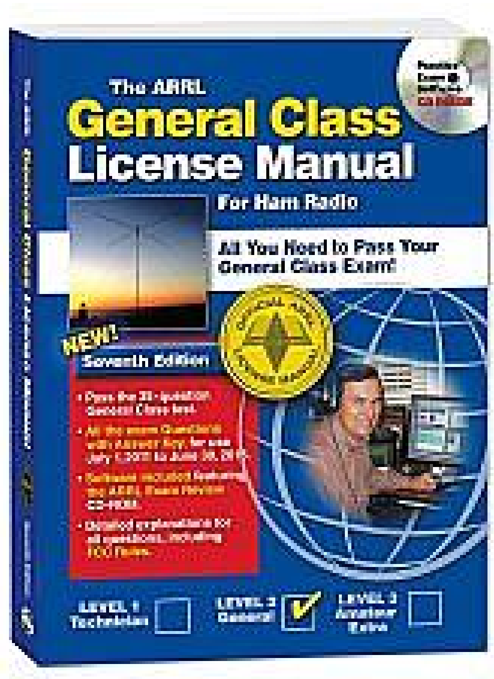
Amateur Radio

General License Class Syllabus

Revision 1.04



Jack Tiley

AD7FO

June 2011

General License Class Syllabus

Revision 1.01

Compiled By Jack Tiley AD7FO

Based on the ARRL General Class License Question pool dated December 2010

This material is based on the 2011, General Class License question pool with additional information added by the author *(in italicized blue text).*

All questions were re-written with the correct answer only, which in the authors view makes it easier when you see the other choices in your exam to identify the correct answer. Question numbers have been included so you can go to the ARRL General Class License Manual, or the question pool itself, to see the actual wording of the questions other answer choices that will be in the exam.

It is recommended (but not required) that you have your own copy of the current ARRL General Class License Manual which is available for purchase from ARRL publication sales on the ARRL web site and through amateur radio dealers. A copy of a recent ARRL Handbook could be used in lieu of purchasing the license manual as a reference to help understand the topics covered in this syllabus.

The electronic file of this syllabus is usually too large to be e-mailed so an alternate form of distribution (printed, CD-ROM or web posting) will be required.

While every effort was made to insure the accuracy of the material herein, this material was prepared by an ordinary human being, and there is always the possibility that a few typographical or other errors remain. Author can be contacted at ad7fo@arrl.net

Additional information and resources to help you study for the General Class License can be found on the ARRL web site. This site has articles and resources for reference materials on all aspects of the exam questions.

General License Class Requirements

1. You must take and pass the General Class written exam (element 3)
   - There are 35 questions on the exam, All questions are multiple choice
   - Questions come from a published pool of questions (all possible questions are covered in this syllabus).
   - The number of possible questions for each topic area is fixed and shown for each question group in the syllabus.
   - There are on line practice sites with the real test questions you cam take for practice. Listed below are three sites where you can take practice exams:
     http://aa9pw.com/radio/
     http://www.eham.net/exams/
     http://www.qrz.com/ham/

2. You should have a copy of the latest ARRL General Class License Manual (or ARRL Handbook). These are recommended but not a must.

These are available on line from ARRL and many amateur radio dealers and booksellers whose web sites are listed below. If you have the previous edition of the general license manual you can use it but keep in mind some of the frequencies and rules may have changed, but the technical information will still be accurate.

http://www.arrl.org/catalog/index
http://www.aesham.com/
http://www.hamradio.com/

3. A copy of the Syllabus written by the instructor. A CD copy or a Printed and Bound copy can be purchased from **The UPS Store, 57th and Regal, Spokane, WA - Phone (509) 448-6368 (ask for Mike or Charles)**

4. It is recommended you have a printed copy of this syllabus to study from and to bring to class. We will be working from the syllabus during the class. All the possible questions in the exam are covered in the syllabus.

5 A Basic Scientific Calculator that you are familiar with that is capable square roots, and Base 10 Log functions (all scientific calculators have these functions) available from office supply stores and Wal-Mart for around $10.

6. A desire to learn and to ask questions if you do not understand something that is being taught.

Planned Order of instruction is normally two 7-8 hour days, but can be taught as a series of six 3 hour evening sessions

Day 1
- G5 Electrical Principals
- G6 Circuit Components
- G7 Practical Circuits
- G3 Radio Wave Propagation
- G4 Amateur Radio Practices

Day 2
- G2 Operating Procedures
- G3 Radio Wave Propagation
- G8 Signals and emissions
- G9 Antennas and Feedlines
- G1 Commission Rules
- G0 Electrical and RF Safety

Evening 1
- G5 Electrical Principals
- G6 Circuit Components

Evening 2
- G7 Practical Circuits
- G3 Radio Wave Propagation

Evening 3
- G4 Amateur Radio Practices
- G2 Operating Procedures

Evening 4
- G3 Radio Wave Propagation
- G8 Signals and emissions

Evening 5
- G9 Antennas and Feedlines
- G1 Commission Rules

Evening 6
- G0 Electrical and RF Safety
- Stump the instructor (any and all questions)

Preparation:

Please read through the scheduled sections in the syllabus before each class. You are not expected to learn and understand what you read but by being familiar with what will be covered you can identify those areas where you may want focus on and/or bring up questions during the class.

Do not be intimidated, The material will be made easy to understand by your instructor and remember you can skip a whole section, study the others and still pass the exam. The instructor will teach all the sections, but you can choose to focus on the topics you can or want to learn while skipping others and still pass your exam. You can then go back later and study the areas where you had difficulty. There are many ñElmerôsò in the ham radio community out there to help you. Check in your region for local ARRL technical specialists if you donôt already know local Hams that can help you.

About The Author

Education:
Electrical Engineering, Penn State University

Work Experience:
American Electronics Laboratories: Ten years managing a Metrology (Calibration Standards) Laboratory responsible for maintaining test instruments and their calibration traceability to the National Standards Laboratory, **NSIT (previously NBS)**.

Hewlett Packard Test Instrument Group: Thirty four years filling various positions in Technical Support, Application Engineering, Field Sales, World Wide Sales Management, Systems Development and Product Management. Retired in 2004

Hobbies

- Amateur Radio
- Test Equipment
- Electronics in general
- Attending every hamfests I can, including Hamvention in Dayton Ohio

Amateur Radio Activities:

- Teaching and mentoring
  - Teaching General and Extra License Classes (with training materials I have written)
  - Lead an amateur radio club at Agilent Technologies (where I used to work). The club operates and maintains a 2 meter repeater and a 440 repeater with Echo Link. The club web site is http://www.asarc.org/ where you will find information on activities, repeaters and upcoming hamfests
  - I provide a radio and general purpose test equipment table every year at the Spokane Hamfest for folks to test their radios and other electronic hamfest treasures.
  - I have my own UHF portable repeater (443.400 with 100Hz CTCSS tone).

ARRL Appointments:

- ARRL VE (Volunteer Examiner)
- ARRL Technical Specialist for Spokane area
- ARRL Technical Coordinator for EWA
- ARRL Registered Instructor
- Officer in the Inland Empire VHF Club

2011-2015 General Class Question Pool

SUBELEMENT G1 - COMMISSION'S RULES [5 Exam Questions - 5 Groups]

G1A - General Class control operator frequency privileges; primary and secondary allocations
G1B - Antenna structure limitations; good engineering and good amateur practice; beacon operation; restricted operation; retransmitting radio signals
G1C - Transmitter power regulations; data emission standards
G1D - Volunteer Examiners and Volunteer Examiner Coordinators; temporary identification
G1E - Control categories; repeater regulations; harmful interference; third party rules; ITU regions

SUBELEMENT G2 - OPERATING PROCEDURES [5 Exam Questions - 5 Groups]

G2A Phone operating procedures; USB/LSB utilization conventions; procedural signals; breaking into a QSO in progress; VOX operation
G2B - Operating courtesy; band plans, emergencies, including drills and emergency communications
G2C - CW operating procedures and procedural signals, Q signals and common abbreviations; full break in
G2D - Amateur Auxiliary; minimizing interference; HF operations
G2E - Digital operating: procedures, procedural signals and common abbreviations

SUBELEMENT G3 - RADIO WAVE PROPAGATION [3 Exam Questions - 3 Groups]

G3A - Sunspots and solar radiation; ionospheric disturbances; propagation forecasting and indices
G3B - Maximum Usable Frequency; Lowest Usable Frequency; propagation
G3C ï Ionospheric layers; critical angle and frequency; HF scatter; Near Vertical Incidence Sky waves

SUBELEMENT G4 - AMATEUR RADIO PRACTICES [5 Exam Questions - 5 groups]

G4A ï Station Operation and setup
G4B - Test and monitoring equipment; two-tone test
G4C - Interference with consumer electronics; grounding; DSP
G4D - Speech processors; S meters; sideband operation near band edges
G4E - HF mobile radio installations; emergency and battery powered operation

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 exam questions – 3 groups]

G5A - Reactance; inductance; capacitance; impedance; impedance matching
G5B - The Decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations
G5C ï Resistors, capacitors and inductors in series and parallel; transformers

SUBELEMENT G6 – CIRCUIT COMPONENTS [3 exam questions – 3 groups]

G6A - Resistors; capacitors; inductors
G6B - Rectifiers; solid state diodes and transistors; vacuum tubes; batteries
G6C - Analog and digital integrated circuits (ICôs); microprocessors; memory; I/O devices; microwave ICôs (MMICôs); display devices

SUBELEMENT G7 – PRACTICAL CIRCUITS [3 exam questions – 3 groups]

G7A - Power supplies; schematic symbols
G7B - Digital circuits; amplifiers and oscillators
G7C - Receivers and transmitters; filters, oscillators

SUBELEMENT G8 – SIGNALS AND EMISSIONS [2 exam questions – 2 groups]

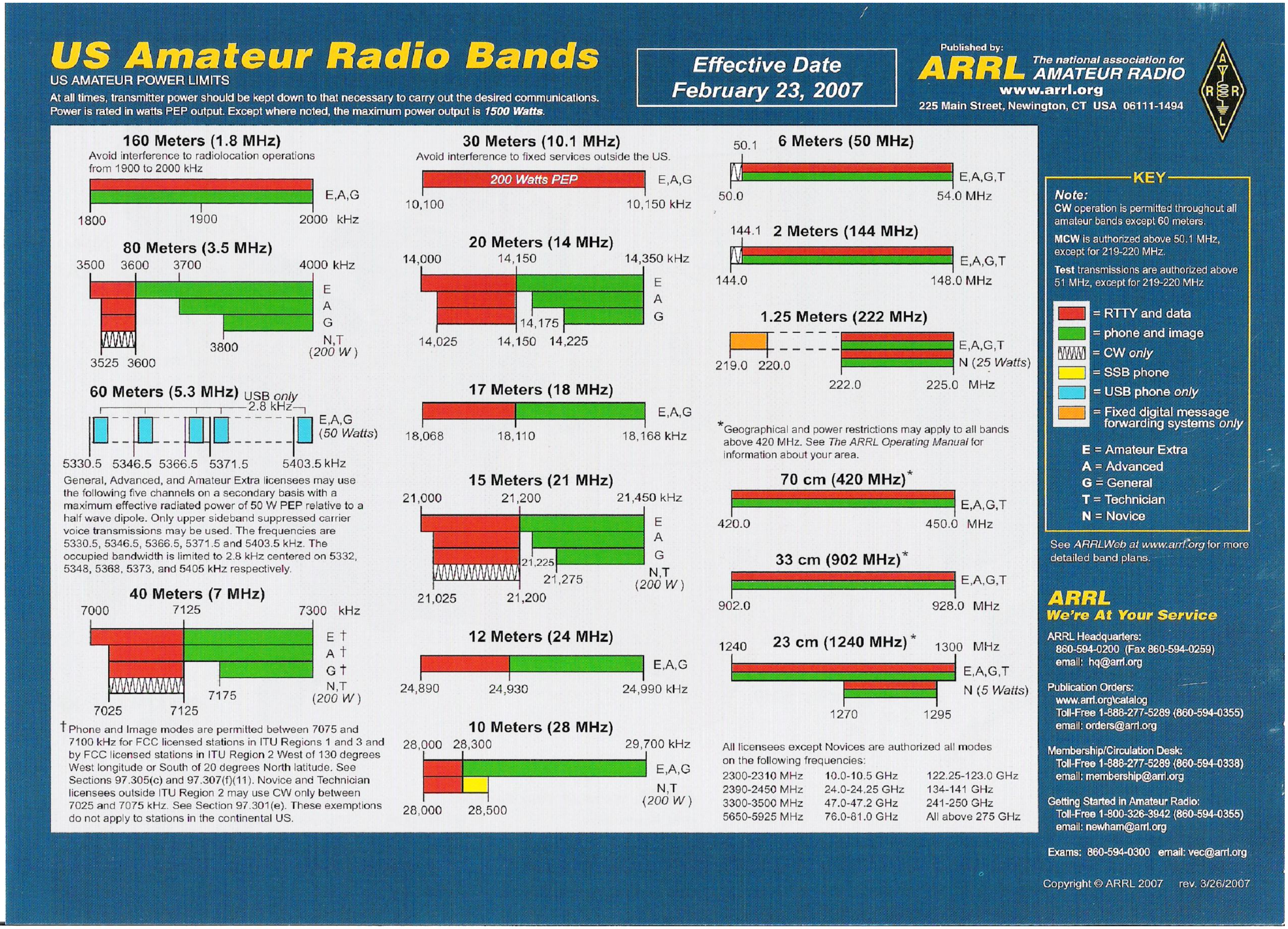
G8A - Carriers and modulation: AM; FM; single and double sideband; modulation envelope; over-modulation
G8B - Frequency mixing; multiplication; HF data communications; bandwidths of various modes; deviation

SUBELEMENT G9 – ANTENNAS AND FEED LINES [4 exam questions – 4 groups]

G9A - Antenna feed lines: characteristic impedance and attenuation; SWR calculation, measurement and effects; matching networks
G9B - Basic antennas
G9C - Directional antennas
G9D - Specialized antennas

SUBELEMENT G0 – ELECTRICAL AND RF SAFETY [2 exam Questions – 2 groups]

G0A - RF safety principles, rules and guidelines; routine station evaluation
G0B - Safety in the ham shack: electrical shock and treatment, safety grounding, fusing, interlocks, wiring, antenna and tower safety


US Amateur Radio Bands
US AMATEUR POWER LIMITS
At all times, transmitter power should be kept down to that necessary to carry out the desired communications. Power is rated in watts PEP output. Except where noted, the maximum power output is 1500 Watts.
Effective Date February 23, 2007
Published by: ARRL The national association for AMATEUR RADIO
www.arrl.org
225 Main Street, Newington, CT USA 06111-1494
160 Meters (1.8 MHz)
Avoid interference to radiolocation operations from 1900 to 2000 kHz
E,A,G
1800 1900 2000 kHz
80 Meters (3.5 MHz)
3500 3600 3700 4000 kHz
E
A
G
N,T (200 W)
3525 3600 3800
60 Meters (5.3 MHz) USB only
2.8 kHz
E,A,G (50 Watts)
5330.5 5346.5 5366.5 5371.5 5403.5 kHz
General, Advanced, and Amateur Extra licensees may use the following five channels on a secondary basis with a maximum effective radiated power of 50 W PEP relative to a half wave dipole. Only upper sideband suppressed carrier voice transmissions may be used. The frequencies are 5330.5, 5346.5, 5366.5, 5371.5 and 5403.5 kHz. The occupied bandwidth is limited to 2.8 kHz centered on 5332, 5348, 5368, 5373, and 5405 kHz respectively.
40 Meters (7 MHz)
7000 7125 7300 kHz
E †
A †
G †
N,T (200 W)
7025 7125 7175
† Phone and Image modes are permitted between 7075 and 7100 kHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11). Novice and Technician licensees outside ITU Region 2 may use CW only between 7025 and 7075 kHz. See Section 97.301(e). These exemptions do not apply to stations in the continental US.
30 Meters (10.1 MHz)
Avoid interference to fixed services outside the US.
200 Watts PEP
E,A,G
10,100 10,150 kHz
20 Meters (14 MHz)
14,000 14,150 14,350 kHz
E
A
G
14,175
14,025 14,150 14,225
17 Meters (18 MHz)
E,A,G
18,068 18,110 18,168 kHz
15 Meters (21 MHz)
21,000 21,200 21,450 kHz
E
A
G
N,T (200 W)
21,225
21,275
21,025 21,200
12 Meters (24 MHz)
E,A,G
24,890 24,930 24,990 kHz
10 Meters (28 MHz)
28,000 28,300 29,700 kHz
E,A,G
N,T (200 W)
28,000 28,500
50.1 6 Meters (50 MHz)
E,A,G,T
50.0 54.0 MHz
144.1 2 Meters (144 MHz)
E,A,G,T
144.0 148.0 MHz
1.25 Meters (222 MHz)
E,A,G,T
N (25 Watts)
219.0 220.0
222.0 225.0 MHz
*Geographical and power restrictions may apply to all bands above 420 MHz. See The ARRL Operating Manual for information about your area.
70 cm (420 MHz)*
E,A,G,T
420.0 450.0 MHz
33 cm (902 MHz)*
E,A,G,T
902.0 928.0 MHz
1240 23 cm (1240 MHz)* 1300 MHz
E,A,G,T
N (5 Watts)
1270 1295
All licensees except Novices are authorized all modes on the following frequencies:
2300-2310 MHz 10.0-10.5 GHz 122.25-123.0 GHz
2390-2450 MHz 24.0-24.25 GHz 134-141 GHz
3300-3500 MHz 47.0-47.2 GHz 241-250 GHz
5650-5925 MHz 76.0-81.0 GHz All above 275 GHz
KEY
Note:
CW operation is permitted throughout all amateur bands except 60 meters.
MCW is authorized above 50.1 MHz, except for 219-220 MHz.
Test transmissions are authorized above 51 MHz, except for 219-220 MHz
= RTTY and data
= phone and image
= CW only
= SSB phone
= USB phone only
= Fixed digital message forwarding systems only
E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice
See ARRLWeb at www.arrl.org for more detailed band plans.
ARRL We're At Your Service
ARRL Headquarters:
860-594-0200 (Fax 860-594-0259)
email: hq@arrl.org
Publication Orders:
www.arrl.org\catalog
Toll-Free 1-888-277-5289 (860-594-0355)
email: orders@arrl.org
Membership/Circulation Desk:
Toll-Free 1-888-277-5289 (860-594-0338)
email: membership@arrl.org
Getting Started in Amateur Radio:
Toll-Free 1-800-326-3942 (860-594-0355)
email: newham@arrl.org
Exams: 860-594-0300 email: vec@arrl.org
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SUBELEMENT G1 - COMMISSION'S RULES [5 Exam Questions - 5 Groups]

G1A - General Class control operator frequency privileges; primary and secondary allocations

note: The number in brackets after the question is the FCC Part 97 rule that applies.

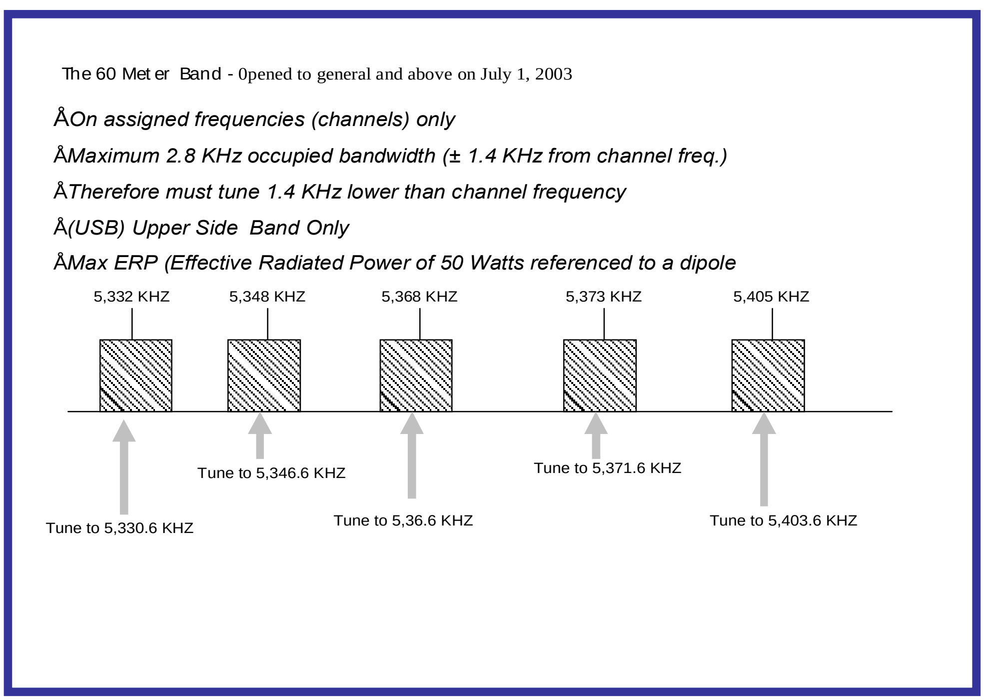
G1A01 [97.301(d), 97.303(s)]
a General Class license holder is granted all amateur frequency privileges on 160, 60, 30, 17, 12, and 10 meters.

$$\text{Wavelength } (\lambda) = \frac{\text{Speed of Light (meters per second)}}{\text{Frequency (in Hertz)}} = \frac{300,000,000}{\text{Frequency}}$$

G1A02 [97.305]
Phone *(voice)* operation is prohibited on the 30 meter band.

G1A03 [97.305]
Image transmission is prohibited on 30 meters.

G1A04 [97.303 (s)]
On the 60 meter amateur band communication is limited to specific channels, rather than frequency ranges.



G1A05 [97.301(d)]
The frequency of 7.250 MHz is in the General Class portion of the 40 meter band.
The test question has two possible answers 7.25 MHz and 7.5 MHz. If you calculate the band frequency using the formula frequency(MHz) =300/band then dividing the band into 300 (frequency=300/40) by the band you would come up with an answer of 7.5 MHz, but the question asks which frequency is in the general class portion of the band. If you look at the US Amateur Radio Bands on page 8 you will see that the 40 meter amateur band stops at 7.3 MHz. so therefore the 7.5 MHz answer would be wrong. The only other answer that is close is 7.25 MHz.

G1A06 [97.301(d)]
A frequency of 24.940 MHz is in the 12 meter band.

G1A07 [97.301(d)]
A frequency of 3,900 kHz frequencies is within the General Class portion of the 75 meter phone band.

G1A08 [97.301(d)] **Question Removed**

G1A09 [97.301(d)]
A frequency of 3,560 kHz is within the General Class portion of the 80 meter band.

G1A10 [97.301(d)]
A frequency of 21,300 kHz is within the General Class portion of the 15 meter band.

G1A11 [97.301(d)]
The following frequencies ARE available to a control operator holding a General Class license
28.020 MHz
28.350 MHz
28.550 MHz

G1A12 [97.301]
When General Class licensees are not permitted to use the entire voice portion of a particular band, the portion of the voice segment band generally available to them is the upper frequency end of the band.

G1A13 [97.303]
No amateur band is shared with the Citizens Radio Service.

G1A14 [97.303]
When the FCC rules designate the Amateur Service as a secondary user on a band amateur stations are allowed to use the band only if they do not cause harmful interference to primary users.

G1A15 [97.303]
When operating on either the 30 or 60 meter bands, and a station in the primary service interferes with your contact you should move to a clear frequency.

G1B - Antenna structure limitations; good engineering and good amateur practice; beacon operation; restricted operation; retransmitting radio signals

G1B01 [97.15(a)]
The maximum height above ground that an antenna structure may be erected without requiring notification to the FAA and registration with the FCC is 200 feet, provided it is not at or near a public use airport *(where the limit may be lower)*.

G1B02 [97.203(b)]
There must be no more than one Beacon station in the same band from a single location.

G1B03 [97.1(a)(9)]
The FCC Rules identify that the purpose of a beacon station is for the observation of propagation and reception.

G1B04 [97.113(b)]
In order for an amateur station to provide communications to broadcasters for dissemination to the public the communications must directly relate to the immediate safety of human life or protection of property **and** there must be no other means of communication reasonably available before or at the time of the event.

G1B05 [97.113(a)(5)(e)]
Music transmission by an amateur station is prohibited, except when it is an incidental part of a manned space craft retransmission.

G1B06 [97.113(a)(4) and 97.207(f)]
An amateur station is permitted to transmit secret codes only when needed to control a space station.

G1B07 [97.113(a)(4)]
The use of abbreviations or procedural signals in the Amateur Service is only allowed when they do not obscure the meaning of a message.

G1B08
When choosing a transmitting frequency to comply with good amateur practice you should:

- Review FCC Part 97 Rules regarding permitted frequencies and emissions.
- Follow generally accepted band plans agreed to by the Amateur Radio community.
- Before transmitting, listen to avoid interfering with ongoing communication.

G1B09 [97.113(a)(3)]
An amateur station may only transmit communications in which the licensee or control operator has a pecuniary (monetary) interest only when other amateurs are being notified of the sale of apparatus normally used in an amateur station and such activity is not done on a regular basis

G1B10 [97.203(c)]
The power limit for beacon stations is 100 watts PEP output.

G1B11 [97.101(a)]
The FCC requires an amateur station to be operated in all respects not specifically covered by the Part 97 rules in conformance with good engineering and good amateur practice.

G1B12 [97.101(a)]
The FCC determines ñgood engineering and good amateur practiceò as applied to the operation of an amateur station in all respects not covered by the Part 97 rules.

G1C - Transmitter power regulations; data emission standards

G1C01 [97.313(c)(1)]
The maximum transmitting power an amateur station may use on 10.140 MHz is 200 watts PEP output.

G1C02 [97.313(a),(b)]
The maximum transmitting power an amateur station may use on the 12 meter band is 1500 watts PEP output.

G1C03 [97.303s]
The maximum bandwidth permitted by FCC rules for Amateur Radio stations when transmitting on USB frequencies in the 60 meter band is 2.8 KHz.

G1C04 [97.313 (a)]
A 1500 watt PEP limit is placed on transmitter power in the 14 MHz band, but the FCC also states that only the minimum power necessary to carry out the desired communications should be used.

G1C05 [97.313]
The maximum transmitting power a station with a General Class control operator may use on the 28 MHz band is 1500 watts PEP output.

G1C06 [97.313(b)]
The maximum transmitting power an amateur station may use on 1825 kHz is 1500 watts PEP. output.

G1C07 [97.305(c), 97.307(f)(3)]
The maximum symbol rate permitted for RTTY or data emission transmission on the 20 meter band is 300 baud.

G1C08 [97.307(f)(3)]
The maximum symbol rate permitted for RTTY or data emission transmitted at frequencies below 28 MHz is 300 baud.

G1C09 [97.305(c) and 97.307(f)(5)]
The maximum symbol rate permitted for RTTY or data emission transmitted on the 1.25 meter and 70 centimeter bands is 56 kilobaud.

G1C10 [97.305(c) and 97.307(f)(4)]
The maximum symbol rate permitted for RTTY or data emission transmissions on the 10 meter band is 1200 baud.

G1C11 [97.305(c) and 97.307(f)(5)]
The maximum symbol rate permitted for RTTY or data emission transmissions on the 2 meter band is 19.6 kilobaud.

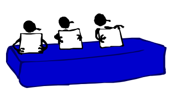
G1D - Volunteer Examiners and Volunteer Examiner Coordinators; temporary identification

G1D01 [97.119]
The temporary way to identify when transmitting using phone on General Class frequencies if you have a CSCE for the required elements but your upgrade from Technician has not appeared in the FCC database is to Give your call sign followed by "slant AG".

G1D02 [97.509(b)(3)(i)]
You may only administer a Technician class license exam when you are an accredited VE holding a General Class operator license.

G1D03 [97.9(b)]
If you are a Technician Class operator and have a CSCE for General Class privileges you may operate on any General or Technician Class band segment.

G1D04 [97.509(a)(b)]
To administer a Technician Class operator examination at least three VEC accredited General Class or higher VEs must be present.



G1D05 [97.509(b)(3)(i)]
An FCC General Class or higher license and VEC accreditation is sufficient for you to be an administering VE for a Technician Class operator license examination.

G1D06 [97.119(f)(2)]
You must add the special identifier "AG" after your call sign if you are a Technician Class licensee and have a CSCE for General Class operator privileges, but the FCC has not yet posted your upgrade on its Web site whenever you operate using General Class frequency privileges

G1D07 [97.509(b)(1)]

Volunteer Examiners are accredited by A Volunteer Examiner Coordinator.

G1D08 [97.509 (b)(3)]
For a non-U.S. citizen to be an accredited Volunteer Examiner they must hold a U.S. Amateur Radio license of General Class or above.

G1D09 [97.9(b)]
A Certificate of Successful Completion of Examination (CSCE) is valid for exam element credit for a period of 365 days.

G1D10 [97.509(b)(2)]
You must be at least 18 years of age to qualify as an accredited Volunteer Examiner.

G1E - Control categories; repeater regulations; harmful interference; third party rules; ITU regions

G1E01 [97.115(b)(2)]
You would disqualify a third party from participating in stating a message over an amateur station if the third partyȏs amateur license had ever been revoked.

G1E02 [97.205(a)]
A 10 meter repeater may retransmit the 2 meter signal from a station having a Technician Class operator only if the 10 meter repeater control operator holds at least a General Class license.

G1E03 [97.301(d)]
In ITU Region 2, operation in the 7.175 to 7.300 MHz band permitted for a control operator holding an FCC-issued General Class license.

G1E04 [97.13(b), 97.311(b), 97.303]
An Amateur Radio station is required to take specific steps to avoid harmful interference to other users or facilities when:

- When operating within one mile of an FCC Monitoring Station.
- When using a band where the Amateur Service is secondary.
- When a station is transmitting spread spectrum emissions.

G1E05 [97.115(a)(2), 97.117]
Only messages relating to Amateur Radio or remarks of a personal character, or messages relating to emergencies or disaster relief may be transmitted by an amateur station for a third party in another country.

G1E06 [97.205(c)]
In the event of interference between a coordinated repeater and an uncoordinated repeater the licensee of the non-coordinated repeater has primary responsibility to resolve the interference.

G1E07 [97.115(a)(2)]
Third party traffic is prohibited in every foreign country, unless there is a third party agreement in effect with that country. The exception is for messages directly involving emergencies or disaster relief communications.

G1E08 [97.115(a)(b)]
For a non-licensed person to communicate with a foreign Amateur Radio station from a US amateur station at which a licensed control operator is present the foreign amateur station must be in a country with which the United States has a third party agreement.

G1E09 [97.119(b)(2)]
You must use English language when identifying your station if you are using a language other than English in making a contact using phone emission.

G1E10 [97.205 (b)]
On the10 meter band, the portion above 29.5 MHz is available for repeater use.

SUBELEMENT G2 - OPERATING PROCEDURES
[5 Exam Questions - 5 Groups]

G2A - Phone operating procedures; USB/LSB utilization conventions; procedural signals; breaking into a QSO in progress; VOX operation

G2A01
Upper sideband is most commonly used mode for voice communications on frequencies of 14 MHz or higher.

Common Practice is For frequencies less than 10 MHz to use Lower Sideband (LSB) and Frequencies greater than 10 MHz to use upper Sideband (USB).

G2A02
Lower sideband is most commonly used for voice communications on the 160, 75, and 40 meter bands.

See rule above

G2A03
Upper sideband is most commonly used for SSB voice communications in the VHF and UHF bands .

See rule above

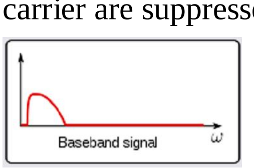
G2A04
Upper sideband is most commonly used for voice communications on the 17 and 12 meter bands.

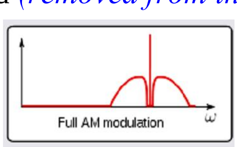
G2A05
For voice communication, Single sideband (SSB) is most commonly used on the high frequency amateur bands.

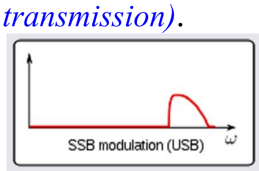
G2A06
The advantage when using single sideband as compared to other analog voice modes on the HF amateur bands is that less bandwidth is used and it has higher power efficiency.

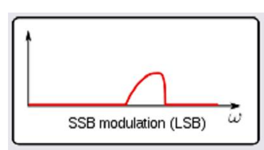
It takes only 2.8 KHz of bandwidth and only transmits power during actual voice.

G2A07
For single sideband (SSB) voice mode only one sideband is transmitted; the other sideband and carrier are suppressed *(removed from the transmission)*.









G2A08
A recommended way to break into a conversation when using phone is to say your call sign during a break between transmissions from the other stations.

G2A09
Most amateur stations use lower sideband on the 160, 75 and 40 meter bands because Current amateur practice is to use lower sideband on these frequency bands

See rule in G2A01

G2A10
SSB VOX operation allows "hands free" operation.

VOX is an abbreviation for Voice Operated Transmit

G2A11
The expression "CQ DX" usually indicates the caller is looking for any station outside their own country

G2B - Operating courtesy; band plans; emergencies, including drills and emergency communications

G2B01
No one has priority access to frequencies, common courtesy should be a guide.

G2B02
The first thing you should do if you are communicating with another amateur station and hear a station in distress break in would be to acknowledge the station in distress and determine what assistance may be needed

G2B03
If propagation changes during your contact and you notice increasing interference from other activity on the same frequency, as a common courtesy, move your contact to another frequency.

G2B04
When selecting a CW transmitting frequency, the minimum frequency separation you should allow in order to minimize interference to stations on adjacent frequencies is 150 to 500 Hz.

G2B05
The customary minimum frequency separation between SSB signals under normal conditions is approximately 3 KHz.

G2B06
A practical way to avoid harmful interference when selecting a frequency to call CQ on CW or phone would be to send "QRL?" on CW, followed by your call sign, or using phone, ask if the frequency is in use, followed by your call sign.

G2B07
Following the voluntary band plan for the operating mode you intend to use complies with good amateur practice when choosing a frequency on which to initiate a call.

G2B08
The ñDX windowò in a voluntary band plan is a portion of the band that should not be used for contacts between stations within the 48 contiguous United States.

G2B09 [97.407(a)]
Only a person holding an FCC issued amateur operator license may be the control operator of an amateur station transmitting in RACES to assist relief operations during a disaster.

G2B10 [97.407(b)]
When the Presidentôs War Emergency Powers have been invoked the FCC may restrict normal frequency operations of amateur stations participating in RACES.

G2B11
You should use whatever frequency has the best chance of communicating the message when sending a distress call.

G2B12 [97.405(b)]
At any time during an actual emergency an amateur station is allowed to use any means at its disposal to assist another station in distress.

G2C - CW operating procedures and procedural signals; Q signals and common abbreviations: full break in

Common Q signals

QRB ***How far are you from my station?***
QRK ***What is the readability of my signal?***
QRL ***are you busy? / Is this frequency in use?***
QRM ***Are you being interfered with?***
QRP ***Shall I decrease power?***
QRV ***Are you ready?***
QTH ***What is you location?***
QTR ***What is the correct time?***
QSK ***Full break in telegraphy***
QRQ ***Send Faster***
QRS ***Send slower***
QRV ***I am ready to receive***
QRZ ***Who is calling me?***
QSL ***Can you acknowledge receipt?***
QSY ***Shall I change to another frequency?***

A complete list of Q signals can be found at

http://bclingan.org/mainpage_000012.htm

G2C01
Full break-in telegraphy (QSK) allows transmitting stations to receive between code characters and elements.

G2C02
If a CW station sends "QRS" you should send slower.

G2C03
When a CW operator sends "KN" at the end of a transmission they are listening only for a specific station or stations.

G2C04
When a CW operator sends "CL" at the end of a transmission they are telling you they are closing the station.

G2C05
The best speed to use answering a CQ in Morse Code is the fastest speed at which you are comfortable copying.

G2C06
The term ñzero beatò in CW operation means matching your transmit frequency to the frequency of a received signal.

Zero beat is the condition reached when the beat frequency between two input signals is no longer detectable because there is no difference in frequency between the two signals..

G2C07
Sending CW, a ñCò added to the RST report means chirpy or unstable signal.

G2C08
The BK Prosign is sent to indicate the end of a formal message when using CW.

G2C09
The Q signal "QSL" means I acknowledge receipt.

G2C10
The Q signal "QRQ" means Send faster.

G2C11
The Q signal ñQRVò means I am ready to receive messages.

G2D - Amateur Auxiliary; minimizing interference; HF operations

G2D01
The Amateur Auxiliary to the FCC is Amateur volunteers who are formally enlisted to monitor the airwaves for rules violations.

G2D02
The objective of the Amateur Auxiliary is to encourage amateur self regulation and compliance with the FCC rules.

G2D03
ñHidden transmitter huntsò help to the Amateur Auxiliary learn direction finding skills used to locate stations violating FCC Rules.

G2D04
An azimuthal projection map is a world map projection centered on a particular location.

G2D05 [97.111 (a) (1)]
It permissible to communicate with amateur stations in countries outside the areas administered by the Federal Communications Commission when the contact is with amateurs in any country except those whose administrations have notified the ITU that they object to such communications.

G2D06
A directional antenna is pointed 180 degrees from its short-path heading when making a ñlong-pathò contact with another station.

G2D07 [97.303s]
If you are using other than a dipole antenna when operating in the 60 meter band, the FCC requires you tot keep a record of the gain of your antenna.

G2D08
Many amateurs keep a log even though the FCC doesn't require it to help with a reply if the FCC requests information.

STATION CALLSIGN: ______________ **HF Log Sheet** PAGE____ OF____.

DATE	UTC		FREQ	MODE	POWER	CALLSIGN	QTH	RST		
	ON	OFF						SENT	RCVD	
										1
COMMENTS										
										2
COMMENTS										
										3
COMMENTS										

G2D09
Information traditionally contained in a station log is:

- Date and time of contact
- Band and/or frequency of the contact
- Call sign of station contacted and the signal report given

G2D10
Low power transmit operation is called QRP operation.

G2D11
A unidirectional HF antenna would be the best to use for minimizing interference.

G2E - Digital operating: procedures, procedural signals and common abbreviations

G2E01
The LSB mode is normally used when sending an RTTY *(Radio Teletype)* signal via AFSK *(Audio Frequency Shift Keying)* with an SSB transmitter.

G2E02
The number data bits used to send in a single PSK31 character varies.

Fewer bits are use to represent the more frequently used letters and longer bit sequences are used for the lesser used letters. This speeds up transmission when compared to ASCII or other conventional character transmission methods.

G2E03
The Header of a data packet contains the routing and handling information.

G2E04
The 14.070 - 14.100 MHz segment of the 20 meter band is most often used for data transmissions.

G2E05
Baudot code is a 5-bit code, with additional start and stop bits.

G2E06
The most common frequency shift for RTTY emissions in the amateur HF bands is 170 Hz.

G2E07
The abbreviation "RTTY" stands for Radioteletype.

G2E08
The 3585 kHzï 3600 kHz segment of the 80 meter band is most commonly used for data transmission.

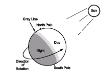
G2E09
In the segment of the 20 meter band below the RTTY segment, near 14.070 MHz,
Is where most PSK31 operations are commonly found.

G2E10
A major advantage of MFSK16 *(**M**ultiple **F**requency **S**h**i**ft **K**eying with 16 tones)* compared to other digital modes is that it offers good performance in weak signal environments without error correction

G2E11
The abbreviation "MFSK" stands for Multi ***(or Multiple)*** Frequency Shift Keying.

G2E12
A receiving station responds to an ARQ data mode packet containing errors by requesting that the packet be retransmitted.

G2E13
In the PACTOR protocol, a NAK response to a transmitted packet means the receiver is requesting the packet be re-transmitted.

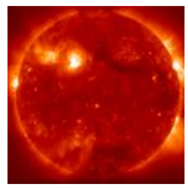


SUBELEMENT G3 - RADIO WAVE PROPAGATION [3 Exam Questions - 3 Groups]

Radio propagation reports are available from on the web from a number of sites, one site is located at http://www.hamradio-online.com/propagation.html

G3A - Sunspots and solar radiation; ionospheric disturbances; propagation forecasting and indices

G3A01
The sunspot number is a measure of solar activity based on counting sunspots and sunspot groups.



G3A02
A Sudden Ionospheric Disturbance *(SID)* disrupts signals on lower frequencies more than those on higher frequencies during daytime ionospheric propagation of HF radio waves.

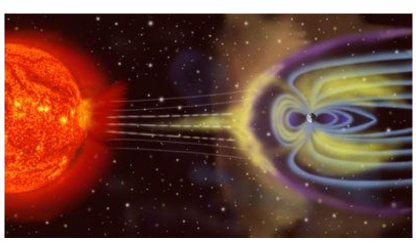
G3A03
It takes 8 minutes for increased ultraviolet and X-ray radiation from solar flares to affect radio-wave propagation on the Earth.

G3A04
The amateur radio HF frequencies of 21 MHz and higher are the least reliable for long distance communications during periods of low solar activity.

G3A05
The solar-flux index is a measure of solar radiation at 10.7 cm

10.7 cm wavelength = 2.80 GHz

G3A06
A geomagnetic storm causes temporary disturbance in the Earth's magnetosphere.



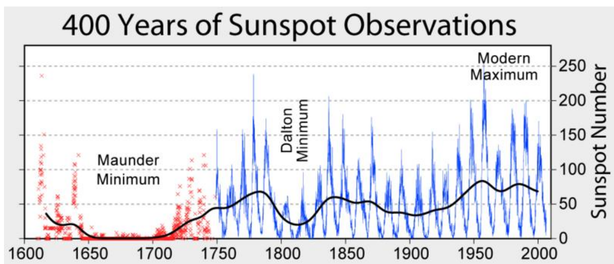
G3A07
At any point in the solar cycle the solar cycle the 20 meter band will usually support worldwide propagation during daylight hours.

G3A08
Degraded high-latitude HF propagation on radio-waves is an effect of a geomagnetic storm.

G3A09
High Sunspot numbers enhance Long-distance communication in the upper HF and lower VHF range.

G3A10
The Sunôs rotation on its axis causes HF propagation conditions to vary periodically in a 28-day cycle.

G3A11
The typical sunspot cycle is Approximately 11 years.

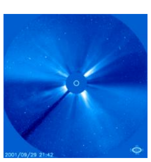


G3A12
The K-index indicates the short term stability of the Earthôs magnetic field.

G3A13
The A-index indicates the long term stability of the Earthôs geomagnetic field.

G3A14
HF communications are usually disturbed by the charged particles that reach the Earth from solar coronal holes.

G3A15
It takes 20 to 40 hours for charged particles from coronal mass ejections to affect radio-wave propagation on the Earth.



*A **coronal mass ejection (CME)** is a massive burst of solar wind, and magnetic fields rising above the solar corona or being released into space*

G3A16
Periods of high geomagnetic activity can generate an Aurora that can benefit radio communications by reflecting VHF signals.

G3B - Maximum Usable Frequency; Lowest Usable Frequency; propagation

G3B01
If a sky-wave signal sound arrives at your receiver by both short path and long path propagation a well-defined echo might be heard.

G3B02
Short skip sky-wave propagation on the 10 meter band is a good indicator of the possibility of sky-wave propagation on the 6 meter band.

G3B03
Select a frequency just below the MUF (maximum useable frequency) for the lowest attenuation when transmitting on HF.

G3B04
Listening for signals from an international beacon is a reliable way to determine if the Maximum Usable Frequency (MUF) is high enough to support skip propagation between your station and a distant location on frequencies between 14 and 30 MHz?

G3B05
Radio waves with frequencies below the Maximum Usable Frequency (MUF) and above the Lowest Usable Frequency (LUF) are bent back to the Earth when they are sent into the ionosphere.

G3B06
Radio waves with frequencies below the Lowest Usable Frequency (LUF) are bent and trapped in the ionosphere to circle the Earth.

G3B07
LUF stands for the Lowest Usable Frequency for communications between two points.

G3B08
MUF stand for the Maximum Usable Frequency for communications between two points.

G3B09
2,500 miles is the approximate maximum distance along the Earth's surface that is normally covered in one hop using the F2 region.

G3B10
1,200 miles is the approximate maximum distance along the Earth's surface that is normally covered in one hop using the E region.

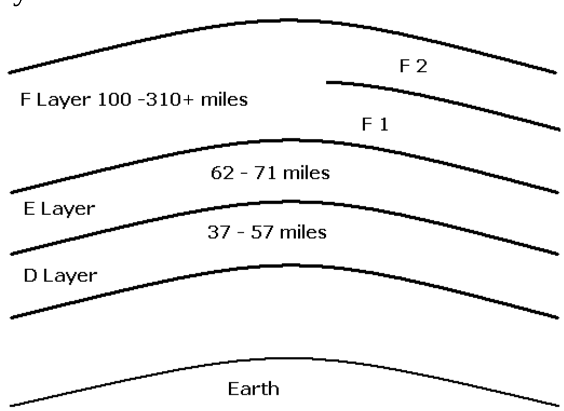
G3B11
When the Lowest Usable Frequency (LUF) exceeds the Maximum Usable Frequency (MUF) for a given path **no** HF radio frequency will support ordinary Skywave communications.

G3B12 (D)
Factors affecting the Maximum Usable Frequency (MUF) include:

- Path distance and location
- Time of day and season
- Solar radiation and ionospheric disturbances

G3C - Ionospheric layers; critical angle and frequency; HF scatter; Near Vertical Incidence Sky waves

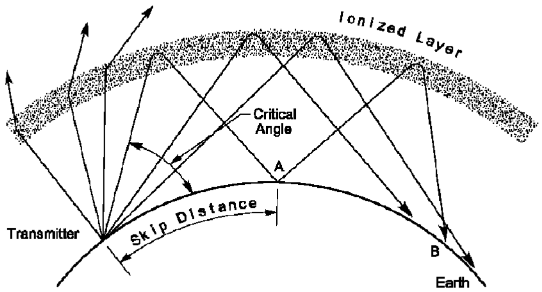
G3C01
The D ionospheric layer is closest to the surface of the Earth?



G3C02
Where the Sun is overhead ionospheric layers reach their maximum height?

G3C03
The F2 region mainly responsible for the longest distance radio wave propagation Because it is the highest ionospheric region.

G3C04
The term ñcritical angleò when used in radio wave propagation describes the highest takeoff angle that will return a radio wave to the Earth under specific ionospheric conditions.



G3C05
Long distance communication on the 40, 60, 80 and 160 meter bands is more difficult during the day because the D layer absorbs signals at these frequencies during daylight hours.

G3C06
A characteristic of HF scatter signals is that they have a wavering sound.

G3C07
HF scatter signals often sound distorted because energy is scattered into the skip zone through several different radio wave paths.

G3C08
HF scatter signals in the skip zone are usually weak because only a small part of the signal energy is scattered into the skip zone.

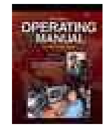
G3C09
Scatter radio wave propagation allows a signal to be detected at a distance too far for ground wave propagation but too near for normal sky-wave propagation.

G3C10
If a signal is heard on an HF frequency above the Maximum Usable Frequency might be an indication that the signals are being received via scatter propagation.

G3C11
An antenna consisting of horizontal dipoles placed between 1/8 and 1/4 wavelength above the ground will be most effective for skip communications on 40 meters during the day.

G3C12
The D layer is the most absorbent of long skip signals during daylight hours on frequencies below 10 MHz.

G3C13
Near Vertical Incidence Sky-wave *(NVIS)* propagation provides short distance HF propagation using high elevation angles.



SUBELEMENT G4 - AMATEUR RADIO PRACTICES
[5 Exam Questions - 5 groups]

G4A – Station Operation and set up

G4A01
The purpose of the "notch filter" found on many HF transceivers is to reduce interference from carriers in the receiver pass-band.

G4A02
It may be possible to reduce or eliminate interference from other signals by selecting the opposite or "reverse" sideband when receiving CW signals on a typical HF transceiver.

G4A03
Operating a transceiver in "split" mode is when the transceiver is set to different transmit and receive frequencies.

G4A04
A pronounced dip in the reading on the plate current meter of a vacuum tube RF power amplifier indicates correct adjustment of the plate tuning control.

The dip occurs because the output circuit is resonant, and some of the current is regenerated in the tank circuit with less coming from the power supply.

G4A05
The purpose of using Automatic Level Control (ALC) with a RF power amplifier is to reduce distortion due to excessive drive.

G4A06
An antenna coupler is often used to enable matching the transmitter output to an impedance other than 50 ohms.

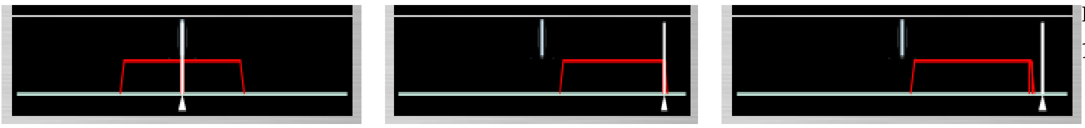
G4A07
Excessive drive power can lead to permanent damage when using a solid-state RF power amplifier.

G4A08
The correct adjustment for the load or coupling control of a vacuum tube RF power amplifier is maximum power output without exceeding maximum allowable plate current.

G4A09
A time delay is sometimes included in a transmitter keying circuit to allow time for transmit-receive changeover operations to complete properly before RF output is allowed.

G4A10
The purpose of an Electronic Keyer is the automatic generation of strings of dots and dashes for CW operation.

G4A11
The IF shift control on a receiver is used to avoid interference from stations very close to the receive frequency.



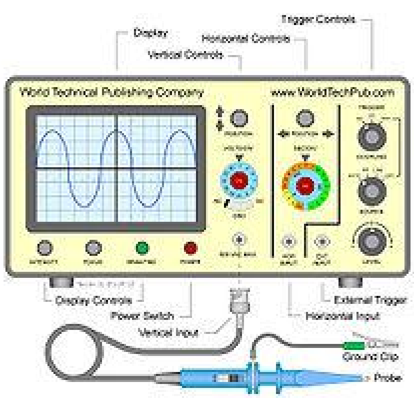
G4A12
A common use for the dual VFO feature on a transceiver is to permit ease of monitoring the transmit and receive frequencies when they are not the same.

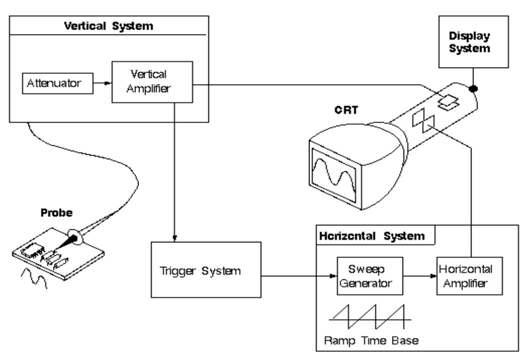
G4A13
One reason to use the attenuator function that is present on many HF transceivers is to reduce signal overload due to strong incoming signals.

G4A14
When transmitting PSK31 data signals the transceiver audio input be adjusted so that the transceiver ALC system does not activate.

G4B - Test and monitoring equipment; two-tone test

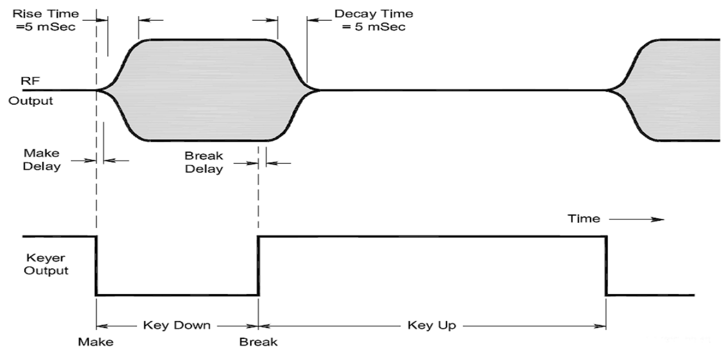
G4B01
An oscilloscope is an item of test equipment that contains horizontal and vertical channel amplifiers *and displays a visual representation of a waveform as amplitude (vertical) vs time (horizontal).*



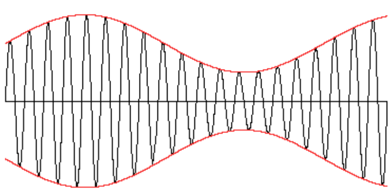


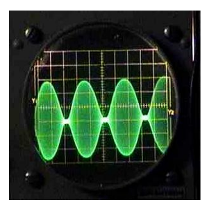
G4B02
The advantage of an oscilloscope versus a digital voltmeter is that complex waveforms can be measured.

G4B03
An oscilloscope is the best instrument to use when checking the keying waveform of a CW transmitter.



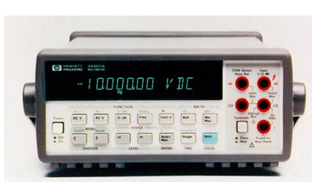
G4B04
The attenuated RF output of the transmitter is connected to the vertical input of an oscilloscope when checking the RF envelope pattern of a transmitted signal.





G4B05
High input impedance is desirable for a voltmeter because it decreases the loading on circuits being measured.

G4B06
An advantage of a digital voltmeter as compared to an analog voltmeter is better precision for most uses.



G4B07
A use for a field strength meter might be a for Close-in radio direction-finding.

G4B08
A field-strength meter may be used to monitor relative RF output when making antenna and transmitter adjustments.

G4B09
The radiation pattern of an antenna can be determined with a field strength meter.

G4B10
Standing wave ratio *(VSWR)* can be determined with a directional wattmeter.

G4B11
The antenna and feed line must be connected to an antenna analyzer when it is being used for SWR measurements.

G4B12
Strong signals from nearby transmitters can affect the accuracy of measurements on an antenna system with an antenna analyzer.

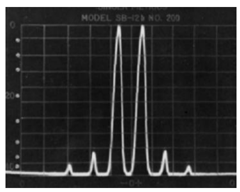
The antenna may pick up strong nearby signals that interfere with measurements in the analyzer.

G4B13
Another use for an antenna analyzer other than measuring the SWR of an antenna system is determining the impedance of an unknown or unmarked coaxial cable

G4B14
When adjusting tuned circuits the use of an instrument with analog readout may be preferred over an instrument with a numerical digital readout.

It is easier to see peaks and nulls on an analog meter than determining which direction the digital meter readings are going.

G4B15
Analyzing the linearity performance of a SSB Transmitter is done using a two-tone test.

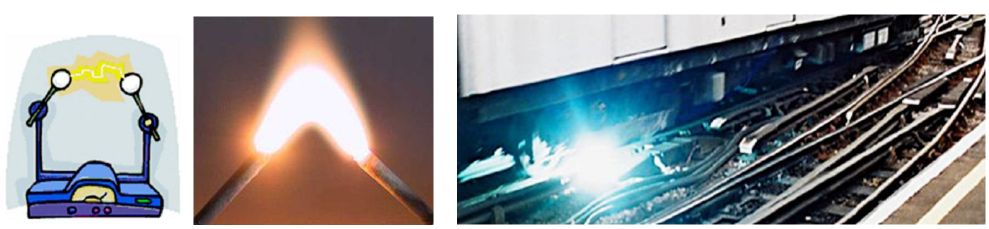


G4B16
Two non-harmonically related audio signals are used to conduct a two-tone test.

G4C - Interference with consumer electronics; grounding; DSP

G4C01
Bypass capacitor might be useful in reducing RF interference to audio-frequency devices?

G4C02
Arcing at a poor electrical connection could be a cause of interference covering a wide range of frequencies.



G4C03
If distorted speech is heard from an audio device or telephone it may be interference from a nearby single-sideband phone transmitter.

G4C04
Interference from a nearby CW transmitter could sound like on-and-off humming or clicking is in an audio device or telephone system.

G4C05
If you receive an RF burn when touching your equipment while transmitting on an HF band, assuming the equipment is connected to a ground rod may be caused by a ground wire has high impedance on that frequency.

This is because at some frequencies the ground wire is inductive and may become resonant at some frequencies Using a lower inductance ground wire will reduce this problem.

G4C06
High RF voltages on the enclosures of station equipment can be caused by a resonant ground connection.

G4C07
One good way to avoid unwanted effects of stray RF energy in an amateur station is to connect all equipment grounds together *at a single point*.

G4C08
Placing a ferrite bead around the cable would reduce RF interference caused by common-mode current on an audio cable.

The ferrite bead acts like a series inductor

G4C09
A ground loop can be avoided by connecting all ground conductors to a single point.

G4C10
If you receive reports of "hum" on your station's transmitted signal it could be a symptom of a ground loop somewhere in your station.

G4C11
Removing noise from received signals is one use for a Digital Signal Process in an amateur station.

G4C12
An advantage of a receiver Digital Signal Processor IF filter as compared to an analog filter is that a wide range of filter bandwidths and shapes can be created.

G4C13
A Digital Signal Processor (DSP) filter can perform automatic notching of interfering carriers.

G4D - Speech processors; S meters; sideband operation near band edges

G4D01
The purpose of a speech processor as used in a modern transceiver is to Increase the intelligibility of transmitted phone signals during poor conditions.

G4D02
A speech processor It increases average power in a transmitted single sideband phone signal.

G4D03
An incorrectly adjusted speech processor can cause:

- Distorted speech
- Splatter
- Excessive background pickup

G4D04
An S meter measures received signal strength

G4D05
An S meter reading of 20 dB over S-9 compared to an S-9 signal, assuming a properly calibrated S meter means the signal is 100 times stronger.

3dB= 2 times, 6dB= 4 times, 10dB=10 times, ***20dB=100 times*** *and 30dB=1000 times stronger See dB section in appendix for more information.*

.

G4D06
An S meter is found in a receiver.

G4D07
The power output of a transmitter must be raised Approximately 4 times to change the S- meter reading on a distant receiver from S8 to S9?

Note that the readings from S1 to S9 are not in dB. The readings above S9 are given in dB above S9. Each S unit represents approx a 6dB voltage change (or a 3dB power change)

G4D08
The frequency range (bandwidth) occupied by a 3 kHz LSB signal when the displayed carrier frequency is set to 7.178 MHz is 7.175 to 7.178 MHZ

The frequency occupied by a SSB signal is approx 3 kHz. For a lower sideband signal the spectrum occupied will be from 3 kHz below the dial set frequency to the dial set frequency. In this case frequency occupied would be(Frequencies shown are in MHz):

The carrier frequency – 3 kHz (for lower SSB) to the carrier set frequency
7.178- .003 to 71.78 or 71.75 to 71.78 MHz

G4D09 (B)
The frequency range is occupied by a 3 kHz USB signal with the displayed carrier frequency set to 14.347 MHz would be 14.347 to 14.350 MHz.

The frequency occupied by a SSB signal is approx 3 kHz. For an upper sideband signal the spectrum occupied will be from +3 kHz above the dial set frequency to the dial set frequency. In this case frequency occupied would be (Frequencies shown are in MHz):

The carrier frequency +3 kHz (for USB) to the carrier set frequency
14.347 +.003 to 14.37 or 14.350 to 14.350

G4D10
The displayed carrier frequency should be set 3 kHz above the lower edge of the 40 meter General Class phone segment for 3 kHz wide LSB?

G4D11
The displayed carrier frequency should be set 3 kHz below upper edge of the 20 meter General Class band when using 3 kHz wide USB?

G4E - HF mobile radio installations; emergency and battery powered operation

G4E01
A "capacitance hat", when referring to a mobile antenna, is a device that electrically lengthens a physically short antenna.

G4E02
The purpose of a "corona ball" on a HF mobile antenna is to reduce high voltage discharge from the tip of the antenna.

G4E03
A direct, fused power connection to the battery using heavy gauge wire would be the best for a 100-watt HF mobile installation?

The both leads, negative and positive, should be connected directly to the battery terminals with fuses at the battery end of the cables.

G4E04
It best **NOT** to draw the DC power for a 100-watt HF transceiver from an automobile's auxiliary power socket because the socket's wiring may be inadequate for the current being drawn by the transceiver.

Typical 100 watt transceivers draw around 20 amperes, typical auxiliary power sockets are rated at approx 10 amperes. .

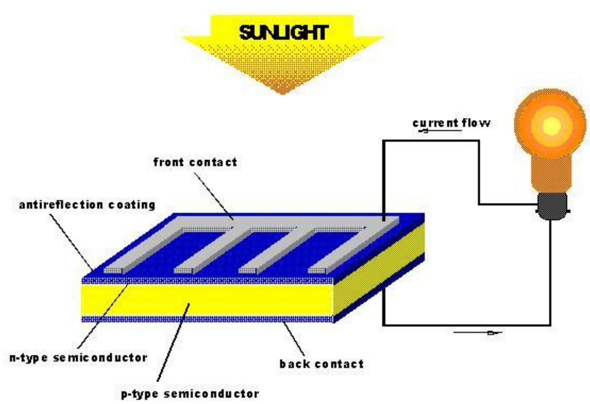
G4E05
The antenna system most limits the effectiveness of an HF mobile transceiver operating in the 75 meter band.

It is not possible to put a full ¼ wavelength antenna on a mobile. Any antennaa for these frequencies would be inefficient.

G4E06
One disadvantage of using a shortened mobile antenna as opposed to a full size antenna is that the operating bandwidth may be very limited.

G4E07
The vehicle control computer is the most likely to cause interfering signals to be heard in the receiver of an HF mobile installation in a recent model vehicle.

G4E08
Photovoltaic conversion is the name of the process by which sunlight is changed directly into electricity.

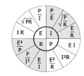


G4E09
The approximate open-circuit voltage from a modern, well-illuminated photovoltaic cell is 0.5 VDC.

G4E10
The reason a series diode is connected between a solar panel and a storage battery that is being charged by the solar panel to prevent self discharge of the battery though the panel during times of low or no illumination.

G4E11
A disadvantage of using wind as the primary source of power for an emergency station is that a large energy storage system is needed to supply power when the wind is not blowing.

SUBELEMENT G5 – ELECTRICAL PRINCIPLES



[3 Exam Questions – 3 Groups]

G5A - Reactance; inductance; capacitance; impedance; impedance matching

G5A01
Impedance is the opposition to the flow of current in an AC circuit.

G5A02
Reactance is the opposition of alternating current flow caused by capacitance or inductance.

Capacitive reactance $= 1/(2(\pi(F_{hertz})(C_{farads})))$

G5A03
Reactance *(inductive)* causes opposition to the flow of alternating current in an inductor.

Inductive reactance $= 2(\pi(F_{hertz})(L_{henries}))$

G5A04
Reactance *(capacitive)* causes opposition to the flow of alternating current in a capacitor.

G5A05
In a inductor as the frequency of the applied AC increases, the reactance increases.

G5A06
In a capacitor as the frequency of the applied AC increases, the reactance decreases.

G5A07
When the impedance of an electrical load is equal to the internal impedance of the power source the source can deliver maximum power to the load

G5A08
Impedance matching is important so the source can deliver maximum power to the load.

G5A09
Reactance is measured in Ohms.

G5A10
Impedance is measured in Ohms.

G5A11
Inserting an LC network between the two circuits is one method of impedance matching between two AC circuits.

G5A12 (B)
One reason to use an impedance matching transformer is to maximize the transfer of power.

G5A13 (D)
The following devices can be used for impedance matching at radio frequencies:

- A transformer
- A Pi-network
- A length of transmission line

G5B - The Decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations

- *A two time's increase or decrease in power would result in a change of 3dB.*
  Ratio = 10 ^(db/10) or Ratio = 10 ^(3/10) or Ratio = 10 ^(.300) Ratio = 1.995
- *What is the percentage of power loss would there be from 1dB transmission line cable loss.*
  Ratio= 10 ↑(db/10) or Ratio = 10 ↑(1/10) or Ratio = .794 or a loss of 20.6% (100%-79.4%=20.6% loss)

G5B01
A two-times increase or decrease in power results in a change of approximately 3 dB.

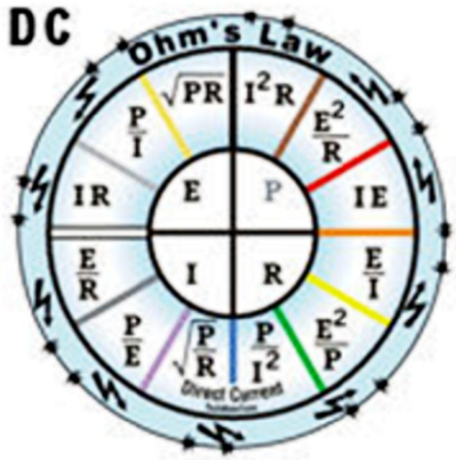
The table below shows common values of dB gain or loss. Multiply the original power by the gain or loss number for the dB of gain or loss.

Gain (+)	dB	Loss (-)
x 1.2	1	**80%**
x 1.6	2	**63%**
x 2	3	**50%**
x 10	10	**10%**

- *A two time's increase or decrease in power would result in a change of 3dB.*
  Ratio = 10 ^(db/10) or Ratio = 10 ^(3/10) or Ratio = 10 ^(.300) Ratio = 1.995
- *What is the percentage of power loss would there be from 1dB transmission line cable loss.*
  Ratio= 10 ↑(db/10) or Ratio = 10 ↑(1/10) or Ratio = .794 or a loss of 20.6% (100%-79.4%=20.6% loss)

G5B02
The total current in a parallel circuit equals the sum of the individual currents in each branch of the circuit.

G5B03
200 watts of electrical power are used if 400 VDC is supplied to an 800-ohm load.



To calculate the power refer to the ohms law circle above to find the equation for power (P) when resistance(R) and voltage (V) are known.

P=E²/R or P=(400)²/800 or P=160,000 / 800 or P= ***200 Watts***

G5B04
2.4 watts of electrical power are used by a 12-VDC light bulb that draws 0.2 amperes.

To calculate the power refer to the ohms law circle under question G5B03 to find the equation for power (P) when voltage (E) and Current(I) are known.

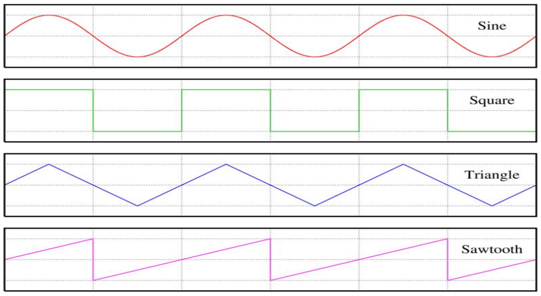
*P=E * I or P = 12 * 0 .2 or P = 2.4Watts*

G5B05 (A)
Approximately 61 milliwatts are dissipated when a current of 7.0 milliamperes will flow through 1.25 kiliohms.

To calculate the power refer to the ohms law circle under question G5B03 to find the equation for power (P) when Current(I) resistance (R) are known.

P= I ² R or P =(0.007)² * 1250 or P = 0.000049 * 1250 or P=0.0613 watts*
0.061 Watts = 61.3 Milliwatts)

AC Waveform Tutorial



*A **Sine Wave** is a waveform whose amplitude when rotated through 360 degrees follows a trigonometric **Sine function**. A pure sine wave contains only the fundamental of it's frequency.*

*A **Square Wave** is a waveform that alternates abruptly between two voltage levels and stays at each voltage level an equal amount of time. A square wave is made up of a fundamental wave and an infinite number of odd harmonics that add up to make the square wave.*

*A **Pulse waveform** (Not shown) is a waveform that alternates abruptly between two voltage levels and stays at each voltage level for an equal or unequal amount of time. When the times are equal we call it a square wave.*

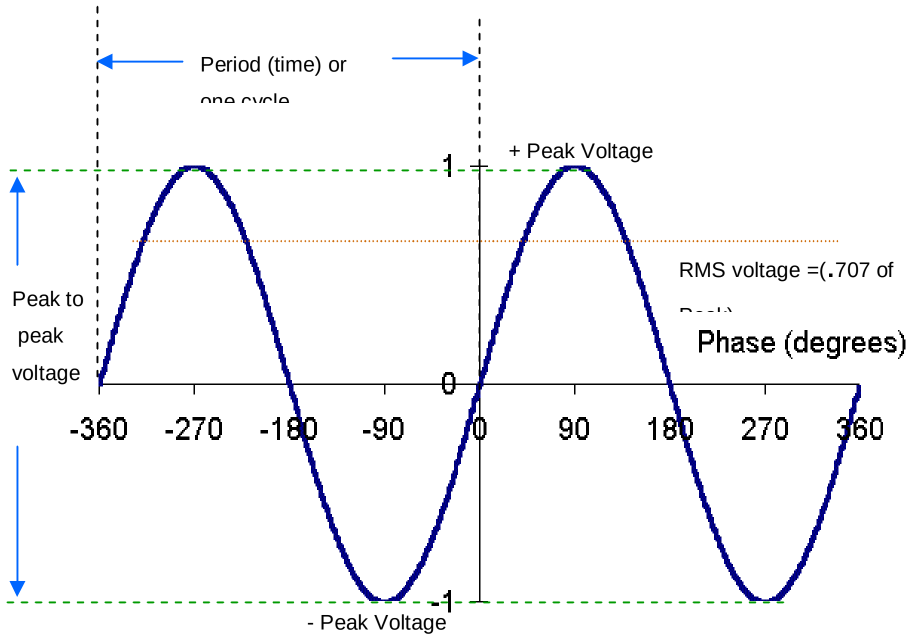
*A **Saw Tooth Waveform** is a wave with a **straight line rise and fall time that is not symmetrical**; that is the rise time is longer than the fall time or visa versa**. A saw tooth wave is made up of a fundamental and all harmonics**.*

A Triangle Waveform** is a special case of the saw tooth wave in that it **has equal rise and fall times.

Characterizing a Sine Waveform

Shown below are two cycles of a sine wave

A sine wave can be displayed on an oscilloscope to determine its frequency by dividing the time for one cycle into 1.00.



F(in Hertz)=1/time for one cycle.

Examples:

What is the frequency of a sine wave with a 10 ms period for one cycle?

F=1/time F = 1/.010 F=100Hz

What is the frequency of a sine wave with a 1 µs period for one cycle?

F=1/time F = 1/.000001 F= 1 MHz

What is the frequency of a sine wave with a 15 µs period for one cycle?

F=1/time F = 1/.000015 F=66.666 kHz

What is the frequency of a sine wave with a 16.66 ms period for one cycle?

F=1/time F = 1/.016.666 F=60.000 Hz

The RMS (Root Mean Square) value for a sine wave is the value of an equivalent DC voltage required to generate the same amount of power or heat in a resistive load (sometimes referred to as the equivalent heating effect).

For a pure sine wave the equivalent RMS value is .707 times the peak value. Conversely the peak voltage can be calculated as 1.414 times the RMS Value. (if you remember .707 (Boeing 707) RMS from the peak voltage you can find the multiplier for RMS to peak by dividing .707 into 1 or 1 / 0.707 = 1.414)

Examples:

The peak voltage present in standard 120V RMS AC line voltage is 1.414 x 120V or ~170 volts peak. The peak to peak (maximum negative to maximum positive peaks) would be two times the peak voltage or ~340 V Peak to Peak.

PP= 2x Peak or PP=2 x (RMS x 1.414) or PP= 2 x 169.7 or PP= 339.4 Volts

An AC voltage that reads 65 volts on an RMS meter will have a peak to peak voltage of 184 Volts.

Peak to peak Voltage = 2 x RMS x 1.414 = 2 x 65 x 1.414 = 183.8 V PP

If we start at the first positive peak to the next positive peak of one cycle of our sine wave you will observe that it crosses through 0 twice in the cycle.

The time it takes for one cycle of a sine wave is the period of the waveform. A 100 Hz sine wave has a period of .01 Seconds (or 10 milliseconds).

The average power dissipated by a 50 ohm resistor during one cycle of voltage with a peak voltage of 35 volts is 12.2 Watts.

$P(avge) = E^2 (RMS) / R = (.707 \times 35)^2 / 50$ $P = 612.3 / 50$ or $P = 12.25$ Watts

IF a voltmeter reads 34 volts RMS when measuring a sinusoidal signal the peak voltage would be 48 Volts.

$V(peak) = V(RMS) \times 1.414$ or $V = 34 \times 1.414$ or $P = 48.08$ volts

Transmitter Power

Because many amateur transmissions are not pure sine waves calculating average or RMS power is not easy. Measuring power for FM and CW (key down) power can be measured as average power. An example would be a two meter FM HT where power is specified as RMS power. SSB transmission on the other hand would be very difficult to measure in terms of RMS directly because the only time there is power present is when you are speaking into the microphone, and the power when you are speaking is a function of your voice level (louder voice more power is transmitted). To characterize a SSB transmitter we talk about its output as PEP or peak enveloped power. Where it gets confusing is that we talk about average power in the peak level of the transmitted power. If we were to look at our SSB signal we would be able to measure the peak level of our modulation as we speak into the microphone. Once we have the peak voltage we can apply the rules to find the RMS value of the peak voltage, which is called Peak Envelope Power or PEP.

Peak Envelope Power (PEP) Calculations

When calculating Peak envelope power for a SSB transmitter using an oscilloscope to measure the voltage we use the equation above Power = E^2 / R Where Power in watts is equal to the RMS value of the RF Voltage divided by the transmitter/antenna impedance in ohms (usually 50 ohms). The oscilloscope measures the peak to peak voltage so to determine the peak voltage we divide it by 2. We multiply the peak voltage by .707 to get the RMS voltage that we will use in the equation.

G5B06
The output PEP from a transmitter if an oscilloscope measures 200 volts peak-to-peak across a 50-ohm dummy load connected to the transmitter output is 100 Watts.

PEP =[(200 / 2) x .707] ² / R or PEP= [70.7] ² / 50 or PEP= 4,998 / 50 or PEP= 99.97 Watts

G5B07
The RMS value of an AC signal results in the same power dissipation as a DC voltage of the same value.

RMS is defined as the value of an ac waveform that has the same heating effect on a resistive load as an equivalent DC voltage.

G5B08
The peak-to-peak voltage of a sine wave that has an RMS voltage of 120 volts is 339.4 volts

*Peak to Peak = 2 (1.414 * RMS) or PP= 2(1.414 * 120) or 2(169.68) or PP = 339.36 Volts*

G5B09 (B)
What is the RMS voltage of a sine wave with a value of 17 volts peak is 12 volts.

*RMS = Peak * 0.707 or RMS = 17 * 0.707 or RMS = 12 Volts*

G5B10
The percentage of power loss that would result from a transmission line loss of 1 dB would be approx. 20 % .

See Table under question *G5B01. It shows a 1 db loss would be 80% of the original power.*

G5B11
The ratio of peak envelope power to average power for an unmodulated carrier is 1.00 *or 100%*

G5B12
The RMS voltage across a 50-ohm dummy load dissipating 1200 watts would be 245 volts.

To calculate the power refer to the ohms law circle under question G5B03 to find the equation for Voltage (E) when voltage (E) and Resistance(R) are known.

*E =√ (P * R) or E = √ (1200 * 50) or E = √ 60,000 or E = 244.9 Volts RMS*

G5B13
The output PEP of an unmodulated carrier when an average reading wattmeter connected to the transmitter output indicates 1060 watts is 1060 watts.

G5B14
The output PEP from a transmitter if an oscilloscope measures 500 volts peak-to-peak across a 50-ohm resistor connected to the transmitter output is 625 watts.
*PEP =[(500 / 2) x .707] ² / R or PEP= [250 * .707] ² / 50 or PEP= [176.75] ² / 50 or PEP= 31,240. 56 / 50 or PEP = 624.81 Watts*

G5C – Resistors, capacitors, and inductors in series and parallel; transformers

G5C01
Mutual inductance causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding.

G5C02
The primary winding of a transformer is normally connected to the incoming source of energy.

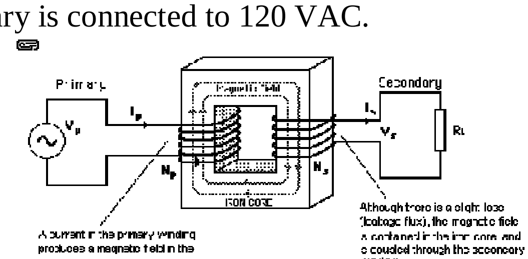
G5C03
A resistor in series should be added to an existing resistor to increase the resistance.

G5C04
The total resistance of three 100-ohm resistors in parallel is 33.3 ohms.

For identical resistors in parallel simply divide the resistance of one resistor by the number of resistors to find the total network resistance.
R = resistor value / number of resistors or R = 100 / 3 or R = 33.333 Ohms

G5C05
If three equal value resistors in parallel produce 50 ohms of resistance, and the same three resistors in series produce 450 ohms, the value of each resistor is 150 ohms
In series R = 150 + 150 + 150 or 450 Ohms
In Parallel R = value of one resistor / number of resistors or R= 150 / 3 or R = 50 Ohms

G5C06
What is the RMS voltage across a 500-turn secondary winding in a transformer would be 26.7 volts if the 2250-turn primary is connected to 120 VAC.



*The Ratio of input to output is: secondary turns / Primary turns or 500 / 2250 or .222 therefore the Secondary output voltage will be .222 times the input voltage or .222 * 120 or 26.666 Volts*

See Appendix for more information on transformers.

G5C07
The turnôs ratio of a transformer used to match an audio amplifier having a 600 ohm output impedance to a speaker having a 4-ohm impedance would be 12.2 to 1.

The impedance ratio of a transformer is equal to the square of the turns ratio
Z ratio = $(T \text{ ratio})^2$ The Desired Z ratio is 600 ohms to 4 0hms therefore:

Z ratio = $T_{(ratio)}^2$ or $T_{(ratio)}^2$ = 600 / 4 or $T_{(ratio)}^2$ =150 or $T_{(ratio)}$ = 12.247

G5C08
The equivalent capacitance of two 5000 picofarad capacitors and one 750 picofarad capacitor connected in parallel is 10750 picofarads.

Capacitors in parallel simply add together therfor the total capacity would be:
5000 pf + 5000pf + 750 pf or 10750 pf

G5C09
The capacitance of three 100 microfarad capacitors connected in series is 33.3 microfarads

For identical capacitors in series simply divide the capacitance of one capacitor by the number of Capacitors.

C=capacitance value / number of capacitors or C = 100 / 3 or C = 33.333 microfarads

G5C10
The inductance of three 10 millihenry inductors connected in parallel would be 3.3 millihenrys

For identical inductors in parallel simply divide the inductance of one inductor by the number of inductors.

L=Inductor value / number of inductors or L = 10 / 3 or L = 3.333 millihenrys

G5C11
The inductance of a 20 millihenry inductor in series with a 50 millihenery inductor would be 70 millihenrys.

Inductors in series simply add. Therfore L = 20 + 50 or L = 70 millihenrys.

G5C12 (B)
The capacitance of a 20 microfarad capacitor in series with a 50 microfarad capacitor would be 14.3 microfarads

C= (1/ (1/C_1) + (1/C_2)) or C = (1/ (1/20) + (1/50)) or C = (1/ (.050)+(1/.020)) or C = (1/.07) or C = 14.285

G5C13

A capacitor in parallel should be added to a capacitor to increase the capacitance?

G5C14
An inductor in series should be added to an inductor to increase the inductance.

G5C15 (A)
Total resistance of a 10 ohm, a 20 ohm, and a 50 ohm resistor in parallel would be 5.9 ohms.

R_t= (1/ (1/R_1) + (1/R_2) + (1/R_3)) or R_t= (1/ (1/10) + (1/20) + (1/50)) or
R_t = (1/ (0.1) + (0.05) + (0.02)) or R_t =1/ .17 or R_t = 5.88 ohms

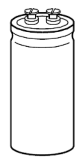
Remember that the total resistance in a parallel circuit will always be less than the smallest resistor in the parallel network.


SUBELEMENT G6 – CIRCUIT COMPONENTS
[3 Exam Questions – 3 Groups]

G6A - Resistors; capacitors; inductors

G6A01
An important characteristic for capacitors used to filter the DC output of a switching power supply would be a low equivalent series resistance.

G6A02
Electrolytic capacitors are often used in power supply circuits to filter the rectified AC (Alternating Current).

G6A03
An advantage of ceramic capacitors as compared to other types of capacitors is comparatively low cost.




G6A04
An advantage of an electrolytic capacitor is high capacitance for given volume.

G6A05
The effect of lead inductance in a capacitor used at VHF frequencies and above is that Effective capacitance may be reduced because of the lead inductance.

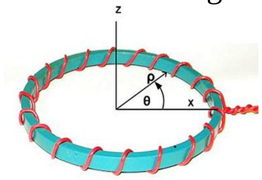
G6A06
The resistance of a resistor will change in a predictable way depending on the resistor's temperature coefficient. As the temperature of the resistor is increased the resistance increases.

G6A07
A reason not to use wire-wound resistors in an RF circuit is that the resistor's inductance could make circuit performance unpredictable

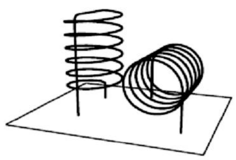

G6A08
A Thermistor is a device which has a specific change in resistance with temperature variations.

G6A09
The advantage of using a ferrite core toroidal inductor is that:

- Large values of inductance may be obtained
- The magnetic properties of the core may be optimized for a specific range of frequencies
- Most of the magnetic field is contained in the core

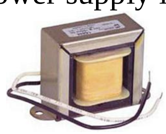


G6A10
The winding axes of solenoid inductors would be placed at right angles to minimize their mutual inductance.

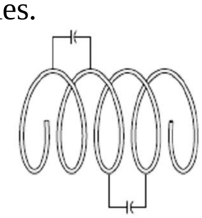


G6A11
It would it be important to minimize the mutual inductance between two inductors to reduce unwanted coupling between circuits

G6A12
What is a common name for an inductor used to help smooth the DC output from the rectifier in a conventional power supply is a Filter Choke.



G6A13
An effect of inter-turn capacitance in an inductor is that the inductor may become self resonant at some frequencies.



G6B - Rectifiers; solid state diodes and transistors; vacuum tubes; batteries

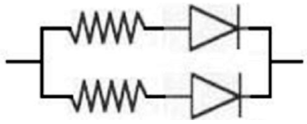
G6B01
The peak-inverse-voltage rating of a rectifier is the maximum voltage the rectifier will handle in the non-conducting direction.

G6B02
There are two major ratings that must not be exceeded for silicon diode rectifiers, peak inverse voltage; averaqge forward current.

G6B03
The approximate junction threshold voltage of a germanium diode is 0.3 volts.

This is the voltage drop across the diode junction when it is conducting in the forward direction.

G6B04
When two or more diodes are connected in parallel to increase current handling capacity, the purpose of the resistor connected in series with each diode is to ensure that one diode doesn't carry most of the current.



G6B05
The approximate junction threshold voltage of a conventional silicon diode is 0.7 volts.

This is the voltage drop across the diode junction when it is conducting in the forward direction

G6B06
An advantage of using a Schottky diode in an RF switching circuit as compared to a standard silicon diode is that it has Lower capacitance.

It is deseirable to have low capacity across the diode junction in higher frequencies where the capacitive reactance forms a significant path around the diode when reverse (Back) biased in the non conductive state.

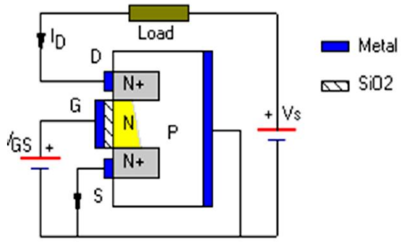
G6B07
The stable operating points for a bipolar transistor used as a switch in a logic circuit are its saturation and cut-off regions.

Saturation is where the transistor is Base biased for maxim emitter to collector current flow Cut-off is where the transistor is base biased for minimum emitter to collector current flow

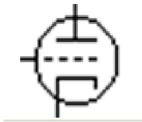
G6B08
The cases of some large power transistors must be insulated from ground to avoid shorting the collector or drain voltage to ground.

In many power transistors the collector is physically and electrically attached to the case for maximum heat transfer.

G6B09
In the construction of a MOSFET the gate is separated from the channel with a thin insulating layer.



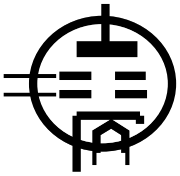
G6B10
The element of a triode vacuum tube is used to regulate the flow of electrons between cathode and plate is the control grid



G6B11
A Field Effect Transistor is most like a vacuum tube in its general operating characteristics?

High input impedance and low control current

G6B12
The primary purpose of a screen grid in a vacuum tube is to reduce grid-to-plate capacitance.



G6B13
An advantage of the low internal resistance of nickel-cadmium batteries is high discharge current.

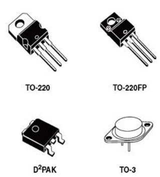
G6B14
The minimum allowable discharge voltage for maximum life of a standard 12 volt lead acid battery is 10.5 volts.

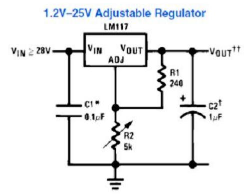
G6B15
It is **never** it acceptable to recharge a carbon-zinc primary cell.

They may explode if you try to recharge them!!!

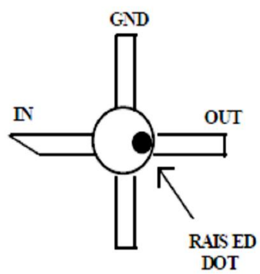
G6C - Analog and digital integrated circuits (IC's); microprocessors; memory; I/O devices; microwave IC's (MMIC's); display devices

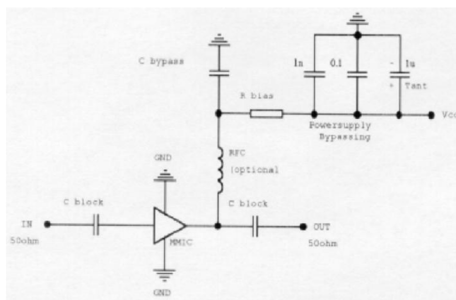
G6C01
A Linear voltage regulator is an analog integrated circuit.





G6C02
The term MMIC stands for Monolithic Microwave Integrated Circuit



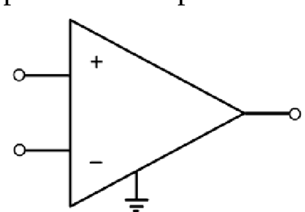


G6C03
Low power consumption is an advantage of CMOS integrated circuits compared to TTL integrated circuits.

G6C04
The term ROM stands for Read Only Memory.

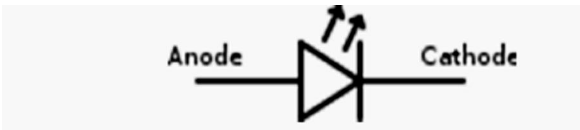
G6C05
When memory is characterized as ñnon-volatileò it means the stored information is maintained even if power is removed.

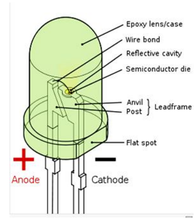
G6C06
An integrated circuit operational amplifier is an analog device.



G6C07
One disadvantage of an incandescent indicator compared to an LED is high power consumption.

G6C08
An LED is forward biased when emitting light.

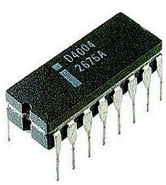


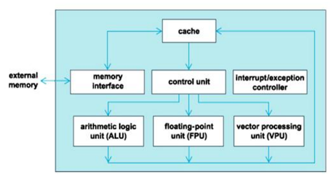


G6C09
A liquid crystal display requires ambient or back lighting.

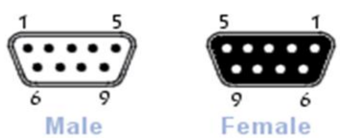
G6C10
Two devices in an Amateur Radio station that might be connected using a USB interface are a computer and transceiver.

G6C11
A microprocessor is a computer on a single integrated circuit.





G6C12
A DB-9 connector would be a good choice for a serial data port.



G6C13
A PL-259 connector is commonly used for RF service at frequencies up to 150 MHz.

G6C14
An RCA Phono connector is commonly used for audio signals in Amateur Radio stations.

G6C15
The main reason to use keyed connectors instead of non-keyed types is to reduce the chance of incorrect mating.

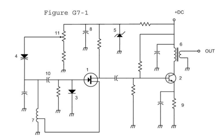
G6C16
A type-N connector is a moisture-resistant RF connector useful to 10 GHz.

G6C17
The general description of a DIN type connector is a family of multiple circuit connectors suitable for audio and control signals.

G6C18 (B)
A type SMA connector is a small threaded connector suitable for signals up to several GHz.

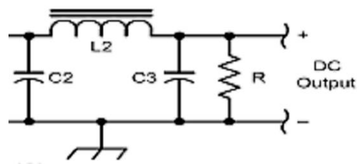
Actually a high quality SMA connector is useable to 18 GHz and beyond



G7 – PRACTICAL CIRCUITS [3 Exam Questions – 3 Groups]

G7A Power supplies; and schematic symbols

G7A01
For safety a power-supply bleeder resistor discharges the filter capacitors.

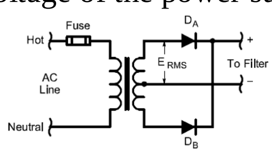


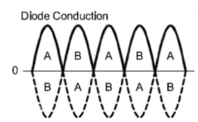
R is the bleeder resistor

G7A02
Capacitors and inductors are used in a power-supply filter network.

See Schematic in G7A01. The filter components are C2, C3 and L2.

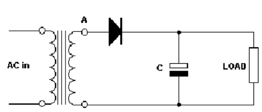
G7A03
The peak-inverse-voltage across the rectifiers in a full-wave power supply is double the normal peak output voltage of the power supply.

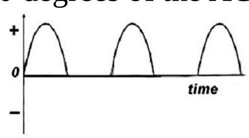




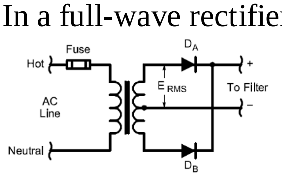
G7A04
The peak-inverse-voltage across the rectifiers in a half-wave power supply is Equal to the normal output voltage of the power supply.

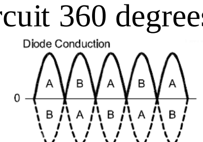
G7A05
In a half-wave rectifier circuit 180 degrees of the AC cycle is converted to DC.

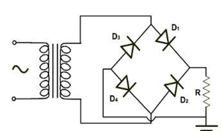




G7A06
In a full-wave rectifier circuit 360 degrees of the AC cycle is converted to DC.



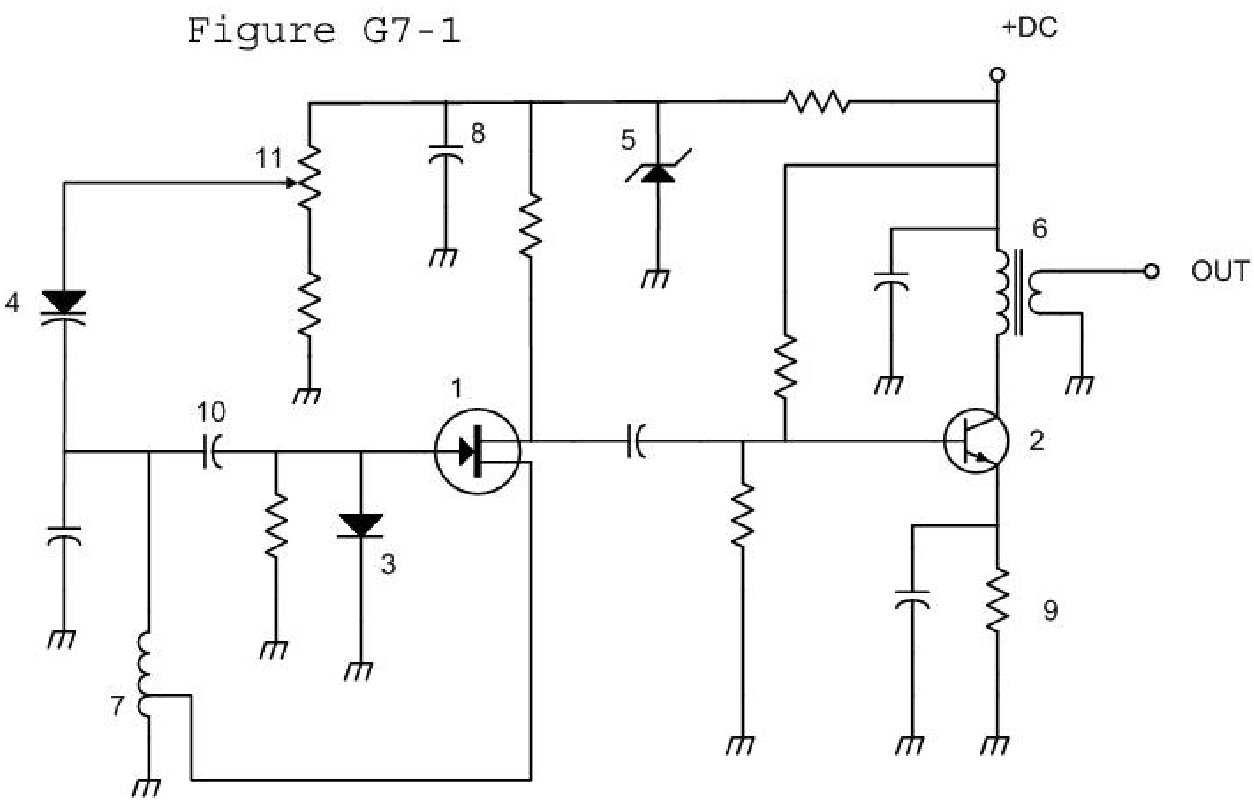




G7A07
The output waveform of an unfiltered full-wave rectifier connected to a resistive load is a series of DC pulses at twice the frequency of the AC input.

G7A08
The advantage of a switch-mode power supply as compared to a linear power supply is that high frequency operation allows the use of smaller *and lighter* components.

G7A09
Symbol 1in figure G7-1 represents a field effect transistor?



G7A10
Symbol 5 in figure G7-1 represents a Zener diode.

G7A11
Symbol 2 in figure G7-1 represents an NPN junction transistor.

In a NPN transistor the emitter arrow is ***NOT POINTING*** *in.*
In a PNP transistor the emitter arrow is ***POINTING*** *in*

G7A12
Symbol 6 in Figure G7-1 represents a multiple-winding transformer.

G7A13
Symbol 7 in Figure G7-1 represents a tapped inductor.

G7B - Digital circuits; amplifiers and oscillators

G7B01
Complex digital circuitry can often be replaced by a microcontroller integrated circuit.

G7B02
An advantage of using the binary system when processing digital signals is that binary "ones" and "zeros" are easy to represent with an "on" or "off" state.

G7B03
The function of a two input AND gate is to output a high only when both inputs are high

*The output function of an AND Gate is to provide a true (or 1 state) output when both the A **and** B inputs are true(or 1 State).*

For more information on digital logic circuits see the "Digital Circuits" section of the appendix.

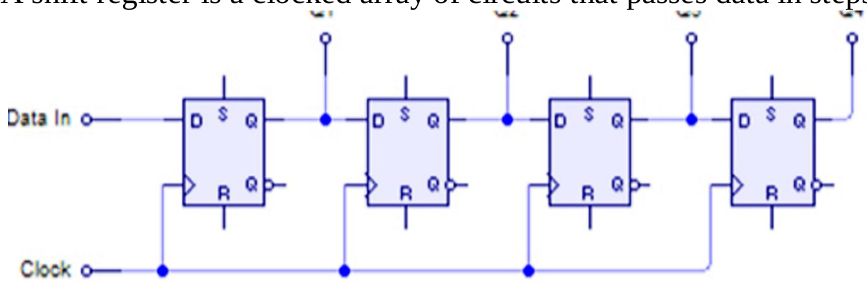
G7B04
The function of a two input NOR gate is to output a low (0 state) when either or both inputs are high (1 State).

*The output function of a NOR Gate is to provide a true (or 1 state) output when neither the A **and** B inputs are true(or 1 State).*

G7B05
A 3-bit binary counter has 8 states

Count	Bit 3	Bit 2	Bit 1
0	0	0	0
1	0	0	1
3	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

G7B06
A shift register is a clocked array of circuits that passes data in steps along the array.



G7B07
The basic components of virtually all sine wave oscillators is a filter and an amplifier operating in a feedback loop.

> *Any amplifier that operates with positive (in phase) feed back will oscillate. Remember the squeal from a public address system when the microphone gets too close to the speaker? That is an oscillator.*

G7B08
The efficiency of an RF power amplifier is determined by dividing the RF output power by the DC input power.

> *Example: A 100 watt 2 meter power amplifier that draws 10 amperes from a 13.8 Volt Power supply has an efficiency of 72%.*

*Efficiency = 100 watts / (13.8 * 10) or Efficiency = 100/138 or Efficiency = 72%*

G7B09
The inductance and capacitance in an LC oscillator tank circuit determines the frequency of oscillation.

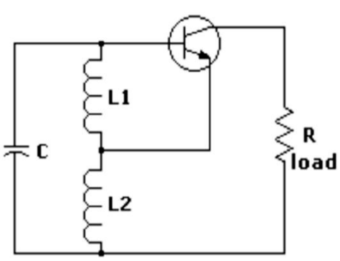


Figure 1 - schematic of a hartley oscillator

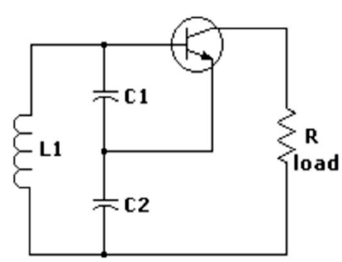
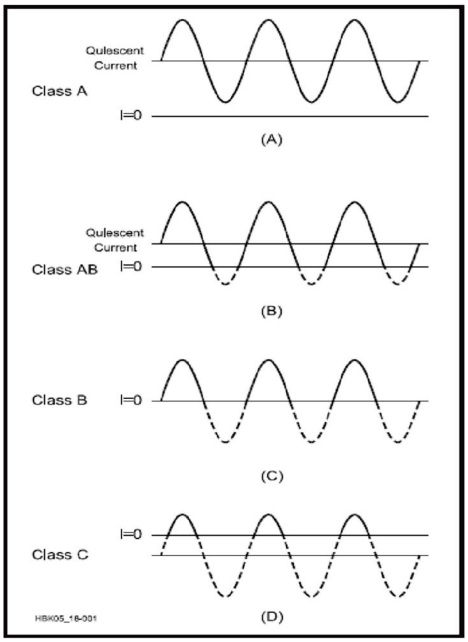


Figure 2 - schematic of a collpitts oscillator

Amplifier types or classes

Power amplifiers are categorized by their power level, intended frequencies of operation, device type, class of operation and circuit configuration.

***CLASSES OF OPERATION** (A AB, B &C)*



The class of operation of an amplifier stage is defined by its conduction angle, the angular portion of the drive cycle, in degrees, during which plate current (or collector or drain current in the case of transistors) flows. This, in turn, determines the amplifier's gain, efficiency, linearity and input and output impedances.

***Class A:** The conduction angle is 360º. DC bias and RF drive level are set so that the device is not driven to output current cutoff at any point in the driving-voltage cycle, so some device output current flows throughout the complete 360º of the cycle. Output voltage is generated by the variation of output current flowing through the load resistance. Maximum linearity and gain are achieved in a Class A amplifier, but the efficiency of the stage is low. Maximum theoretical efficiency is 50%, but 25 to 30% is more common in practice.*

***Class AB**: The conduction angle is greater than 180º but less than 360º. In other words, dc bias and drive level are adjusted so device output current flows during appreciably more than half the drive cycle, but less than the whole drive cycle. Efficiency is much better than Class A, typically reaching 50-60% at peak output power. Class AB linearity and gain are not as good as that achieved in Class A, but are very acceptable for even the most rigorous high-power SSB applications in Amateur Radio.*

***Class B:** Conduction angle = 180º. Bias and RF drive are set so that the device is just cut off with no signal applied (see Fig 18.1C), and device output current flows during one half of the drive cycle. Efficiency commonly reaches as high as 65%, with fully acceptable linearity.*

***Class C:** The conduction angle is much less than 180º—typically 90º. DC bias is adjusted so that the device is cut off when no drive signal is applied. Output current flows only during positive crests in the drive cycle, so it consists of pulses at the drive frequency. Efficiency is relatively high— up to 80%—but linearity is extremely poor. Thus Class C amplifiers are not suitable for amplification of amplitude modulated signals such as SSB or AM, but are quite satisfactory for* *use in on off keyed stages or with frequency or phase modulation. Gain is lower than for the previous classes of operation, typically 10-13 dB.*

G7B10
A characteristic of a Class A amplifier is Low distortion.

This is because 100 % or the waveform is amplified.

G7B11
A Class C power stage is appropriate for amplifying a CW modulated signal.

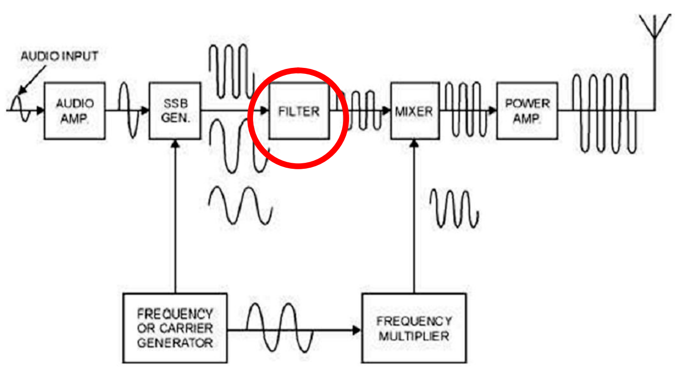
G7B12
A Class C amplifier has the highest efficiency.

G7B13
The reason for neutralizing the final amplifier stage of a transmitter is to eliminate self-oscillations.

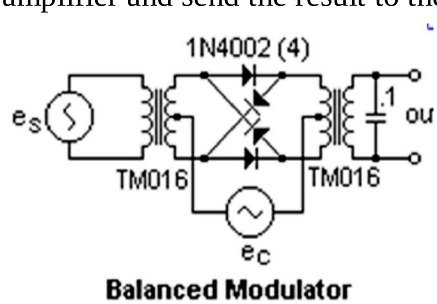
G7B14 (B)
A linear amplifier is an amplifier in which the output preserves the input waveform.

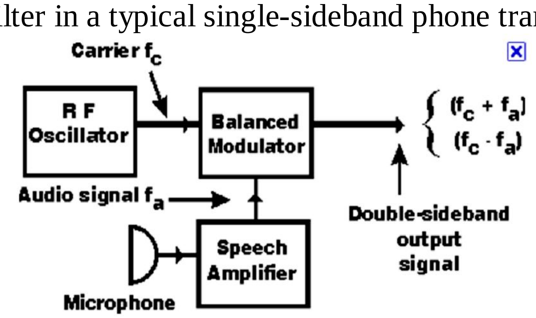
G7C - Receivers and transmitters; filters, oscillators

G7C01 (B)
A Filter is used to process signals from the balanced modulator and send them to the mixer in a single-sideband phone transmitter.

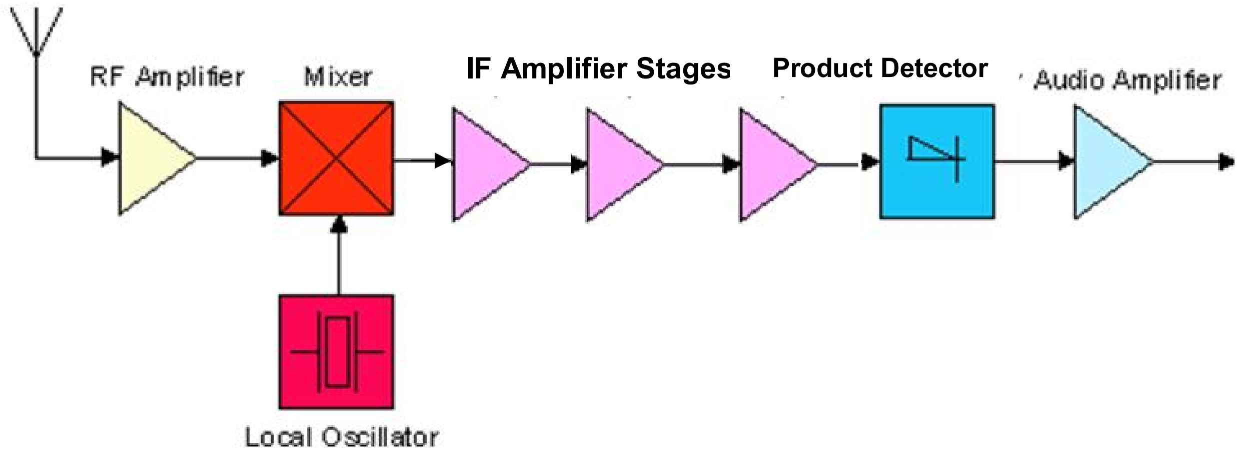


G7C02 (D)
A Balanced modulator circuit is used to combine signals from the carrier oscillator and speech amplifier and send the result to the filter in a typical single-sideband phone transmitter.

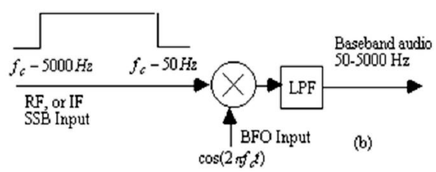


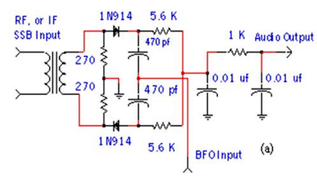


G7C03
In a superheterodyne receiver the mixer circuit is used to process signals from the RF amplifier and local oscillator and send the result to the IF filter.

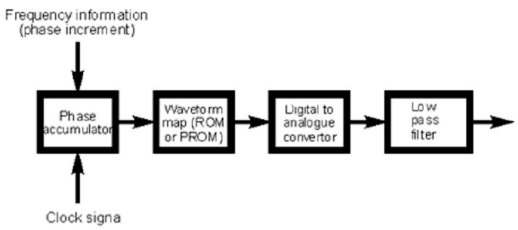


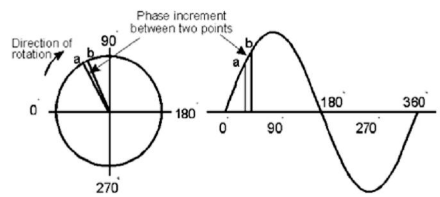
G7C04
The product detector circuit is used to combine signals from the IF amplifier and BFO and send the result to the AF amplifier in a single-sideband receiver.





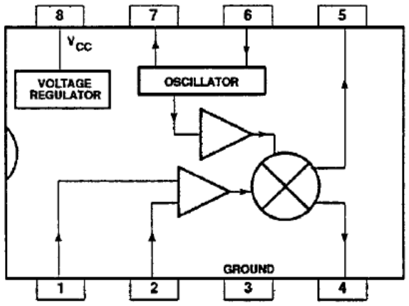
G7C05
An advantage of a transceiver controlled by a direct digital synthesizer (DDS) is Variable frequency with the stability of a crystal oscillator.

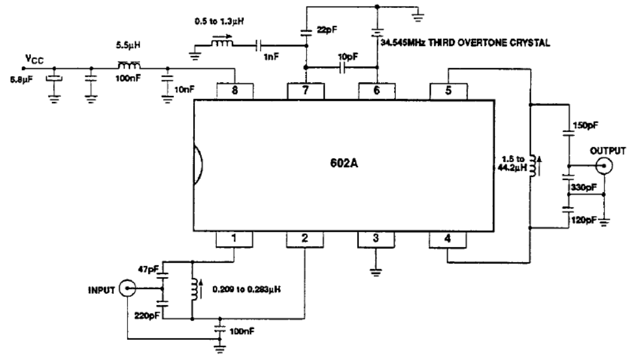




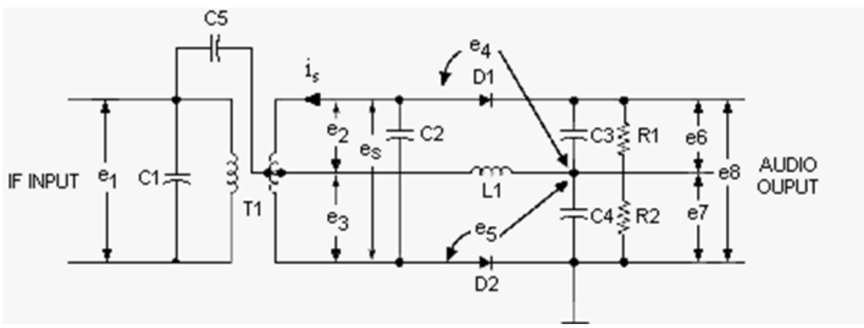
G7C06
The impedance of a low-pass filter should be about the same as the impedance of the transmission line into which it is inserted.

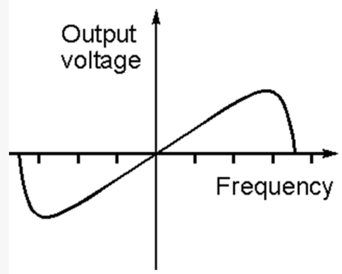
G7C07
The simplest combination of stages that implement a superheterodyne receiver would be an HF oscillator, mixer, and detector





G7C08 (D)
A discriminator circuit is used in many FM receivers to convert signals coming from the IF amplifier to audio.



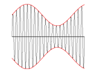


G7C09 (D)
The following is needed for a Digital Signal Processor IF filter:

- An analog to digital converter
- A digital processor chip
- A digital to analog converter

G7C10 (B)
Digital Signal Processor filtering is accomplished by converting the signal from analog to digital and using digital processing.

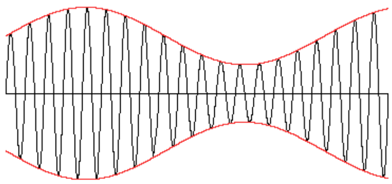
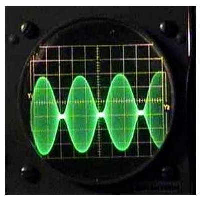
G7C11 (A)
A "software Defined Radio" (SDR) is a radio in which most major signal processing functions are performed by software.



SUBELEMENT G8 – SIGNALS AND EMISSIONS
[2 Exam Questions – 2 Groups]

G8A - Carriers and modulation: AM; FM; single and double sideband; modulation envelope; overmodulation

G8A01
Amplitude modulation is the name of the process that changes the envelope of an RF wave to carry information.

G8A02
The name of the process that changes the phase angle of an RF wave to convey information is phase modulation (PM).

G8A03
The name of the process which changes the frequency of an RF wave to convey information is frequency modulation (FM).

G8A04
Phase modulation (PM) emission is produced by a reactance modulator connected to an RF power amplifier.

G8A05
Amplitude modulation (AM) modulation varies the instantaneous power level of the RF signal.

G8A06
One advantage of carrier suppression in a single-sideband phone transmission is that the available transmitter power can be used more effectively.

G8A07
Single Sideband phone emission uses the less frequency bandwidth than Double sideband, Frequency or phase modulation.

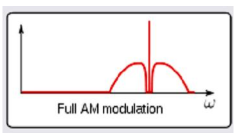
G8A08 (D)
Over-modulation causes you signal to occupy excessive bandwidth.

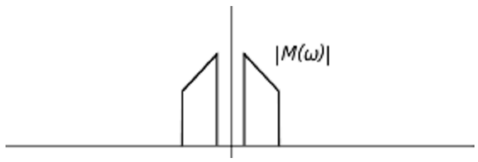
G8A09
Transmit audio or microphone gain controls are typically adjusted for proper ALC setting on an amateur single sideband transceiver.

G8A10
Signal distortion caused by excessive drive is caused by flat-topping of a single-sideband phone transmission.

G8A11
The carrier frequency changes proportionally to the instantaneous amplitude of the modulating signal when a modulating audio signal is applied to an FM transmitter.

G8A12
Both upper and lower sidebands signal(s) would be found at the output of a properly adjusted balanced modulator.





G8B - Frequency mixing; multiplication; HF data communications; bandwidths of various modes; deviation

G8B01
In a receiver the Mixer stage combines a 14.250 MHz input signal with a 13.795 MHz oscillator signal to produce a 455 kHz intermediate frequency (IF) signal.

In a mixer the output is the sum and the difference of the two applied signals:
The sum would be 14.250 + 13.795 or 28.045 MHz
The sum would be 14.250 - 13.795 or 0 .455 MHz
The Sum frequency is much higher than the IF amplifier bass band and would be rejected, only the difference frequency would match the 455 KHz IF amplifier pass band frequency

G8B02
If a receiver mixes a 13.800 MHz VFO with a 14.255 MHz received signal to produce a 455 kHz intermediate frequency (IF) signal, an interfering image response would be produced if a 13.345 MHz signal were present at the antenna input to the receiver.

This is because both the 14.255 and 13.345 signals would produce a difference frequency of 455 KHz in the mixer. To prevent this many receivers use a tuned preamplifier before the mixer input (sometimes called a preselector).

G8B03
Heterodyning is another term for the mixing of two RF signals.

G8B04
The multiplier stage in a VHF FM transmitter generates a harmonic of a lower frequency signal to reach the desired operating frequency.

G8B05
Frequency modulated (FM) phone is not used below 29.5 MHz because the wide bandwidth it requires is prohibited by FCC rules.

G8B06
The total bandwidth of an FM-phone transmission having a 5 kHz deviation and a 3 kHz modulating frequency is 16 KHz.

> *Total Bandwidthis equal to the peak devation + the highest modulating frequency times 2 (because the FM signal is symetrical about the carrier frequency). In this example the total bandwidth would be (5 KHz + 3KHz) * 2 or (8 KHz) *2 or 16 KHz*

G8B07
The required frequency deviation for a 12.21-MHz reactance-modulated oscillator in a 5-kHz deviation, 146.52-MHz FM-phone transmitter would be 416.7 Hz.

> *Since the FM deviation is also multiplied, there will be much less than 5 KHz deviation on the oscillator that is being multiplied up to the transmit frequency. The multiplier would be 146.52 MHz divided by 12.21 MHz or 12. Therefore if we desired 5 KHz of deviation at 146.52 would only need 1/12 of that at 12.21 or the required deviation would be 5,000 Hz divided by 12 or 416.66 Hertz.*

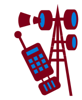
G8B08
It important to know the duty cycle of the data mode you are using when transmitting because some modes have high duty cycles which could exceed the transmitter's average power rating.

G8B09
It good to match receiver bandwidth to the bandwidth of the operating mode, because it results in the best signal to noise ratio.

G8B10
The number 31 represents the approximate transmitted symbol rate in PSK31.

G8B11
Forward error correction allows the receiver to correct errors in received data packets by transmitting redundant information with the data.

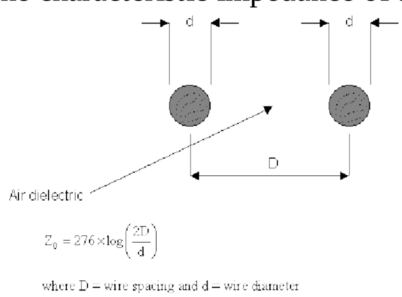
G8B12
The relationship between transmitted symbol rate and bandwidth is that higher symbol rates require higher bandwidth.

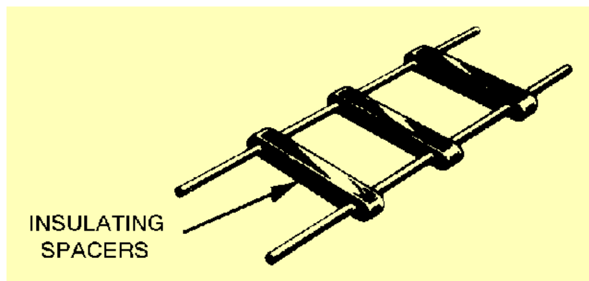


SUBELEMENT G9 – ANTENNAS AND FEED LINES
[4 Exam Questions – 4 Groups]

G9A - Antenna feed lines: characteristic impedance, and attenuation; SWR calculation, measurement and effects; matching networks

G9A01
The distance between the centers of the conductors and the radius of the conductors determine the characteristic impedance of a parallel conductor antenna feed line.





G9A02
The typical characteristic impedances of coaxial cables used for antenna feed lines at amateur stations are 50 and 75 ohms.

G9A03
The characteristic impedance of flat ribbon TV type twinlead is 300 ohms.

G9A04
The reason for reflected power at the point where a feed line connects to an antenna is a difference between the feed-line impedance and antenna feed-point impedance.

G9A05
The attenuation of coaxial cable increases as the frequency of the signal it is carrying increases.

G9A06 (D)
The values are RF feed line losses usually expressed in dB per 100 ft *(at a specified frequency)*.

G9A07
The antenna feed-point impedance must be matched to the characteristic impedance of the feed line to prevent standing waves on the antenna feed line.

G9A08
If the SWR on an antenna feed line is 5 to 1, and a matching network at the transmitter end of the feed line is adjusted to 1 to 1 SWR, the resulting SWR on the feed line will be 5 to 1.

The antenna tuner allows the transmitter to see a matched impedance so that it can deliver full power. It does not change the antenna or feedline impedance on its output.

G9A09
A standing wave ratio of 4:1 will result from the connection of a 50-ohm feed line to a non-reactive load having 200-ohm impedance.

SWR= Z_1 / Z_2 or 200 / 50 or 4:1 VSWR

G9A10
A standing wave ratio of 5:1 will result from the connection of a 50-ohm feed line to a non-reactive load having 10-ohm impedance.

SWR= Z_1 / Z_2 or 50 / 10 or 5:1 VSWR

G9A11
A standing wave ratio of 1:1 will result from the connection of a 50-ohm feed line to a non-reactive load having 50-ohm impedance.

SWR= Z_1 / Z_2 or 50 / 50 or 1:1 VSWR

G9A12
The SWR if you feed a vertical antenna that has a 25-ohm feed-point impedance with 50-ohm coaxial cable would be 2:1.

SWR= Z_1 / Z_2 or 50 / 25 or 2:1 VSWR

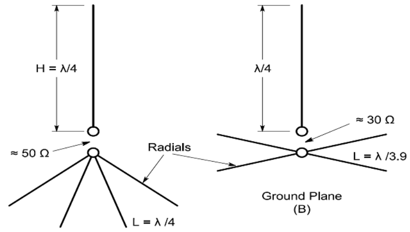
G9A13
The SWR if you feed an antenna that has a 300-ohm feed-point impedance with 50-ohm coaxial cable would be 6:1.

SWR= Z_1 / Z_2 or 300 / 50 or 6:1 VSWR

G9B - Basic antennas

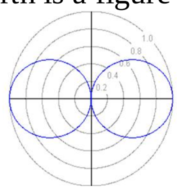
G9B01
One disadvantage of a directly fed random-wire antenna is that you may experience RF burns when touching metal objects in your station.

G9B02
An advantage of downward sloping radials on a quarter wave ground-plane antenna is that they bring the feed-point impedance closer to 50 ohms.

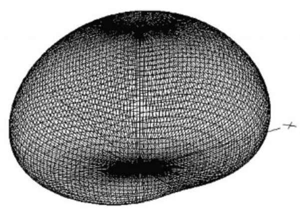


G9B03
The feed-point impedance of a ground-plane antenna increases when its radials are changed from horizontal to downward-sloping.

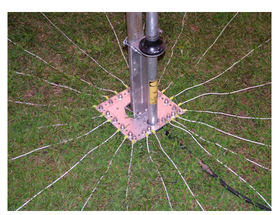
G9B04
The low angle azimuthal radiation pattern of an ideal half-wavelength dipole antenna installed 1/2 wavelength high and parallel to the Earth is a figure-eight at right angles to the antenna.



G9B05
If a HF dipole antenna is less than 1/2 wavelength high, the horizontal (azimuthal) radiation pattern is almost omnidirectional.



G9B06
The radial wires of a ground-mounted vertical antenna system should be on the surface or buried a few inches below the ground on the surface or buried a few inches below the ground.



G9B07
The feed-point impedance of a 1/2 wave dipole antenna steadily decreases as the antenna is lowered from 1/4 wave above ground.

G9B08
The feed-point impedance of a 1/2 wave dipole steadily increases as the feed-point location is moved from the center toward the ends.

G9B09
An advantage of a horizontally polarized as compared to vertically polarized HF antenna is Lower ground reflection losses.

G9B10
The approximate length for a 1/2-wave dipole antenna cut for 14.250 MHz is 32 feet.

Calculate ½ wavelength in feet by dividing 468 by the frequency in MHz. In this question it would be 468 / 14.250 or 32.8 Feet

G9B11
The approximate length for a 1/2-wave dipole antenna cut for 3.550 MHz is 131 feet.

Calculate ½ wavelength in feet by dividing 468 by the frequency in MHz. In this question it would be 468 / 3.550 or 131.8 Feet

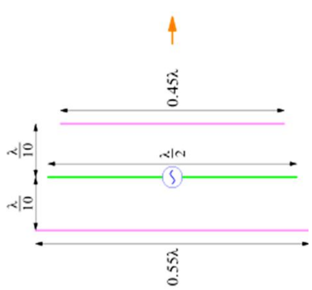
G9B12
The approximate length for a 1/4-wave vertical antenna cut for 28.5 MHz is 8 feet.

Calculate ½ wavelength in feet by dividing 468 by the frequency in MHz. In this question it would be 468 / 28.5 or 16.4 Feet. A ¼ wave antenna would be ½ of the length of a ½ wave antenna or in this case 16.4 / 2 or 8.2 feet

G9C - Directional antennas

G9C01
Larger diameter elements would increase the bandwidth of a Yagi antenna.

G9C02
The approximate length of the driven element of a Yagi antenna is 1/2 wavelength.



G9C03
In a three-element, single-band Yagi antenna the director is normally the shortest parasitic element.

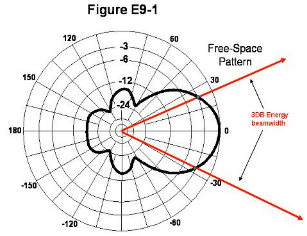
G9C04
In a three-element; single-band Yagi antenna the reflector is normally the longest parasitic element.

G9C05
Increasing boom length and adding directors to a Yagi antenna increases the gain.

G9C06 A Yagi antenna is often used for radio communications on the 20 meter band because it helps reduce interference from other stations to the side or behind the antenna.

G9C07
The power radiated in the major radiation lobe compared to the power radiated in exactly the opposite direction is the "front-to-back ratioò in a Yagi antenna, usually expressed in dB.

Figure E9-1



G9C08
The "main lobe" of a directive antenna is the direction of maximum radiated field strength from the antenna.

G9C09
The approximate maximum theoretical forward gain of a three element, single-band Yagi antenna is 9.7 dBi.

dBi refers to a reference level of dB Intrinsic which is the signal strength from an ideal point source of energy that radiates equally in all directions in a sphere surrounding the point RF source.

SPHERE (Isotropic source)

G = 0 dB

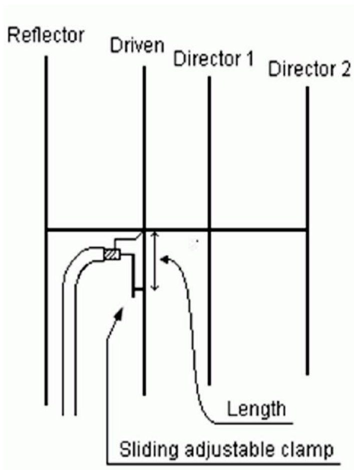
Since it is not practical to build an isotropic source many antenna gains are referenced to a dipole, which has 2.14 dB gain over a theoretical isotropic source. In this question the gain over a dipole would be (9.7 dB – 2.14 db) or a gain of 7.56 dB over a dipole. Giving gain in dBi makes the antenna look better. When comparing antennas be sure you know what the gain number is referenced to so the comparison is between equals.

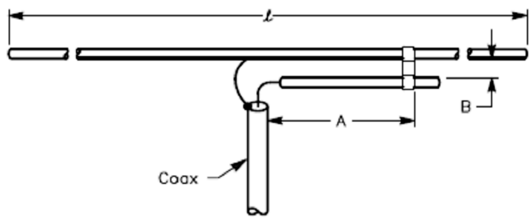
G9C10
In a Yagi antenna design the following variables could be adjusted to optimize forward gain, front-to-back ratio, and SWR bandwidth:

- The physical length of the boom

- The number of elements on the boom
- The spacing of each element along the boom

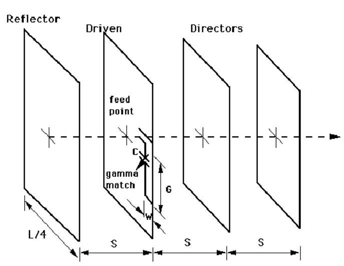
G9C11
The purpose of a gamma match used with Yagi antennas is to match the relatively low feed-point impedance to 50 ohms.





G9C12
An advantage of using a gamma match for impedance matching of a Yagi antenna to 50-ohm coax feed line is that it does not require that the elements be insulated from the boom.

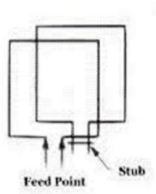
G9C13
Each side of a quad antenna driven element is approximately 1/4 wavelength.



G9C14
The forward gain of a two-element quad antenna is about the same as the forward gain of a three-element Yagi antenna.

G9C15
Each side of a quad antenna reflector element is slightly more than 1/4 wavelength.

G9C16
The gain of a two-element delta-loop beam is about the same as the gain of a two-element quad antenna.



G9C17
Each leg of a symmetrical delta-loop antenna is approximately 1/3 wavelength

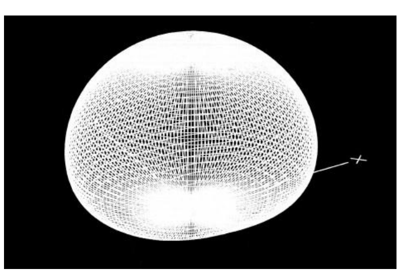
G9C18
If the feed point of a quad antenna is changed from the center of the either horizontal wire to the center of either vertical wire the polarization of the radiated signal changes from horizontal to vertical.

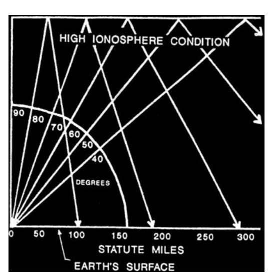
G9C19
The reflector element must be approximately 5% longer than the driven element loop for a two-element quad antenna to operate as a beam antenna.

G9C20
The gain of two 3-element horizontally polarized Yagi antennas spaced vertically 1/2 wavelength apart typically provides 3 dB of gain more than a single 3-element Yagi

G9D - Specialized antennas

G9D01
The term "NVIS" as related to antennas refers to Near Vertical Incidence Sky wave propagation.

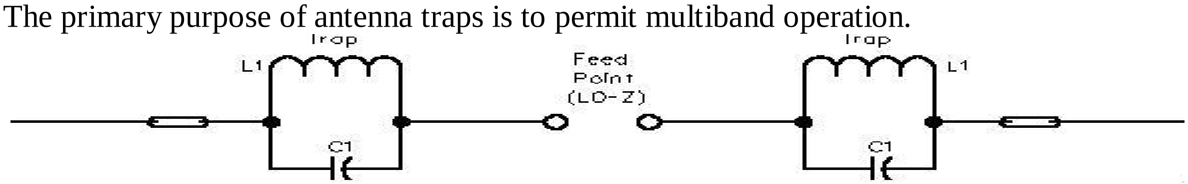




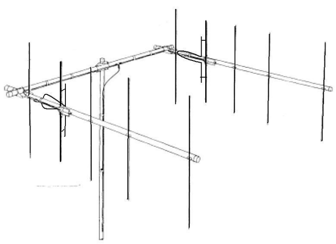
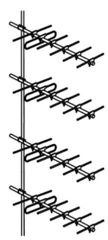
G9D02
The advantage of an NVIS antenna is high vertical angle radiation for working stations within a radius of a few hundred kilometers.

G9D03
An NVIS antenna is typically installed at a height between 1/10 and 1/4 wavelength above the ground.

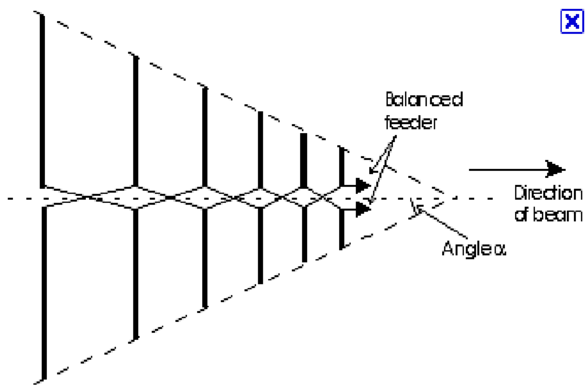
G9D04
The primary purpose of antenna traps is to permit multiband operation.



G9D05
The advantage of vertical stacking of horizontally polarized Yagi antennas is it narrows the main lobe in elevation.

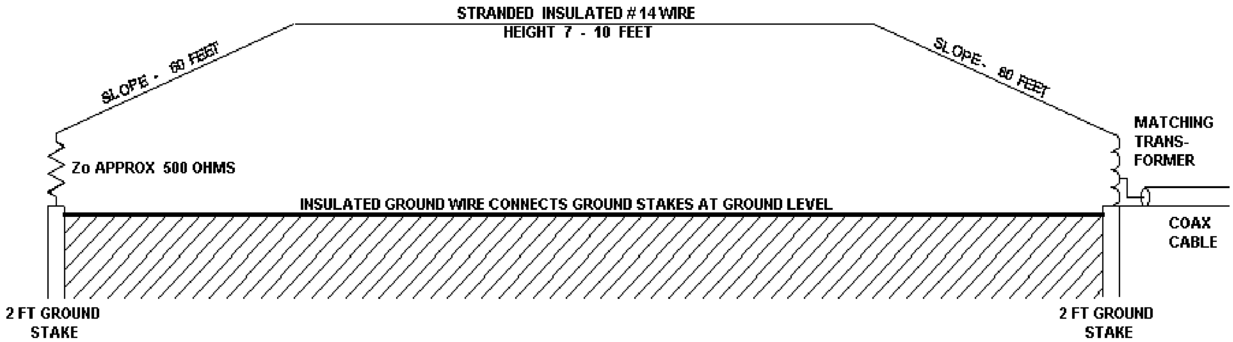




G9D06
An advantage of a log periodic antenna is Wide bandwidth.



G9D07
In a log periodic antenna, length and spacing of the elements increases logarithmically from one end of the boom to the other.

G9D08
A Beverage antenna is not used for transmitting because it has high losses compared to other types of antennas.



G9D09
Directional receiving for low HF bands an application for a Beverage antenna.

G9D10
A Beverage antenna is a very long and low directional receiving antenna.

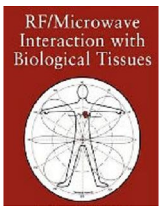
G9D11
A disadvantage of multiband antennas is they have poor harmonic rejection.

SUBELEMENT G0 – ELECTRICAL AND RF SAFETY

[2 Exam Questions – 2 Groups]

G0A - RF safety principles, rules and guidelines; routine station evaluation

G0A01
RF energy can affect human body tissue by heating it.



G0A02
The following properties are important in estimating whether an RF signal exceeds the maximum permissible exposure (MPE):

- Its duty cycle
- Its frequency
- Its power density

G0A03 [97.13(c)(1)]
You can determine that your station complies with FCC RF exposure regulations:

- By calculation based on FCC OET Bulletin 65.
- By calculation based on computer modeling.
- By measurement of field strength using calibrated equipment.

See MPE evaluation check list in appendix

G0A04
"Time averaging" in reference to RF radiation exposure means the total RF exposure averaged over a certain time.

G0A05
If an evaluation of your station shows RF energy radiated from your station exceeds permissible limits you must take action to prevent human exposure to the excessive RF fields.

G0A06
Operators of any transmitter that contributes 5% or more of the MPE at a multiple user site are responsible for RF safety compliance.

G0A07
A lower transmitter duty cycle permits greater short-term exposure levels when evaluating RF exposure.

G0A08
An amateur operator must perform a routine RF exposure evaluation to ensure compliance with RF safety regulations when transmitter power exceeds levels specified in part 97.13.

G0A09
A calibrated field-strength meter with a calibrated antenna can be used to accurately measure an RF field.

G0A10
If evaluation shows that a neighbor might receive more than the allowable limit of RF exposure from the main lobe of a directional antenna you should take precautions to ensure that the antenna cannot be pointed in their direction

G0A11
If you install an indoor transmitting antenna make sure that MPE limits are not exceeded in occupied areas.

G0A12
Whenever you make adjustments or repairs to an antenna turn off the transmitter and disconnect the feed line.

G0A13
When installing a ground-mounted antenna it should be installed so no one can be exposed to RF radiation in excess of maximum permissible limits

G0B - Safety in the ham shack: electrical shock and treatment, safety grounding, fusing, interlocks, wiring, antenna and tower safety

G0B01
Only the hot wires in a four-conductor line cord should be attached to fuses or circuit breakers in a device operated from a 240-VAC single-phase source.

G0B02
AWG number 12 is the minimum wire size that may be safely used for a circuit that draws up to 20 amperes of continuous current.

Wire-size-amp chart for home

Copper wire size	Ampacity of wire
18	Lamp cord
16	Toaster cord
14	15 Amps
12	20
10	30
8	50
6	65 Amps
4	85
3	100
2	115
1	130
1/0	150
2/0	175
3/0	200
4/0	230

G0B03
A 15 amperes fuse or circuit breaker would be appropriate to use with a circuit that uses AWG number 14 wiring.

G0B04
A primary reason for not placing a gasoline-fueled generator inside an occupied area is the danger of carbon monoxide poisoning.

G0B05
Current flowing from one or more of the hot wires directly to ground will cause a Ground Fault Circuit Interrupter (GFCI) to disconnect the 120 or 240 Volt AC line power to a device.

G0B06
The metal enclosure of every item of station equipment should be grounded to ensure that hazardous voltages cannot appear on the chassis.

G0B07
When climbing on a tower using a safety belt or harness always attach the belt safety hook to the belt D-ring with the hook opening away from the tower.

G0B08
Any person preparing to climb a tower that supports electrically powered devices should make sure all circuits that supply power to the tower are locked out and tagged

G0B09
Because a soldered joint will likely be destroyed by the heat of a lightning strike soldered joints not be used with the wires that connect the base of a tower to a system of ground rods.

G0B10
A danger from lead-tin solder is that lead can contaminate food if hands are not washed carefully after handling.

G0B11
Good engineering practice for lightning protection grounds is that they must be bonded together with all other grounds.

G0B12
The purpose of a transmitter power supply interlock is to ensure that dangerous voltages are removed if the cabinet is opened

G0B13
When powering your house from an emergency generator you must disconnect the incoming utility power feed.

G0B14
Electrical safety inside the ham shack is covered by the National Electrical Code.

G0B15
When planning an emergency generator installation the generator should be located in a well ventilated area

G0B16
When being charged a lead acid storage battery may give off explosive hydrogen gas.

Appendix

Of Useful Information

- Parallel and series resistors, capacitors and inductors, AC reactance Page 79
- International System of Units (SI)—Metric Units Page 80
- The Decibel or dB Page 81
- Transformers Page 82
- The Ohms Law Circle Page 84
- Digital Circuits Page 85
- MPE Decision Tree Page 86
- VSWR Table Page 87

Ohms Law

I=E/R	R=E/I	E=I * R	(Amperes ï Volts-Ohms)
P=E * I	P= E^2 /R	I= P/E	(amperes-volts-ohms-watts)

Series connected Resistors

R = R1 + R2 + R3 + Rx

Parallel connected Resistors

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \text{é ..} \frac{1}{R_x}}$$

Series inductors

Total Inductance = $L_1 + L_2 + L_3 + L_x$

Parallel inductors

$$L = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \text{é ..} \frac{1}{L_x}}$$

Capicators in parallel

$C = C_1 + C_2 + C_3 + C_x$

Capacitors in series

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \text{é ..} \frac{1}{C_x}}$$

Reactance

Reactance is the equivalent AC resistance of a capacitor or inductor at a given frequency

For an inductor, X_L =2´ FL

X_L =2´ FL frequency is in Hertz and Inductance is in Henries. or Mili-Henries and Kilo-Hertz or Micro-Henries and Megahertz

Example 20 mH inductor at 3.5 KHz
XL =2´ FL = 6.28 x .02 x 3,500 = 6.28x 70 = 439.8 Ý (Ohms and Henries)

For a capacitor
Reactance (Xc) is equal to 1/ (2π FC) frequency is in Hertz and Capacitance is in Farads. or Microfarads and Megahertz

Example 20 µF Capacitor at 3.5 KHz
Xc =1/(2πFC) = 1/(6.28 x .000,020 x 3,500) = 1/(6.28x .07) = 2.27 Ý (ohms and Farads)

International System of Units (SI)—Metric Units Table

International System of Units (SI)—Metric Units

Prefix	Symbol	Multiplication Factor
exe	E	10+18 1,000,000 000,000,000,000
peta	P	10+15 1,000 000,000,000,000
tera	T	10+12 1,000,000,000,000
giga	G	10+9 1,000,000,000
mega	M	10+6 1,000,000
kilo	k	10+3 1,000
hecto	h	10+2 100
deca	da	10+1 10
(unit)		10+0 1
deci	d	10-1 0.1
centi	c	10-2 0.01
milli	m	10-3 0.001
micro	µ	10-6 0.000001
nano	n	10-9 0.000000001
pico	p	10-12 0.000000000001
femto	f	10-15 0.000000000000001
atto	a	10-18 0.000000000000000001

The Decibel or dB

Many times in electronics is necessary to compare values that are quite far apart; to make this comparison we use a term called the Decibel or dB. If we had a transmitter with a 1,000 watt of output power and a receiver with a 0.01 µwatt sensitivity the ratio between these two values would be 100 Billion to 1, which is a difficult number to work with. By expressing the value as an exponent we can make these large ratios more manageable (in the above 100 billion to one it would be 110 dB). Using dB values we can calculate the effect of gains and losses in networks.

The dB value for power in a network can be calculated using the following equation :

dB = 10 (log (power 1/ Power 2))

(use the base 10 logarithm key not natural log key on your calculator)

Examples:

What is the ratio in db between power levels of 50 watts with 100 watts?

dB = 10 (log (P1/ P2)) or dB= 10(log(50/100)) or dB= 10 (Log(.5)) or dB=10(-.301) or dB =-3.01

What is the ratio in db between the power level of 100 watts with 50 watts?

dB=10 (log (P1/ P2)) or dB=10(log(100/50)) or dB=10 (Log(2)) or dB=10(301) or dB =3.01

What is the ratio in db between a power level of 85 watts with 13 watts?

dB=10 (log (P1/ P2)) or dB=10(log(85/13)) or dB=10 (Log(6.53)) or dB=10(.815) or dB =8.15

To find a ratio from a dB value take the db value, divide it by 10 then raise ten to that power (a log is an exponent of 10 that is why they are called base 10 logarithms.

Ratio = 10 ^(db/10)

Examples:

What is the ratio expressed by 15 dB?

Ratio = 10 ^(db/10) or Ratio = 10 ^(15/10) or Ratio = 10 ^(1.5) Ratio = 31.62

What is the ratio expressed by 2dB?

Ratio = 10 ^(db/10) or Ratio = 10 ^(2/10) or Ratio = 10 ^(.200) Ratio = 1.585

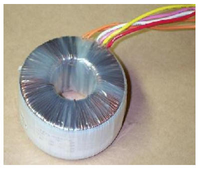
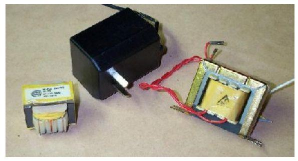
What is the radio expressed by -12dB

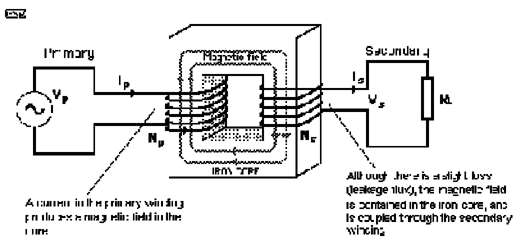
Ratio = 10 ^(dB/10) or Ratio = 10 ^(15/10) or R atio= 10 ^(-1.2) Ratio = .0631

To answer questions on the general exam you can remember the above equations and calculation s or remember a few simple db ratios that will get you through all the questions.

Gain (+)	dB	Loss (-)
x 1.2	1	**80%**
x 1.6	2	**63%**
x 2	3	**50%**
x 10	10	**10%**

Transformers



The magnitude of the voltage in the secondary is determined by a very simple formula, which determines the "turnôs ratio" (N) of the component - this is traditionally calculated by dividing the secondary turns by the primary turns ...

$$N = T_S / T_P$$

Tp is simply the number of turns of wire that make up the primary winding, and Ts is the number of turns of the secondary. A transformer with 500 turns on the primary and 50 turns on the secondary has a turns ratio of 1:10 (i.e. 1/10 or 0.1)

$$V_S = V_P * N$$

Mostly, you will never know the number of turns, but of course we can simply reverse the formula so that the turnôs ratio can be deduced from the primary and secondary voltages.

$$N = V_S / V_P$$

If a voltage of 240V (AC, naturally) is applied to the primary, we would expect 24V on the secondary, and this is indeed what will be measured. The transformer has an additional useful function - not only is the voltage "transformed", but so is the current.

$$I_s = I_p / N$$

If a current of 1A were drawn by the primary in the above example, then logically a current of 10A would be available at the secondary - the voltage is reduced, but current is increased. This would be the case if the transformer were 100% efficient, but even this - the most efficient "machine" we have - will sadly never be perfect.

How a Transformer Works

At no load, an ideal transformer draws virtually no current from the mains, since it is simply a large inductance. The whole principle of operation is based on induced magnetic flux, which not only creates a voltage (and current) in the secondary, but the primary as well! It is this characteristic that allows any inductor to function as expected, and the voltage generated in the primary is called a "back EMF" (electromotive force). The magnitude of this voltage is such that it almost equals (and is effectively in the same phase as) the applied EMF.

When you apply a load to the output (secondary) winding, a current is drawn by the load, and this is reflected through the transformer to the primary. As a result, the primary must now draw more current from the mains.

Now, another interesting fact about transformers can now be examined.

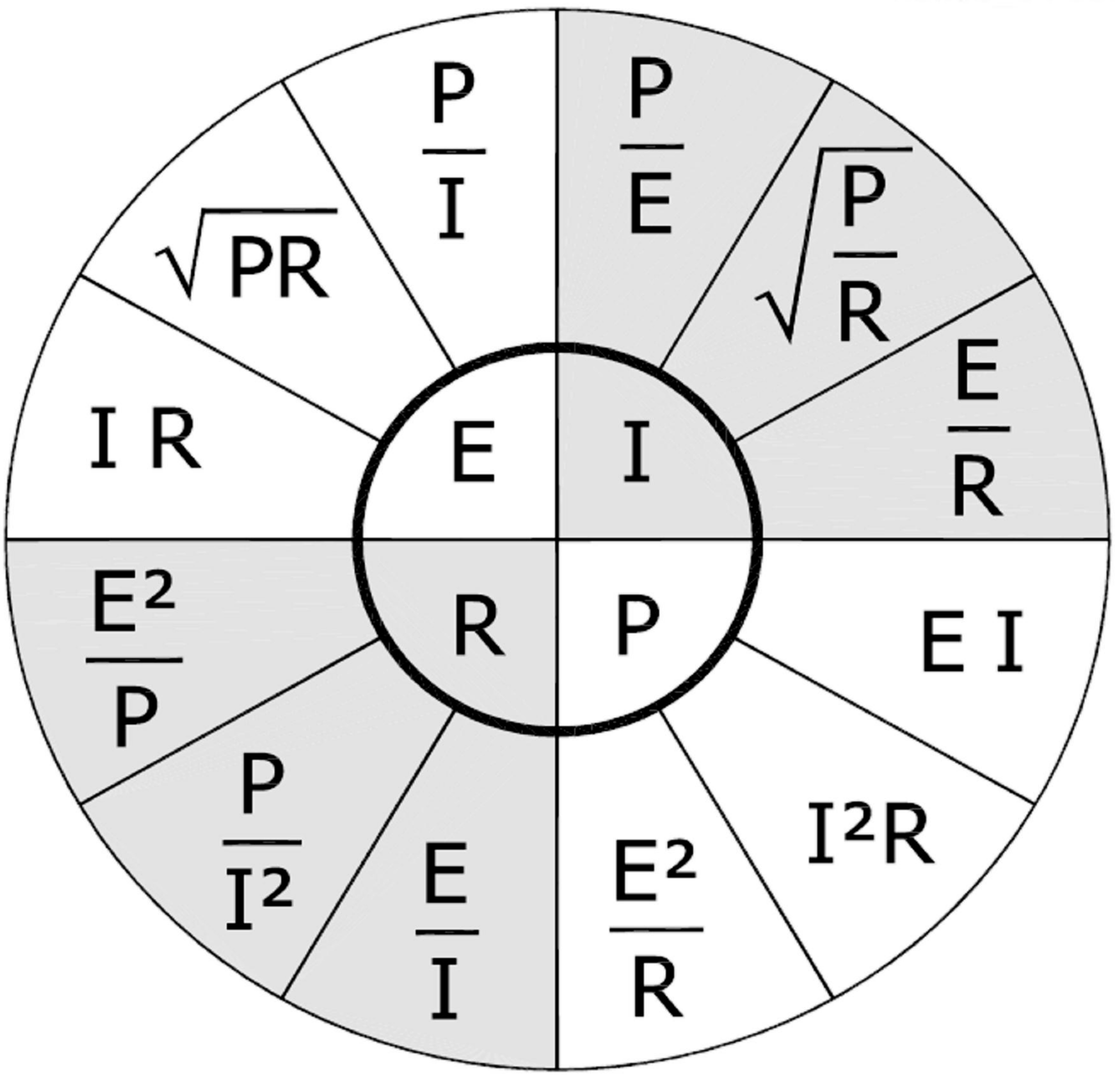
We will use the same example as above. A 240V primary draws 1A and the 24V secondary supplies 10A to the load. Using Ohm's law, the load resistance (impedance) is therefore 24/10 = 2.4 Ohms. The primary impedance must be 240/1 = 240 Ohms. This is a ratio of 100:1, yet the turns ratio is only 10:1 - what is going on?

The impedance ratio of a transformer is equal to the square of the turns ratio ...

$$Z\ \mathbf{ratio} = (\mathbf{T_{ratio}})^2$$

- The source of energy is usually connected to the primary winding of as transformer.
- When there is no current being drawn from the secondary of a transformer the current in the primary is called the magnetizing current.
- What is the voltage across the 500 turn secondary of a transformer with a 2250 turn primary connected to 120 VAC?
  Secondary Voltage = Primary voltage x turns ratio or V= 120 x 500/2250 or V=120 x .222 or V=26.67
- What is the turns ratio of a transformer used to match an audio amplifier having a 600 ohm output impedance with a speaker having a 4 ohm impedance?
  TR= ã (600/4) or TR = ã (150) or TR= 12.25:1

The Ohms Law Circle



Digital Circuits

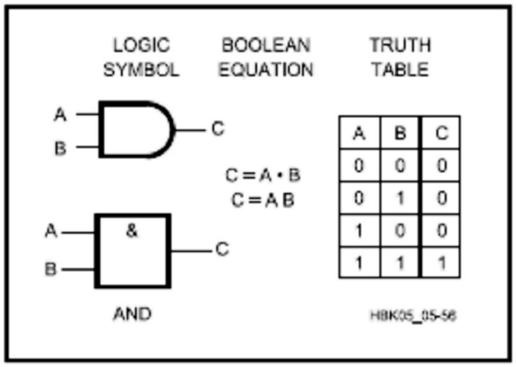


Fig 5.56 — Two-input AND gate.

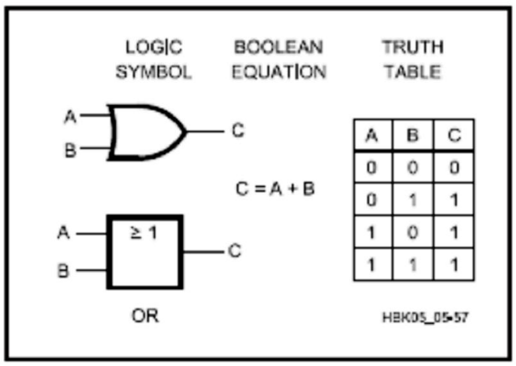


Fig 5.57 — Two-input OR gate.

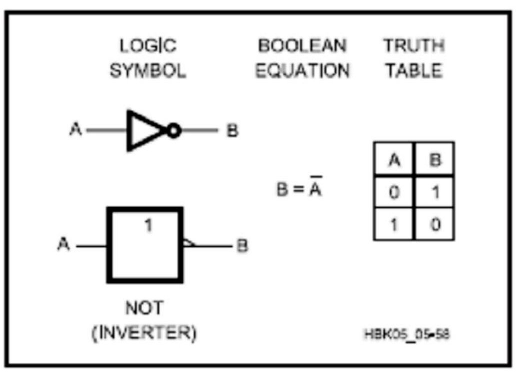


Fig 5.58 — Inverter.

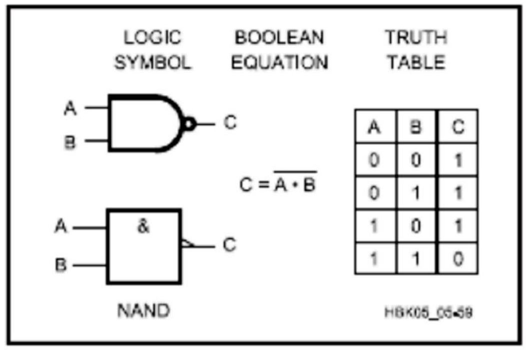


Fig 5.59 — Two-input NAND gate.

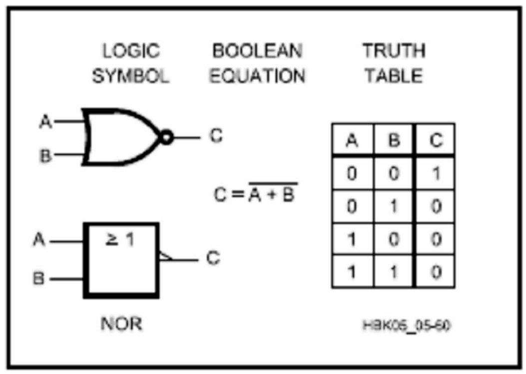


Fig 5.60 — Two-input NOR gate.

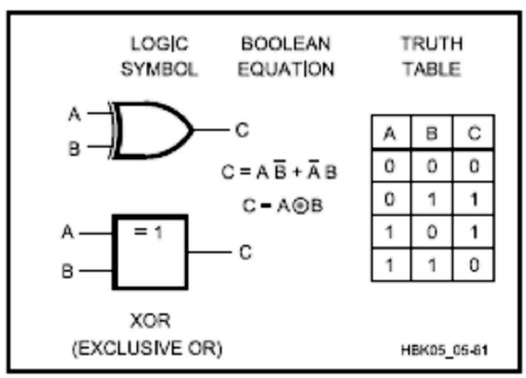
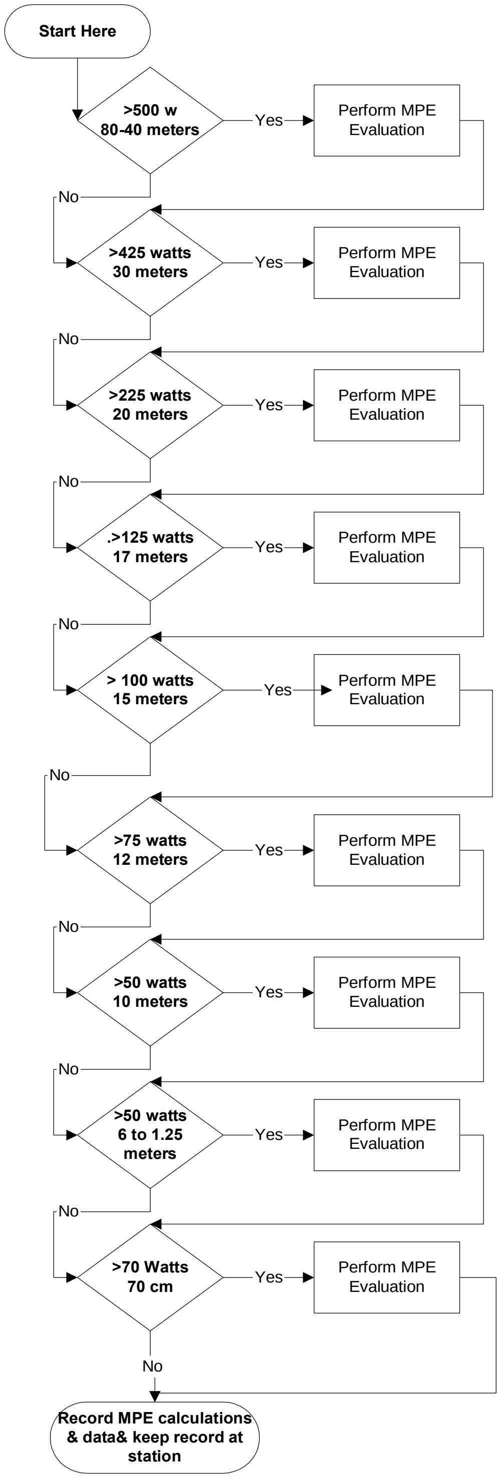


Fig 5.61 — Two-input XOR gate.

MPE Evaluation Decision Tree



Note- Decision for running MPE at any specific frequency is determined by the ERP which is the transmiter output power plus antenna gain minus any feed line losses, filter or other losses

Example: The ERP for a 200 watt transmitter on 80 meters with an antenna gain of 9dB, feedline loss of 1.5 db and a band pass filter wit a loss of 1.5 dB would hava an ERP of 800 watts and would requires an MPE evaluation

MPE = 200 watts +9dB -1.5 dB -1.5 dB or 200 watts with + 6db of gain. #db would be 2 times the power and an additional 3db to make 6 db would be times 2 again for a total of times 4. Withe the 200 watt input the ERP would be 4 x 200 or 800 watts. An MPE evaluation would be required

VSWR vs return loss – Reflected power and Transmission loss Table

VSWR	Return Loss (dB)	Reflected Power (%)	Transmiss. Loss (dB)	VSWR	Return Loss (dB)	Reflected Power (%)	Transmiss. Loss (dB)
1.00	oo	0.000	0.000	1.38	15.9	2.55	0.112
1.01	46.1	0.005	0.0002	1.39	15.7	2.67	0.118
1.02	40.1	0.010	0.0005	1.40	15.55	2.78	0.122
1.03	36.6	0.022	0.0011	1.41	15.38	2.90	0.126
1.04	34.1	0.040	0.0018	1.42	15.2	3.03	0.132
1.05	32.3	0.060	0.0028	1.43	15.03	3.14	0.137
1.06	30.7	0.082	0.0039	1.44	14.88	3.28	0.142
1.07	29.4	0.116	0.0051	1.45	14.7	3.38	0.147
1.08	28.3	0.144	0.0066	1.46	14.6	3.50	0.152
1.09	27.3	0.184	0.0083	1.47	14.45	3.62	0.157
1.10	26.4	0.228	0.0100	1.48	14.3	3.74	0.164
1.11	25.6	0.276	0.0118	1.49	14.16	3.87	0.172
1.12	24.9	0.324	0.0139	1.50	14.0	4.00	0.18
1.13	24.3	0.375	0.0160	1.55	13.3	4.8	0.21
1.14	23.7	0.426	0.0185	1.60	12.6	5.5	0.24
1.15	23.1	0.488	0.0205	1.65	12.2	6.2	0.27
1.16	22.6	0.550	0.0235	1.70	11.7	6.8	0.31
1.17	22.1	0.615	0.0260	1.75	11.3	7.4	0.34
1.18	21.6	0.682	0.0285	1.80	10.9	8.2	0.37
1.19	21.2	0.750	0.0318	1.85	10.5	8.9	0.40
1.20	20.8	0.816	0.0353	1.90	10.2	9.6	0.44
1.21	20.4	0.90	0.0391	1.95	09.8	10.2	0.47
1.22	20.1	0.98	0.0426	2.00	09.5	11.0	0.50
1.23	19.7	1.08	0.0455	2.10	09.0	12.4	0.57
1.24	19.4	1.15	0.049	2.20	08.6	13.8	0.65
1.25	19.1	1.23	0.053	2.30	08.2	15.3	0.73
1.26	18.8	1.34	0.056	2.40	07.7	16.6	0.80
1.27	18.5	1.43	0.060	2.50	07.3	18.0	0.88
1.28	18.2	1.52	0.064	2.60	07.0	19.5	0.95
1.29	17.9	1.62	0.068	2.70	06.7	20.8	1.03
1.30	17.68	1.71	0.073	2.80	06.5	22.3	1.10
1.31	17.4	1.81	0.078	2.90	06.2	23.7	1.17
1.32	17.2	1.91	0.083	3.00	06.0	24.9	1.25
1.33	17.0	2.02	0.087	3.50	05.1	31.0	1.61
1.34	16.8	2.13	0.092	4.00	04.4	36.0	1.93
1.35	16.53	2.23	0.096	4.50	03.9	40.6	2.27
1.36	16.3	2.33	0.101	5.00	03.5	44.4	2.56
1.37	16.1	2.44	0.106	6.00	02.9	50.8	3.08