE	Austria
ON	Belgium
LZ	Bulgaria
9A	Croatia
5B	Cyprus
OK	Czech Republic
OZ	Denmark
ES	Estonia
OH	Finland
F	France
DL	Germany
SV	Greece
HA	Hungary
TF	Iceland
EI	Ireland
I	Italy
YL	Latvia
LY	Lithuania
LX	Luxembourg
9H	Malta
PA	Netherlands
LA	Norway
SP	Poland
CT	Portugal
YO	Romania
UA	Russia
OM	Slovakia
S5	Slovenia

European countries / entities (cont'd)	
EA	Spain
SM	Sweden
HB	Switzerland
UR	Ukraine
G & M	England
GM & MM	Scotland
GW & MW	Wales
GI & MI	Northern Ireland
GD & MD	Isle of Man
GJ & MJ	Jersey
GU & MU	Guernsey

North America	
K, N, W	USA
VE	Canada

Note: Many other call sign prefixes are allocated to these countries and entities, however those listed here are the prefixes which exam candidates should be familiar with.

This Annex forms part of the Syllabus

Q-codes

Code	Question	Answer
QRK	What is the readability of my signals?	The readability of your signals is ...
QRM	Are you being interfered with?	I am being interfered with
QRN	Are you troubled by static?	I am troubled by static
QRO	Shall I increase transmitter power?	Increase transmitter power
QRP	Shall I decrease transmitter power?	Decrease transmitter power
QRT	Shall I stop sending?	Stop sending
QRZ	Who is calling me?	You are being called by ...
QRV	Are you ready?	I am ready
QSB	Are my signals fading?	Your signals are fading
QSL	Can you acknowledge receipt?	I am acknowledging receipt
QSO	Can you communicate with ... direct?	I can communicate ... direct
QSY	Shall I change to transmission on another frequency?	Change transmission to another frequency
QRX	When will you call again?	I will call you again at ... hours on ... kHz (or MHz)
QTH	What is your position in latitude and longitude (or according to any other indication)?	My position is ... latitude, ... longitude (or according to any other indication)

Operational Abbreviations

BK Signal used to interrupt a transmission in progress

CQ General call to all stations

CW Continuous wave

DE From, used to separate the call sign of the station called from that of the calling station

K Invitation to transmit

MSG Message

PSE Please

RST Readability, signal-strength, tone-report

R Received

RX Receiver

TX Transmitter

UR Your

This Annex forms part of the Syllabus

Phonetic Alphabet

A = Alpha	**J** = Juliett	**S** = Sierra
B = Bravo	**K** = Kilo	**T** = Tango
C = Charlie	**L** = Lima	**U** = Uniform
D = Delta	**M**= Mike	**V** = Victor
E = Echo	**N** = November	**W**= Whiskey
F = Foxtrot	**O** = Oscar	**X** = X-ray
G = Golf	**P** = Papa	**Y** = Yankee
H = Hotel	**Q** = Quebec	**Z** = Zulu
I = India	**R** = Romeo	

RST Code

Readability

- **R1** Unreadable
- **R2** Barely readable, occasional words distinguishable
- **R3** Readable with considerable difficulty
- **R4** Readable with practically no difficulty
- **R5** Perfectly readable

Signal Strength

- **S1** Faint signal, barely perceptible
- **S2** Very weak
- **S3** Weak
- **S4** Fair
- **S5** Fairly good
- **S6** Good
- **S7** Moderately strong
- **S8** Strong
- **S9** Very strong signals

Tone

- **T1** Extremely rough hissing note
- **T2** Very rough AC note, no trace of musicality
- **T3** Rough AC. tone, rectified but not filtered
- **T4** Rough note, some trace of filtering
- **T5** Filtered rectified AC but strongly ripple-modulated
- **T6** Filtered tone, definite trace of ripple modulation
- **T7** Near pure tone, trace of ripple modulation
- **T8** Near perfect tone, slight trace of modulation
- **T9** Perfect tone, no trace of ripple or modulation of any kind

This Annex does not form part of the Syllabus

Amateur radio licence examination and the ITU Radio Regulations

The International Telecommunication Union (ITU) Radio Regulations govern the legal and technical requirements of all users of radio frequencies, whether they be government, commercial, amateur or any other group.

For the purposes of the regulatory part of the amateur radio licence examination, candidates should note in particular the following points from the Radio Regulations:

1. **Definition of the amateur service (i.e. purpose):** A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest.

2. **Emission Designations:** These have a minimum of 3 characters, showing:
   1: Type of modulation **2:** Nature of modulating signal **3:** Type of information transmitted
   For purposes of the examination, the following emission designations should be known:

   A1A = CW (Morse, on/off keying of the carrier)
   F3E = FM (frequency modulation, speech)
   J3E = SSB (single sideband, suppressed carrier, speech)
   F1B, F2B, J2B = RTTY / AMTOR
   A3E = AM (amplitude modulation, speech)
   F1D, F2D, J2D = Packet / Data

3. **Permitted Communications:**
   - Radiocommunication between amateur stations of different countries shall be permitted unless the administration of one of the countries concerned has notified that it objects to such radiocommunications.
   - Transmissions between amateur stations of different countries shall be limited to communications incidental to the purposes of the amateur service and to remarks of a personal character.
   - Transmissions between amateur stations of different countries shall not be encoded for the purpose of obscuring their meaning, except for control signals exchanged between earth command stations and space stations in the amateur-satellite service.
   - Amateur stations may be used for transmitting international communications on behalf of third parties only in case of emergencies or disaster relief. An administration may determine the applicability of this provision to amateur stations under its jurisdiction

4. **Use of call signs:** During the course of their transmissions, amateur stations shall transmit their call sign at short intervals.

5. **Secondary allocations:** Stations of a secondary service:
   a) shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date
   b) cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date

6. **Composition of call signs:** There are complex rules and provisions for exceptions, however for practical purposes a normal amateur radio call sign will generally consist of:
   i) one or two characters identifying the nationality of the operator (at least one character will be a letter : letter-number, number-letter or letter-letter combination is possible)
   ii) a single digit (i.e. a number)
   iii) a group of not more than four characters, the last of which must be a letter.

Sample Paper

Amateur Radio Licence Examination

(in accordance with T/R 61-02 to the HAREC Standard)

60 Questions – Duration Two Hours

Read the following notes BEFORE you answer any questions:

1. FOUR possible answers are shown for each question – 'A', 'B', 'C' and 'D'. Only ONE is correct. Decide which one is correct and mark your answer by ticking the appropriate box on the answer sheet.
2. There may be other possible answers to the questions, however the choice of the correct answer from the options given is required.
3. You may only tick ONE BOX to indicate 'A', 'B', 'C' or 'D' as your answer.
4. If you make a mistake or change your mind having ticked one of the boxes, then clearly shade out the box you initially ticked, and tick the box indicating the answer you wish to give:

   This box is ticked (i.e. *this is my answer*): [√] or [/] or [x]

   This box is shaded (i.e. *I have changed my mind, this is <u>not</u> my answer*): [■]

5. Remember it is vitally important that your answer sheet shows unambiguously which ONE answer you have selected and/ or if you have cancelled an answer (by shading out a box). If there is any ambiguity – e.g. if it is not clear which ONE box has been ticked – then the answer will be disallowed.
6. Any calculations or rough work can be done on the question sheet or on the "Calculations & Comments" page at the end of the paper. You may need a calculator to answer some of the questions – a suitable non-programmable calculator will be provided.
7. You should attempt all questions; note that 'negative marking' is <u>not</u> used in this examination. If you find a question difficult, leave it and return to it later.
8. The paper, with your answers, must be handed in at the end of the examination. The paper cannot be removed from the examination centre, even if you decide not to proceed with the examination.
9. The pass mark is 60% and a pass is required in each of the two main sections of the paper, Section A and Section B.
10. If you have any comments on the examination or the questions, please include them in the 'Calculations & Comments' section at the end of the paper.

Put your details here:

Name (PRINT):	
Candidate Number:	
Examination Venue:	
Examination Date:	
Your Signature:	

Section A
Amateur Radio Regulations and Related Topics

Licensing Conditions (9 Questions)

1. According to ITU Regulations, radiocommunications between amateur stations of two different countries is permitted:

A [ ] Only when a reciprocal agreement permitting such transmissions is in place between the two countries

B [ ] Unless the administration of one of the countries concerned has notified that it objects to such radiocommunications

C [ ] If the two countries are members of the IARU

D [ ] If the two countries are members of the ITU

---

2. A CEPT Class 1 amateur radio licence entitles the holder to:

A [ ] Broadcast on the amateur radio frequency bands

B [ ] Broadcast to the general public, subject to the frequency and power limits specified in the licence

C [ ] Establish communications on amateur radio frequencies with other amateur radio stations

D [ ] Establish communications with anyone on the amateur radio frequency bands

---

3. The authorised frequency range in the "40 metre band" is:

A [ ] 7.000 to 7.100 MHz

B [ ] 7.000 to 7.200 MHz

C [ ] 7.000 to 7.268 MHz

D [ ] 7.000 to 7.300 MHz

4. Which one of these frequencies is not on the list of frequencies which radio amateurs are authorised to use?

A [ ] 3.750 MHz

B [ ] 14.400 MHz

C [ ] 24.900 MHz

D [ ] 431 MHz

---

5. The maximum power permitted when operating MOBILE on 70.200 MHz is:

A [ ] 200W (23 dBW)

B [ ] 100W (20 dBW)

C [ ] 50W (17 dBW)

D [ ] 25W (14 dBW)

---

6. The station logbook must include:

A [ ] Power level used

B [ ] Details of the antenna used

C [ ] Location of stations contacted

D [ ] Signal reports sent and received

---

7. The call sign **M/EI8XYZ** would be used by:

A [ ] An English visitor to Ireland who has been issued with a visitor's call sign

B [ ] The holder of **EI8XYZ** while on a visit to England

C [ ] The holder of **EI8XYZ** while operating mobile in Ireland

D [ ] The holder of **EI8XYZ** while operating mobile in Northern Ireland

Section A
Amateur Radio Regulations and Related Topics

8. Radio amateurs have a "Secondary" allocation in which one of these frequency ranges?

A [ ] 18.068 to 18.168 MHz

B [ ] 21.000 to 21.450 MHz

C [ ] 50.000 to 52.000 MHz

D [ ] 144.000 to 146.000 MHz

---

9. J3E is the ITU emission designation for:

A [ ] Single sideband, suppressed carrier, speech

B [ ] RTTY / AMTOR

C [ ] CW (Morse)

D [ ] Frequency modulation

Operating Rules and Procedures (10 Questions)

10. In order to comply with the IARU Region 1 Band Plan, the lowest dial setting for LSB (voice) transmissions on the 1.8 MHz band should be:

A [ ] 1807 kHz

B [ ] 1837 kHz

C [ ] 1843 kHz

D [ ] 1903 kHz

---

11. Under the IARU Region 1 Band Plan, which mode(s) may be used in the frequency range 14.000 – 14.060 MHz:

A [ ] All modes

B [ ] CW

C [ ] CW and digimodes

D [ ] SSB (however, no contests)

12. In the Q Code, QRZ? means:

A [ ] Are you operating on low power?

B [ ] Who is calling me?

C [ ] Are my signals fading?

D [ ] Can you change frequency?

---

13. The call sign of a radio amateur in Ukraine might have the prefix:

A [ ] UA

B [ ] PA

C [ ] UR

D [ ] 9A

---

14. Which of these complies with the ITU Radio Regulations for a normal amateur radio call sign?

A [ ] EJ6

B [ ] 6EGJ

C [ ] 2E6J

D [ ] 2EJ6

---

15. A signal strength report of "33" would mean:

A [ ] Unreadable, very weak signal

B [ ] Strong signal, readable with no difficulty

C [ ] Perfectly readable, very strong signals

D [ ] Readable with considerable difficulty, weak signal strength

---

16. The IARU Region 1 Band Plan gives priority for intercontinental operation in the segment:

A [ ] 3600 to 3625 kHz

B [ ] 3675 to 3700 kHz

C [ ] 3725 to 3750 kHz

D [ ] 3775 to 3800 kHz

Section A
Amateur Radio Regulations and Related Topics

17. The Morse Code message "**CQ CQ DE EI3XYZ K**" indicates that:

A [ ] EI3XYZ has put out a general call for a contact

B [ ] Someone is calling EI3XYZ

C [ ] EI3XYZ is giving a signal report

D [ ] EI3XYZ is making a test transmission and should not be answered

---

18. Under the IARU HF Band Plan, contests are not permitted on which amateur band?

A [ ] 14 MHz

B [ ] 18 MHz

C [ ] 21 MHz

D [ ] 28 MHz

---

19. The call sign NK3GR in the phonetic alphabet would be correctly spoken as:

A [ ] November-Kilo-Three-Golf-Romeo

B [ ] November-Kilowatt-Three-George-Radio

C [ ] Nancy-Kilowatt-Three-Golf-Romeo

D [ ] November-Kilo-Three-George-Romeo

Electromagnetic Compatibility and Transmitter Interference (7 Questions)

20. The inclusion of a 1:1 balun between the elements of a balanced antenna and the coaxial feeder is often recommended in order to:

A [ ] Prevent the outer braid of the coaxial feeder from radiating

B [ ] Resonate the antenna

C [ ] Improve impedance matching

D [ ] Eliminate sub-harmonics of the transmitted signal

21. Harmonics from a transmitter operating at 70 MHz are causing interference to a television receiver tuned to 210 MHz. Which component fitted to the transmitter's antenna lead is likely to be best suited to deal with this problem?

A [ ] An open-circuit coaxial stub (i.e. open at the end) which is an electrical quarter wavelength at 70 MHz

B [ ] A closed-circuit coaxial stub (i.e. shorted at the end) which is an electrical quarter wavelength at 70 MHz

C [ ] An open-circuit coaxial stub which is an electrical quarter wavelength at 210 MHz

D [ ] A closed-circuit coaxial stub which is an electrical quarter wavelength at 210 MHz

---

22. Parasitic oscillations could be described as:

A [ ] The principal cause of non-ionising radiation

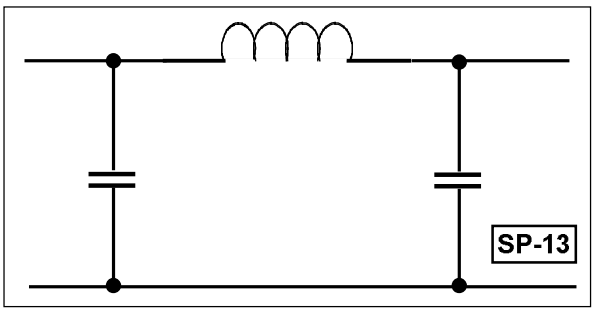
B [ ] High powered harmonics

C [ ] Additional or undesired oscillations

D [ ] Interference due to antenna mis-matches

---

23. The circuit diagram below shows a:



A [ ] Wave trap

B [ ] Low pass filter

C [ ] High pass filter

D [ ] Band stop filter

Section A
Amateur Radio Regulations and Related Topics

24. Intermodulation in a receiver is more likely to be caused by:

A [ ] The mixing of two or more frequencies in some part of the receiver circuitry

B [ ] Lack of sensitivity

C [ ] Absence of mains filtering

D [ ] Excessively low SWR on the antennal feed line

---

25. A band-pass filter:

A [ ] Passes signals at all frequencies

B [ ] Attenuates signals at all frequencies

C [ ] Passes signals between two frequencies

D [ ] Increases the receiver bandwidth

---

26. A neighbour's hi-fi system is suffering radio frequency break-through. A remedy for this might be to:

A [ ] Place a capacitor in series with the transmitter output

B [ ] Put ferrite rings on the hi-fi system's loudspeaker cables

C [ ] Place a ferrite ring on the transmitter output cable

D [ ] Use open wire feeder for the transmitter

Safety (4 Questions)

27. Selecting from the choices below, a mains plug for a power supply which has a power consumption of 500 watts should have a fuse rated at _____ to provide the highest possible level of protection:

A [ ] 1 amp

B [ ] 3 amps

C [ ] 5 amps

D [ ] 13 amps

---

28. The smoothing capacitors in a High Voltage supply for a valve power amplifier need:

A [ ] Large value resistors to discharge the capacitors when switched off

B [ ] Forced air-cooling

C [ ] A heat sink

D [ ] RF decoupling

---

29. When installing a resonant half-wave dipole, in order to keep high voltages away from possible human contact which is the more important consideration?

A [ ] The location of the ends of the dipole

B [ ] The location of the centre of the dipole

C [ ] The location of the low-pass filter

D [ ] All are equally important; the voltages are the same at all points

---

30. To ensure the level of non-ionising radiation from an amateur radio station is within the guideline limits, choosing from the options below, the main focus would be on:

A [ ] The design of the output stages of the final amplifier

B [ ] Filtering at the output stages

C [ ] The design and location of the antenna

D [ ] Minimising parasitic oscillations

Section B
Radio Theory and Related Topics

Electrical and Electronic Principles including Components and Circuits (8 Questions)

31. Which of the following sets of materials are all electrical insulators?

A [ ] Ceramic, Brass, Iron

B [ ] Copper, Glass, Mica

C [ ] Silver, Gold, Iron

D [ ] Glass, Mica, Ceramic

---

32. The Q-factor of a resonant circuit refers to:

A [ ] The resonant frequency

B [ ] 0.707 times the resonant frequency

C [ ] The bandwidth relative to the resonant frequency

D [ ] The square root of the DC resistance of the circuit

---

33. The current flowing through the 27Ω resistor in the circuit below is:

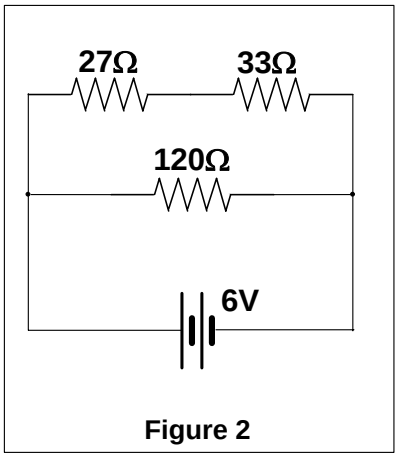


Figure 2

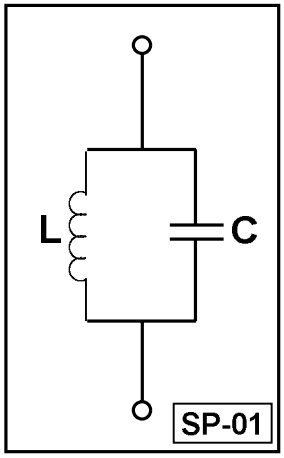
A [ ] 27mA

B [ ] 33mA

C [ ] 60mA

D [ ] 100mA

34. In the circuit below, ignoring component losses:



A [ ] Current at the resonant frequency and below that frequency will be unaffected

B [ ] Current at the resonant frequency will be impeded

C [ ] Current at the resonant frequency will readily pass through

D [ ] Current at the resonant frequency and above that frequency will be unaffected

---

35. A low-pass filter includes an inductor with a value of 3.4µH. Following some tests, it is decided to increase the inductance to 5.1µH. This can be achieved by:

A [ ] Adding a 1.7µH inductor in parallel with the existing inductor

B [ ] Adding a 1.7µH inductor in series with the existing inductor

C [ ] Adding a 8.5µH inductor in parallel with the existing inductor

D [ ] Adding a 8.5µH inductor in series with the existing inductor

Section B
Radio Theory and Related Topics

36. A power supply could use a(n) _____ to provide a regulated output voltage:

A [ ] Zener diode

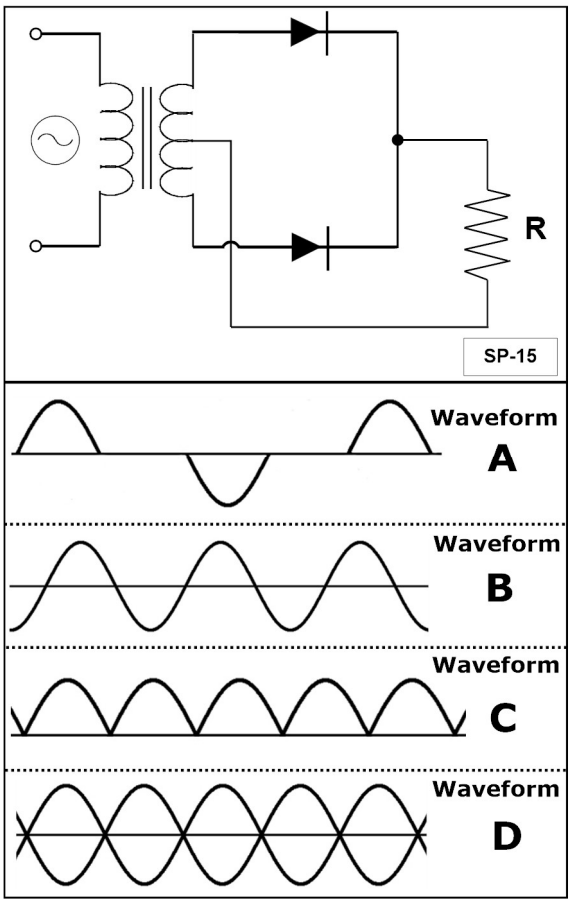
B [ ] Electrolytic capacitor

C [ ] Mica capacitor

D [ ] Quartz crystal

---

37. In the circuit below, the output waveform at resistor R would look like:



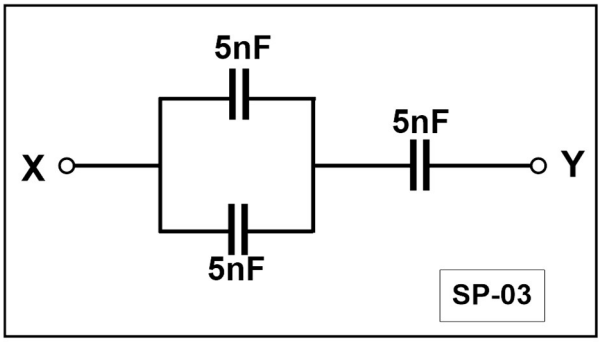
A [ ] Waveform A

B [ ] Waveform B

C [ ] Waveform C

D [ ] Waveform D

38. Each of the capacitors in the circuit below has a value of 5nF. What value would be measured between points X and Y?



A [ ] 3.33nF

B [ ] 5nF

C [ ] 7.5nF

D [ ] 15nF

Transmitters and Receivers (6 Questions)

39. In an SSB receiver the frequencies of the CIO (Carrier Insertion Oscillator) might be:

A [ ] ±1.5 kHz from the intermediate frequency

B [ ] Approximately 3 kHz and 6 kHz

C [ ] Approximately 6 kHz and 10 kHz

D [ ] 455 kHz and 10.7 MHz

---

40. All other things being equal, SSB transmissions:

A [ ] Occupy about twice the bandwidth of AM transmissions

B [ ] Contain more information than AM transmissions

C [ ] Occupy the same bandwidth as CW transmissions

D [ ] Occupy about half the bandwidth of AM transmissions

Section B
Radio Theory and Related Topics

41. The sensitivity of a receiver refers to:

A [ ] The bandwidth of the RF preamplifier

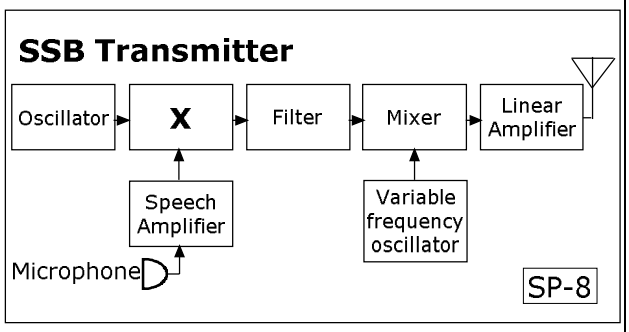
B [ ] The stability of the oscillator

C [ ] Its ability to receive weak signals

D [ ] Its ability to reject strong signals

---

42. The block diagram below shows an SSB transmitter. What is the component marked "X" most likely to be?



A [ ] SWR meter

B [ ] Balanced modulator

C [ ] Low pass filter

D [ ] Frequency multiplier

---

43. The total bandwidth of an FM audio transmission is equivalent to:

A [ ] Twice the highest audio frequency

B [ ] Twice the sum of the peak deviation frequency and the highest audio frequency

C [ ] The peak deviation frequency

D [ ] Twice the peak deviation frequency

---

44. The advantage of a high IF (intermediate frequency) in a superhet receiver is better:

A [ ] Selectivity

B [ ] Image rejection

C [ ] Frequency stability

D [ ] Impedance matching

Feeders and Antennas (7 Questions)

45. The characteristic impedance of coaxial cable typically used as an antenna feeder could be:

A [ ] < 1Ω

B [ ] 50Ω

C [ ] 600Ω

D [ ] 1kΩ

---

46. If an antenna feeder must pass near grounded metal objects, the following type of feed line should be used:

A [ ] Narrow-spaced open wire

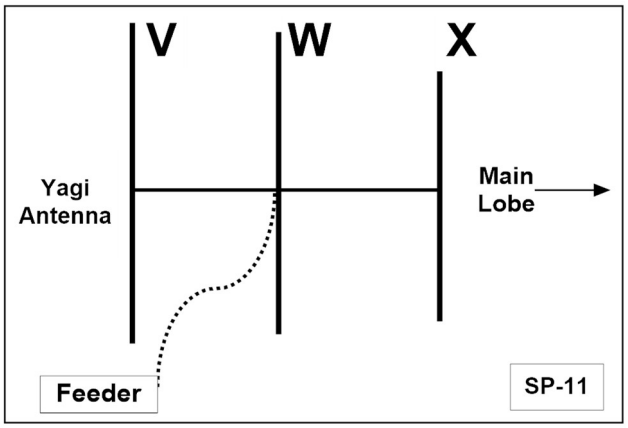
B [ ] Wide-spaced open wire

C [ ] Twisted lead

D [ ] Coaxial cable

---

47. In the diagram below, item X corresponds to the:



A [ ] Boom

B [ ] Driven element

C [ ] Director

D [ ] Reflector

Section B
Radio Theory and Related Topics

48. The impedance of an electrical quarter-wavelength transmission line shorted at the end will be:

A [ ] Zero

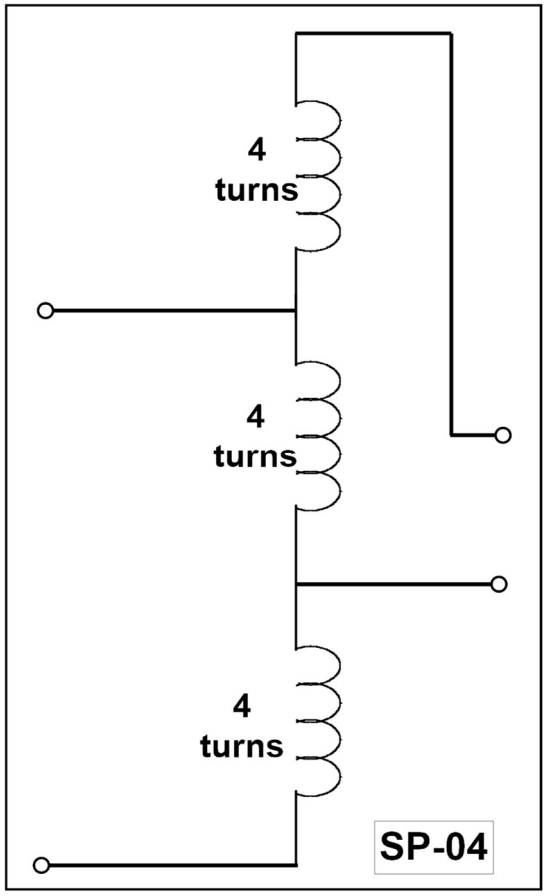
B [ ] Very low

C [ ] Equal to the impedance of the transmission line

D [ ] Very high

---

49. The circuit diagram below represents:



A [ ] A 1:1 balun

B [ ] An isolation transformer

C [ ] A resonant filter

D [ ] A 4:1 balun

50. A half-wave dipole antenna with 20 metres of wire each side of a centre insulator will be resonant at approximately:

A [ ] 3600 kHz

B [ ] 7050 kHz

C [ ] 10150 kHz

D [ ] 14200 kHz

---

51. A dipole antenna is found to be resonant on 7100 kHz. Which of the following should be tried in order to increase the resonant frequency of the dipole to 7150 kHz?

A [ ] Reduce the length of each side of the antenna

B [ ] Increase the length of each side of the antenna

C [ ] Adjust the antenna tuning unit

D [ ] Add a band-pass filter, tuned to 7150 kHz, to the antenna feed line

---

Propagation (6 Questions)

52. Radio communication between Ireland and Australia on the 2 metre band is sometimes possible by reflecting the signals off the:

A [ ] D-layer (or " D region")

B [ ] F-layer

C [ ] Moon

D [ ] Troposphere

---

53. The 160 metre band is not usually used for long-distance communication during daylight hours because:

A [ ] The Sun ionises the F-layer

B [ ] The signal is absorbed by the D-layer (or " D region")

C [ ] The signal is absorbed by the E-layer

D [ ] The signal is absorbed by the F-layer

Section B
Radio Theory and Related Topics

54. The factor least likely to affect the single-hop sky wave skip distance of a HF transmission is the:

A [ ] Frequency of the transmission

B [ ] Mode of transmission

C [ ] Angle of radiation

D [ ] Height of the ionospheric layer reflecting the transmission

---

55. Two amateur radio stations that are four kilometres apart and separated by a low hill blocking their line-of-sight path are communicating on the 160 metre band. What type of propagation is probably being used?

A [ ] Ground wave

B [ ] Tropospheric ducting

C [ ] Ionospheric propagation

D [ ] Sporadic E

---

56. The highest frequency above which a radio signal directed vertically upwards is not returned to ground is called:

A [ ] The critical frequency

B [ ] The maximum usable frequency

C [ ] The optimum traffic frequency

D [ ] The standard frequency

---

57. The F-layer will normally be found at a height of approximately:

A [ ] 50 to 100 kilometres

B [ ] 200 to 400 kilometres

C [ ] 1,000 to 2,000 kilometres

D [ ] 3,000 to 4,000 kilometres

Measurements (3 Questions)

58. An oscilloscope is being used to analyse the output signals from a transmitter. The y-axis (vertical axis) will represent:

A [ ] The signal frequency

B [ ] The audio frequency

C [ ] The intermediate frequency

D [ ] The signal voltage

---

59. The range of an analogue meter used to measure DC voltage would be extended by placing a(n):

A [ ] Capacitor in series with the meter

B [ ] Inductor across the meter terminals

C [ ] Resistor in series with the meter

D [ ] Resistor across the meter terminals

---

60. One way to establish SWR could be to measure:

A [ ] Frequency deviation

B [ ] Forward and reverse voltages

C [ ] Antenna polarisation

D [ ] The velocity factor of the feed line

Calculations & Comments

Use the space below for your calculations or comments
This page does not count for the examination results

Sample Paper Answers

Question Number	Answer
1	B
2	C
3	B
4	B
5	D
6	A
7	B
8	C
9	A
10	C
11	B
12	B
13	C
14	C
15	D
16	D
17	A
18	B
19	A
20	A
21	C
22	C
23	B
24	A
25	C
26	B
27	B
28	A
29	A
30	C

Question Number	Answer
31	D
32	C
33	D
34	B
35	B
36	A
37	C
38	A
39	A
40	D
41	C
42	B
43	B
44	B
45	B
46	D
47	C
48	D
49	A
50	A
51	A
52	C
53	B
54	B
55	A
56	A
57	B
58	D
59	C
60	B

Radio Experimenter Examination

A record number of candidates sat the recent Radio Experimenter Examination in centres in Dublin and Carrigtwohill, Co. Cork. Twenty candidates sat the exam in the ComReg offices in Dublin while twenty-five turned up for the exam in the Carrigtwohill Community Centre. The exam was held on the same day and time in both centres and all candidates sat the same paper. The total number of candidates presenting, at forty-five, was the largest number sitting the Radio Experimenter Examination since it was taken over by IRTS in 2005 and brings to 111 the total number who have taken the exam in that period.

The results of the recent exam, which have now been communicated to all candidates, show twenty-three passes from forty-five candidates. This represents a pass rate of 51% and is somewhat lower than the pass rate in previous exams, which tended to hover between 60% and 70%. The Exam Board has expressed disappointment at the drop in the success rate and has expressed the hope that future examinations will see a return to a higher percentage of passes. Incidentally, of those who failed, seven candidates failed all three sections, twelve failed two sections, while three failed in just one section. If the seven candidates who failed all three sections are discounted, the pass rate would have been 64%

Most European countries (and quite a few outside Europe) either belong to or are associated with the CEPT organisation and subscribe to the HAREC syllabus. HAREC (Harmonised Amateur Radio Examination Certificate) is the standard syllabus that now operates in all those countries. As a member of CEPT, Ireland is party to all the benefits and responsibilities associated with HAREC. Irish amateurs are entitled to operate on the strength of their Irish licences in many parts of the world, and indeed are also entitled to be issued with a local licence if they go to live in another HAREC country. Similarly, amateurs from CEPT member or subscribing countries are entitled to come and operate freely here. The key to all this is the HAREC syllabus and standards. To retain our privileges abroad, our examinations must continue to be operated to HAREC standards and HAREC means that anybody aspiring to an Irish Experimenter licence must show a minimum level of competency in technical knowledge and operating standards.

An analysis of the answers to the questions in the recent examination would seem to indicate that while many of the candidates had prepared diligently and had reasonable prospects of reaching the pass mark, others had only a vague knowledge of the subject and were trusting to luck to get them through. Unfortunately, for this latter group, they are unlikely to get by on luck alone, and need to do further study before they sit the examination again.

IRTS proposed to ComReg that all candidates would be given details of the marks they achieved in each Section of the examination. ComReg readily agreed to this proposal and each candidate now knows where he or she has performed well and, more importantly, where he or she was deficient. Congratulations to those who passed. Others did not pass but were reasonably close to the pass marks, and with some effort should have no difficulty getting through on the next attempt. To those we say “don’t give up, you’re nearly there”. To those who now know that they are well below the standard required, there can only be a plea to make a serious attempt to do some study before tackling the examination again.

In analysing the answer papers, some surprising situations emerge. Because the examination is in three sections and a pass is required in each section, difficulties occur where a candidate is strong in, say, the technical sections but weak in the Rules and Operating Procedures section. It has been said before that it is very important for every experimenter, or aspiring experimenter, to know the Rules and Regulations. That advice still holds! For example, a question on the frequency range of one of the popular HF bands was very poorly answered, as was a question on the permitted modes in a section of Top Band. Most candidates were unable to identify the main prefix used by radio amateurs in one of our European neighbours, while quite a few failed to identify the ITU emission designation for one of the principal modes used by radio amateurs.

In the Theory Section, the Ohms Law questions were answered well, as were those related to resistance etc. The paper had two questions that required a knowledge of amplifier classes. Both were poorly answered, as was a question on keying a CW transmitter. Candidates displayed a reasonable knowledge of Feeders and Antennas but had considerable difficulty with one of the Propagation questions, with many candidates confusing "critical frequency" with "maximum usable frequency". In general, questions accompanied by circuit or other diagrams were rather poorly answered, but the phonetic alphabet was universally known and the fact that almost everybody knew what to do in the event of a nearby thunderstorm was very reassuring!

The lessons to be learnt from the June 2007 Examination are as follows:

1. A superficial general knowledge of Radio Theory is not enough.
2. Technical Knowledge without the Rules and Regulations won't get you through.
3. Time spent listening on the bands is very valuable and
4. If at first you fail, do some further study and try again. It's well worth it!

IRTS Examinations Board, July 2007

Notes:

- This report was first published in the July-August 2007 issue of Echo Ireland
- The examination is now (in 2014) in two parts

Amateur Radio Licence Examination Report

The most recent Amateur Radio Licence Examination was held in July 2010 at two centres – Limerick and Dublin. Twenty-one candidates sat the examination, twelve of whom were successful.

In this report we highlight some of the topics that seemed to cause difficulty for candidates. Bear in mind, of course, that the examination questions can cover any of the topics in the syllabus. The document "Studying for the Amateur Radio Examination" (which can be found at **www.irts.ie/downloads**) includes a copy of the HAREC (Harmonised Amateur Radio Examination Certificate) syllabus to be used up to the end of 2010; examinations held in 2011 onwards will be based on a revised HAREC-standard syllabus – see **www.irts.ie/syllabus** for more about the revised syllabus.

Those familiar with the examination will be aware that it consists of 60 multiple-choice questions, divided over three sections, each of which must be passed in order to gain an overall pass. The pass mark for each section is 60%.

Section A – Elementary Theory of Radiocommunications (35 questions)
An amateur radio licence entitles the holder to transmit using home-constructed equipment, so part of the licence examination is designed to test candidates knowledge of basic electrical and electronic principles including components, simple circuits, transmitters and receivers. Questions in this section also cover feeders, antennas, propagation and measurements. For those without a technical background, this part of an amateur radio licence course may seem daunting. However, the level of technical knowledge expected is, indeed, "elementary"; furthermore, in the few questions that involve arithmetical calculations, only very basic maths is needed to identify the correct answer from the four choices given.

While some candidates clearly had little or no difficulty with this section – two answered all 35 questions correctly and many more had just a few incorrect answers – other candidates seemed to struggle with some of the most basic concepts dealt with in the questions; for example there was confusion between the meaning of volts and amps, some candidates were unable to identify the correct total capacitance in a circuit involving just 3 capacitors, some did not know that the value of an inductor could be measured in microhenrys, nor could they identify the correct option for increasing the inductance of a coil.

The questions on transmitters and receivers require a broad understanding of the architecture of transmitters and receivers. Looking at the answers given in the recent exam, this was one of the areas that candidates could usefully spend more time on: they need to have a good understanding of the purpose of the basic building blocks of transmitters and receivers and their interrelationships, i.e. what is going on in each of the building blocks (VFO, mixer, BFO etc.) and what it is contributing to the transmitter or receiver.

The second half of Section A is devoted to the more practical topics of feeders, antennas, propagation and measurements. The standard of answering here was better than in the earlier parts, although we were somewhat surprised at the number of incorrect answers given for questions on areas that we would expect prospective radio amateurs to be familiar with, such as:

- how to increase the resonant frequency of a dipole antenna
- how to achieve the furthest possible skip distance
- measuring current drawn from a power supply

The easiest and most enjoyable way of preparing for questions such as these is to gain some practical experience of setting up and operating an amateur radio station in a club or similar environment.

Section B – National and International Rules and Operating Procedures (15 questions)
Radio amateurs potentially have access to more than 20 frequency bands spanning the entire radio spectrum. When you think of the other services that use radio signals – broadcast stations, marine and air navigation and safety, satellites, GPS and mobile phones, to name but a few – you can see why radio amateurs, like all others licensed to transmit radio signals, must abide by certain rules.

Section B of the examination covers the Irish regulations contained in published ComReg documents along with international regulations relating to amateur radio published by the ITU and CEPT, band plans (IARU) and accepted operating procedures such as Q-Codes, operational abbreviations, the phonetic alphabet and distress signals.

While some of the questions in this section were well answered, we were very surprised to discover that more than half of the candidates did not know the frequency range covered by the 10 metre band, and a similar proportion of candidates were unable to correctly identify a contest band from the choices given. Knowing the frequency range of a major amateur band, or knowing where contests are and are not permitted, are key competencies that radio amateurs are expected to have.

Section C – Safety and Electromagnetic Compatibility (10 questions)
While licensed radio amateurs are given the unique privilege of being permitted to construct, install and operate home-constructed radio transmission equipment, to get a licence they must first demonstrate a knowledge of issues around electromagnetic compatibility (EMC); they must also show that they know how to minimise transmitter interference and that they are aware of key safety considerations.

Nearly all candidates passed this section. A question about selecting the most appropriate quarter-wave stub to minimise interference was the only one that was poorly answered by the majority of candidates. Some also had problems identifying the purpose of an earth wire.

Conclusions
Success in the exam leads to a Harmonised Amateur Radio Examination Certificate (HAREC) qualification which entitles the holder to apply for a lifetime Amateur Station Licence and opens the door to full participation in the amateur radio hobby. It's a very worthwhile goal.

To get the HAREC qualification, candidates need to have some technical knowledge and they also need a reasonable understanding of the rules and regulations that apply to amateur radio stations. The point has already been made that practical experience can be an important part of exam preparation. We would particularly encourage those who were unsuccessful in the recent exam to seek out opportunities to participate in setting up and operating an amateur radio station under the supervision of an existing licence holder. This could improve their understanding of the practical aspects of amateur radio such as antennas, propagation, operating practices and band plans. Some home study or class work covering the basics of electricity, electronic components and circuits is also suggested.

IRTS Examinations Board, August 2010

Note: This report was first published in the August 2010 issue of Echo Ireland

Amateur Station Licence Examination Report

The Amateur Station Licence exam has two sections of 30 questions each: the first section deals with amateur radio regulations and related topics while the second section covers the theory side. The pass mark for each section is 60%. Five exams were held in 2012 and 2013, involving 70 candidates, with 49 (70%) being successful.

The majority of candidates sitting the exam in recent years have been studying on their own; unfortunately few clubs are now offering classes for would-be licensees – principally, they say, because there is not enough demand. The ready availability of home-study materials on the web has changed the way people prepare for all types of exams. One weakness in this approach for the amateur station licence exam is that practical experience, which in the past would have been gained in a club environment, is absent for those relying exclusively on home-study: this absence becomes all too clear when it comes to tackling questions about permitted frequencies, operating procedures, country prefixes and band plans.

Like many other hobbies and pastimes, amateur radio is changing; the emphasis on home construction and circuit design is reducing, for various reasons including the fact that sourcing discrete components is becoming increasingly difficult. The majority of radio amateurs are now using commercial transceivers, leaving the experimental side of the hobby to areas such as antenna construction and propagation. The HAREC syllabus, which forms the basis of the topics to be covered in the exam, has not changed significantly in the recent past, however we have been able, with the support of ComReg, to develop a HAREC-standard syllabus that reflects some of the technical and other developments in our hobby. In particular, the syllabus we now use has a strong emphasis on regulatory issues, while on the theory side the focus is on examining how well candidates understand the key concepts and principles behind radio communications.

Moving to the individual topics examined in the five recent exams, we can make a number of specific observations that should be of assistance to prospective candidates for future exams.

Section A – Amateur Radio Regulations and Related Topics

Some of the questions in this section tests the candidates knowledge of parts of ComReg's "Amateur Station Licence Guidelines", of published band plans and of the Radio Regulations relevant to amateur radio. The syllabus identifies specifically which topics may be covered in the exam, and the 'Notes for Candidates' included in the syllabus document elaborates further on these.

It is not surprising that prospective EI licensees are expected to demonstrate familiarity with the fundamental rules, regulations and procedures governing amateur radio, in view of the fact that the radio spectrum that we amateurs use is shared with so many different services, plus the fact that our activities on the bands can often be received many thousands of kilometres away. What is surprising, however, is the number of candidates who seem to approach the exam without a proper grasp of some of the basic rules and procedures – such as the frequency ranges available to radio amateurs, or the band plan provisions about contests, beacons and permitted modes. We must demonstrate that, if licensed, we will know what frequencies we can use, and how amateur activities within the authorised frequency bands are organised.

Studying rules and regulations can be tedious, however this is an area where operating under supervision, such as in a club, can be a great help: we would therefore advise students to seek guidance from the more experienced operators who might be willing to supervise their initial efforts. Experience on the air can very quickly make frequency ranges, country prefixes and band plans seem interesting!

Section A also covers electromagnetic compatibility, transmitter interference and safety, which test some of the more practical aspects of setting up and operating a station. Again, practical

experience can help candidates prepare for these topics. Areas that candidates seem to have some difficulty with include the design and usage of filters, the purpose and placement of fuses, antenna safety and minimising risks from the mains power supply.

Section B – Amateur Radio Theory and Related Topics

The first part of Section B will typically include a few questions that involve calculations with resistors, capacitors or inductors in parallel or in series. While calculators are provided to the candidates, the maths involved is very simple and, as is pointed out in the 'Notes for Candidates', an intuitive understanding of what happens when these components are put in series or in parallel is just as important as knowing what formula to use.

Many candidates are well prepared for the Ohm's Law related questions, but seem less certain of their ground when it comes to understanding the usage of components such as diodes, transistors and quartz crystals, or the pros and cons of different amplifier biasing methods.

Moving to more practical areas such as feeders, antennas, propagation and measurements, the standard of answering improves: one weak point is the understanding of transmission line impedance, another topic that has created problems is the effect of standing waves on a transmission line. We were surprised in some recent exams to discover that only a minority of candidates displayed a knowledge of the desirable features of a good voltmeter, and likewise the relationship between voltage, power and resistance was poorly understood.

The next exam – April / May 2014

The best advice we can give to those planning to sit the amateur station licence exam in 2014 is, ideally, to participate in a formal course but, if this is not possible, to try to get experience operating under supervision.

Plenty of study material is available on the web:

- **Syllabus** This can be downloaded from the IRTS web site – see www.irts.ie/exam. The document 'Studying for the Harmonised Amateur Radio Examination Certificate' includes the syllabus and a sample paper. See also the 'Notes for Candidates' in the syllabus document, as well as the four pages of Annexes, containing key information that is very relevant to the exam questions.
- **Course CD** IRTS has published a CD-based guide to topics covered by the syllabus; see the Amateur Station Licence Examination page on the IRTS web site for details of how to order this CD.
- **Radio Theory Links** The page at www.irts.ie/theory includes links to a number of web sites containing information on radio theory.
- **ComReg** The Wireless Telegraphy (Amateur Station Licence) Regulations and the Amateur Station Licence Guidelines are both available on the ComReg web site – which is linked from the Radio Theory Links page referred to above.

While clubs may have difficulty gathering enough support to mount a formal training programme, we would urge them to look at other ways of helping newcomers to become familiar with amateur radio practices and procedures. Allowing newcomers to operate under supervision – on an ordinary club night or at a special event, field day or contest – is a great way of introducing them to the hobby and developing their operating skills.

IRTS Examinations Board, February 2014

Notes:

- This report was first published in the February 2014 issue of Echo Ireland
- The Course CD is now web-based, and is available at www.irts.ie/course

Amateur Station Licence Examination Report – 2016

Amateur Radio is an unusual hobby in that, to fully participate in it requires a licence, and this licence has to be earned by passing an exam. Some of us starting out may have felt that the process of getting an amateur station licence is unnecessarily burdensome. However, once we pass the exam and set up our amateur station, we recognise that the licence gives us the freedom to use a wide range of frequency bands and modes throughout the radio spectrum, and that this is a very valuable privilege considering the vital role that the radio spectrum plays in our everyday lives. Passing the exam also gives us the internationally-recognised **Harmonised Amateur Radio Examination Certificate** (HAREC), entitling the holder to obtain an amateur station licence, subject to local regulations, in almost 50 countries.

Most candidates who sit the exam pass at the first attempt, and indeed many of those who don't reach the required 60% are not far off the mark. We highlight here some of the areas that seem to be causing the greatest difficulty; a bit more focus on these areas could make all the difference.

Section A – Amateur Radio Regulations and Related Topics – four topics.

Licensing Conditions: Exam questions under this heading cover specific aspects of national and international regulations and guidelines. The content that is relevant for exam purposes is set out in the Syllabus and is also covered in the Course Guide. This is a critical area that any regulator and existing amateur radio operator would expect a prospective licence holder to be very familiar with, yet the number of incorrect answers around basic knowledge such as band limits, power limits and permitted modes is surprisingly high. It is also clear that some candidates are taking the exam without an understanding of some of the fundamental Radio Regulations governing radio communications: questions on permitted communications and emission designations are frequently answered incorrectly.

Operating Procedures: This topic is mainly about the rules and practices developed over the years by radio amateurs to manage their own conduct in the interests of the radio amateur community; EI licence holders have a deservedly high reputation for good behaviour on air, and it is important that this reputation be maintained. Prospective licence holders need to be able to demonstrate that they are familiar with accepted procedures. Band plans, which are maintained by the International Amateur Radio Union (IARU), are key components of the self-governing facet of amateur radio so most exam papers will include one or more questions in this area. A high proportion of band plan questions are answered incorrectly. The original IARU band plan documents have been adapted and simplified for exam purposes in the Course Guide.

Another area that seems to be poorly understood is the format of CQ calls. On the other hand, we have noted that questions on the Q-code, RST code and phonetic alphabet have been well answered.

Electromagnetic Compatibility (EMC) and Transmitter Interference: The role that the radio spectrum plays in our everyday lives has already been mentioned; radio amateurs must be able to demonstrate that they understand the causes of interference, so that they can ensure that their activities will not interfere with the different radio services that we all now take for granted – mobile phones, WiFi, TV, Bluetooth and so on. Radio amateurs also need to know what steps might be necessary to deal with interference generated by other devices which could affect reception in their own station. RF filters form an important element of interference suppression, but many candidates were unable to correctly identify different filter circuits, their uses or where best to locate them. Also, questions based on the use of coaxial stubs seem to cause particular difficulties.

Safety: In general, the standard of answering on this topic is good. Problem areas include questions on fuses (including their function and appropriate ratings) and on the danger points in an antenna. Also, the factors that can have an impact on the level of non-ionising radiation do not appear to be well understood.

Section B – Amateur Radio Theory and Related Topics – five topics.

Electrical & Electronic Principles including Components and Circuits: Amateur radio is an experimental hobby, and exam candidates are expected to have a basic knowledge of electronics, covering areas such as Ohm's Law and simple components such as resistors, capacitors, inductors, diodes, transistors and transformers. An understanding of some circuits – identified in the Syllabus – as well as alternating current is also expected. The Syllabus and Notes for Candidates provide clear directions on the type of questions to be expected. One point in the Notes, worth repeating here, is that an "intuitive understanding" of how resistors, capacitors and inductors perform in practical circuits is as important as their behaviour in a mathematical sense: in other words *the exam is testing your understanding of the function of components like resistors, capacitors and inductors, and how they interact with AC or DC, not your ability at maths.* This is an important point, because when we review the papers submitted by candidates in recent exams we see that questions involving simple components in series and parallel were answered incorrectly by 40% of candidates. These incorrect answers were unlikely to be due to mathematical errors, as the correct answer should be apparent to anyone with the "intuitive understanding" referred to earlier.

Other areas causing problems for candidates include amplifier biasing, the significance of the different ways of expressing AC voltages (peak, peak-to-peak, average and RMS), output waveforms of various power supplies and the consequences for a resonant circuit of a high or low Q-factor.

Transmitters and Receivers: This topic covers the key concepts behind transmitters and receivers for CW, SSB, AM and FM. Candidates are expected to have a broad understanding of the nature of the output signal (including bandwidth) for each of these modes, plus the functions of the various stages of simple transmitters and receivers. This can be a difficult area for someone who is not technically-minded. The challenge for anyone tutoring this topic may well be to cover the Syllabus content without making the subject unnecessarily complicated; the Notes for Candidates and the Course Guide can come in useful here. The areas that have caused particular problems for candidates in recent exams include:

- operation of a BFO (beat frequency oscillator)
- balanced modulator usage
- ways of achieving selectivity in a superhet receiver
- high IF / low IF pros and cons
- filter widths for reception of different modes
- calculation of ERP from output power, antenna gain and feeder loss (decibel arithmetic)

In relation to the final bullet above, those not familiar with "decibel arithmetic" should refer to the Course Guide, which explains it quite simply: *When amplifiers and or attenuators are connected in series the overall gain in dB is calculated by adding (or subtracting) the individual dB gains.*

Feeders and Antennas: This is a very practical topic as most newly licensed radio amateurs can expect to be involved in putting up and maintaining antennas. The questions on Feeders that seem to cause the greatest difficulty were those on velocity factor and characteristic impedance. Turning

to Antennas, questions about voltage and current distribution caused problems, as did questions on reactance in antennas that are shorter / longer than a half-wave, and questions about baluns. Also, in a recent exam, one-third of candidates could not correctly identify the length of a half-wave dipole for one of the amateur bands. Some questions on antennas were very well answered, e.g. feed point impedance, and the components or characteristics of Yagi and trap antennas.

Propagation: This is another very practical topic, very much based around ionospheric layers – their location, the influence of the Sun and their effect on propagation. Some topics are well understood, such as the causes of fading and the sunspot cycle. That different ionospheric layers have different characteristics is not so well understood, and there is clearly some difficulty with the fact that some layers are known to *reflect* radio signals, but this is not the case with the D-layer, which can *absorb* signals. Of course the impact of all the ionospheric layers depends on signal frequency, time of day, time of year and the sunspot cycle.

Finally, here are some other areas that seem to cause difficulties:

- the concepts of Maximum Usable Frequency (MUF) and critical frequency
- effect of distance on RF field strengths
- significance of the angle of radiation

Measurements: The amateur station licence entitles us to build and set up our own equipment, so we must be able to demonstrate that we know what instruments to use to ensure that our equipment is operated within the authorised frequency bands and power levels, and that signal quality is within permitted bounds. The Syllabus headings for this topic are divided between 'Making Measurements' and 'Measuring Instruments'.

Reviewing the answers on this topic contained in submitted papers, it is clear that many candidates preparing for the exam are not paying sufficient attention to this area. Straightforward questions on SWR meters, voltmeters and ammeters are being answered incorrectly by more than half the candidates. Also, the constituents of RF power and measurement methods are not well understood.

This report has highlighted some of the areas that have caused problems for candidates in recent exams. Those preparing to sit their first exam and those who need to re-sit may get some pointers from this. It is important to study the Syllabus and Notes for Candidates – not forgetting the Annexes attached to the Syllabus. We also strongly recommend making use of the Course Guide, which includes in its Introduction: "*while we cannot of course guarantee that every question asked in an exam is dealt with comprehensively in the Course Guide, we are confident that a candidate who is familiar with the material in the Couse Guide should have no difficulty passing the exam.*"

Participation in club activities and in a formal course, if available, is also well worthwhile. Listening to the amateur bands in the months leading up to the exam can be very rewarding, being the easiest way of gaining expertise in areas such as band plans and other operating procedures as well as propagation.

IRTS Examinations Board, August 2016

Note: This report was first published in the September 2016 issue of Echo Ireland

Amateur Station Licence Examination Report – 2018

The Amateur Station Licence exam is in two sections with 30 multiple-choice questions each:

Section A - Amateur Radio Regulations and Related Topics

Section B – Amateur Radio Theory and Related Topics

The pass mark is 60% and a pass is required in both sections. Those who pass receive a **Harmonised Amateur Radio Examination Certificate** (HAREC) which is recognised in nearly all European countries and many others including Australia, Japan, New Zealand and South Africa.

Seven exam sessions were held in the two years 2016/2017, involving 76 candidates; 51 were successful, of whom 46 were sitting the exam for the first time. Many of the successful candidates achieve very high marks indeed and have clearly prepared very well for the exam; 40% of the successful candidates achieved overall marks of 80% or more.

Amateur Radio is just a hobby … what's the problem?

Before looking at the areas that have caused problems for candidates it is worth reflecting on why getting an Amateur Station Licence entails sitting and passing an exam. Yes, amateur radio is a hobby, but a very unique one with unparalleled rights and corresponding responsibilities. Holders of an Amateur Station Licence are permitted to use more than 20 internationally agreed frequency bands right across the radio spectrum to carry out radiocommunication experiments using self-built or commercially-built equipment meeting the Technical Conditions set out in ComReg's guidelines. The same radio spectrum is occupied by countless other users for broadcasting, safety and security, geolocation, mobile phones, Internet of Things and lots more. The Amateur Station Licence give the holder far greater flexibility in terms of equipment type and permitted frequencies compared to other users. Therefore, we need to establish that we can safely operate an amateur station and in particular that we understand the regulatory framework within which radio amateurs are required to operate and the accepted operating rules and procedures. Furthermore we need to demonstrate that we have the requisite technical knowledge to carry out radiocommunication experiments.

The importance of retaining the *uniqueness* of amateur radio, including its experimental and self-training nature, cannot be over-emphasised. The bands currently available to radio amateurs were secured mainly at a time when the radio spectrum was not under the same commercial pressures as it is at present: with literally billions of devices now using radio frequencies, the competition for spectrum is intense, so amateur radio needs to continue to be seen as significant and distinctive if we are to retain what we have.

Problem areas – Section A:

Licensing Conditions. Exam candidates need to have some familiarity with key aspects of the Amateur Station Licence Guidelines published by ComReg. Unfortunately, many of the questions on permitted frequencies and power levels are being answered incorrectly. Other problem areas include the requirements for logbook keeping, the permitted content of transmissions between amateur stations and the additional constraints that apply to frequency allocations with *secondary* status.

Operating Rules and Procedures. Transmissions from an Irish amateur radio station can potentially be heard around the world, so it is essential that aspiring EI licence holders show that they are familiar with the operating rules and procedures used by radio amateurs worldwide. This is the area within Section A that the standard of answering has been the most disappointing in recent years. Knowledge of band plans is poor as is the composition of amateur radio call signs and the format of CQ calls. Candidates could benefit significantly from participating in club activities in the months leading up to an exam, or if this is not possible, some 'shortwave listening' on the amateur bands.

Electromagnetic Compatibility and Transmitter Interference. Understanding the methodology for coexisting with other users of the radio spectrum is a fundamental obligation for Amateur Station Licence holders. The exam questions for this topic include the use of filters to avoid interfering with other services or to minimise interference received from other users. Some of the answers indicate a very limited knowledge of the simple filter circuits typically used by radio amateurs, as well as how and where these filters should be deployed.

Safety. It's no surprise that the exam includes a number of questions to test a candidate's knowledge of safety. The standard of answering for this topic is generally good, however there does appear to be some confusion about the function of fuses and the selection of an appropriate current rating; other areas of weakness are around the most likely sources of RF burns from antennas, and the implications of non-ionising radiation emissions / ways of minimising such emissions.

Problem areas – Section B:

Electrical and Electronic Principles including Components and Circuits. This section provides a test of a candidate's understanding of basic electrical and electronic principles and circuits. Ohm's Law and equivalent rules for inductors and capacitors might suggest that complex mathematical calculations may be necessary to identify the correct answer, but that is not the case, as the relevant multiple-choice questions are designed in such a way that anyone with an intuitive understanding of how resistors, inductors and capacitors perform in circuits should be able to identify the correct answer without difficulty. The standard of answering for these "quasi-mathematical" questions is very good. Less well understood is the usage of other components (e.g. diodes, rectifiers, transformers) within circuits, the relationship between peak, peak-to-peak, average and RMS values, amplifier biasing or the consequences for a circuit of a high or low Q-factor.

Transmitters and Receivers. Many of the questions in this section are about the building blocks of transmitters and receivers and the nature of the output signal from CW, SSB, AM and FM transmissions. These are areas that do not seem to be well understood by candidates; also questions on why and how signals are shifted to an IF (intermediate frequency) are getting a poor response. All we can suggest is that the Course Guide, which includes numerous helpful block diagrams, should be studied.

Feeders and Antennas. This is a very practical area, most radio amateurs will spend a proportion of their time experimenting with different feeders and antennas. Some of the candidates' answering on this topic is very good, but two areas that have caused particular problems are the expected impedance of different antenna types and the impact of the velocity factor on transmission lines. We also note that more than 40% of candidates in recent years have been unable to correctly identify the length of a half-wave dipole for one of the HF bands.

Propagation. This topic is of great interest to every radio amateur as it has an enormous influence on what we can achieve in our experiments. An understanding of the characteristics and propagation implications of the different ionospheric layers is one of the core themes within this topic, however when we review the answers provided in recent exams, it is clear that many candidates have not achieved a satisfactory understanding of this fundamental aspect of propagation. Other themes, such as angle of radiation, skip distance, the sunspot cycle and the causes of fading are better understood.

Measurements. This is the smallest topic in the syllabus, with just 3 questions in the exam. It is also the topic with the lowest level of correct answers – averaging just over 60% in recent

years. Questions on measuring resonant frequency, on SWR meters, voltmeters and ammeters are being answered incorrectly. While some maths would be involved in calculating the answer from scratch for some of the measurement question, as in the case of the Ohm's Law questions referred to earlier, the multiple-choice questions in the measurements section are designed so that the correct answer should be obvious to a candidate who understands the underlying principles.

Preparing for the next exam

The next Amateur Station Licence exam is due to be held in May / June 2018. Those preparing for an exam should ideally attend a course, however we recognise that courses for the Amateur Station Licence are few and far between. Radio club attendance with participation in club activities is the next best thing. For study material, see the "Licensing" menu at *www.irts.ie*

We suggest that candidates and tutors obtain a copy of **Studying for the Harmonised Amateur Radio Examination Certificate**, available on *www.irts.ie/downloads* This document contains …

1. The **exam syllabus** – essential reading! As well as outlining the topics to be covered in the exam, the syllabus includes –
    - **Notes for candidates** – designed to assist candidates and their teachers with their work in preparing for the exam by suggesting certain areas worth focusing on
    - **Four pages of Annexes** – containing key information very relevant to the exam questions
2. **Sample paper** – a useful guide to how the questions are presented in the exam
3. **Examination Reports** – four previous reports published between 2007 and 2016 are included. These reports include observations and advice that should be of assistance to anyone studying for the Amateur Station Licence

An online **Course Guide** is available at *www.irts.ie/course* A zip file of this guide is available on the downloads page at *www.irts.ie/downloads* for offline viewing.

We also suggest that candidates look at some of the material in the links on the IRTS **Radio Theory Links** page at *www.irts.ie/theory*

For those who prefer printed material, there are a number of online bookstores specialising in amateur radio material, including those run by PW Publishing and the Radio Society of Great Britain. Note, however, that as the UK amateur radio licensing system is based around three separate examinations [Foundation, Intermediate, Advanced], material on all three examinations would need to be covered by candidates studying for a full HAREC-level examination.

IRTS Licence Examination Board, February 2018

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